CIO 2014

XX ICIEOM 2014

Institute of Industrial Engineers

THE GLOBAL REACH OF INDUSTRIAL ENGINEERING. ENHANCING SYNERGIES IN A COLLABORATIVE ENVIRONMENT

Book of Proceedings of the

8th International Conference on Industrial Engineering and Industrial Management

XX International Conference on Industrial Engineering and Operations Management

International IIE Conference 2014

ADINGOR Asociación para el Desarrollo de la Ingeniería de Organización

ABEPRO Associação Brasileira de Engenharia de Produção

Institute of Industrial Engineers

Andalucía Tech

The Global Reach of Industrial Engineering.
Enhancing Synergies in a Collaborative Environment

BOOK OF PROCEEDINGS

8th International Conference on Industrial Engineering and Industrial Management

XX International Conference on Industrial Engineering and Operations Management

International IIE Conference 2014

Málaga, Spain.

July 23-25, 2014

Tittle / Título de la obra:

“The Global Reach of Industrial Engineering. Enhacing Synergies in a Collaborative Environment”. Book of Proceedings of the 8th International Conference on Industrial Engineering and Industrial Management – XVIII Congreso de Ingeniería de Organización – XX International Conference on Industrial Engineering and Operations Management – International IIE Conference 2014.

Editors / Editores:

Elvira Maeso González
Pablo Cortés Achedad

Andalucía Tech
Universidad de Sevilla
Universidad de Málaga

Legal Deposit/Depósito Legal
ISBN-13978-84-616-9935-3

Foreword and Welcome

It is an honour to present the Book of Proceedings of the CIO-ICIEOM-IIIE 2014, “8th International Conference on Industrial Engineering and Industrial Management” (XVIII Congreso de Ingeniería de Organización), “XX International Conference on Industrial Engineering and Operations Management” and “International IIE Conference 2014”.

This Joint Conference is a result of an agreement among ADINGOR (Asociación para el Desarrollo de la Ingeniería de Organización), ABEPRO (Associaçâo Brasileira de Engenharia de Produçâo) and IIE (Institute of Industrial Engineers), and it will take place at the School of Industrial Engineering of the University of Malaga (Spain).

The CIO-ICIEOM-IIIE 2014 International Conference’s motto is: “THE GLOBALREACH OF INDUSTRIAL ENGINEERING. ENHANCING SYNERGIES IN A COLLABORATIVE ENVIRONMENT”. It aims to provide a forum to disseminate, to all branches of industry, information on the most recent and relevant research, theories and practices in Industrial Engineering, Management and Operations. It is a conference with a very high standard, built on the experience of previous editions of CIO, ICIEOM and IIE conferences.

We want to thank to the Institutional Supporters and Sponsors. We gratefully acknowledge to the Invited Speakers, Reviewers and Authors. We must also recognize the great effort of the Scientific and Organizing Committees.

We hope that CIO-ICIEOM-IIIE 2014 will meet expectations of strength networking, enjoy a high quality scientific programme and an exciting social programme in Málaga.

Best wishes,

Málaga, July 2014

Elvira Maeso González	Pablo Cortés Achedad
Chair of the Organising Committee	Chair of the Scientific Committee

Honorary Committee

Adelaida de la Calle, *Rector University of Málaga*
Antonio Ramírez de Arellano, *Rector University of Sevilla*

Steering Committee

Elvira Maeso, *Chair of the Organising Committee*
Luis Onieva, *President of ADINGOR*
Milton Vieira Junior, *President of ABEPRO*
Bopaya Bidanda, *IEE Senior VP International*
Pablo Cortes, *Chair of the Scientific Committee*

Organizing Committee

Chair:
Elvira Maeso, *University of Málaga*

Members:
Javier Caballero, *University of Málaga*
Alejandro Escuder, *University of Seville*
Germán Gémar, *University of Málaga*
Guadalupe González, *University of Málaga*
José Guadix, *University of Seville*
Macarena Marchante, *University of Málaga*
Jesús Molina, *University of Málaga*
Jesús Muñuzuri, *University of Seville*
Antonio Olmedo, *University of Málaga*
M. Isabel Olmo, *University of Málaga*
Luis Onieva, *University of Seville*
Antonio Rosa, *University of Málaga*
Antonio Ruíz, *University of Málaga*
Enrique Sarria, *University of Málaga*
José Solano, *University of Málaga*
Dolores Tous, *University of Málaga*

Technical Secretariat:
Viajes El Corte Inglés. División de Congresos.

International Scientific

Chair:
Pablo Cortés, *University of Seville (Spain)*

Members:
Fouad Al-Suni, *King Fahd University of Petroleum and Minerals (Saudi Arabia)*
Sakine Batun, *Middle East Technical University (Turkey)*
Carlos Benavides, *University of Malaga (UMA)*
Bopaya Bipanda, *University of Pittsburgh (USA)*
Yuval Cohen, *Afeka Tel-Aviv College of Engineering (Israel)*
Zhihua Cui, *Taiyuan University of Science and Technology (China)*
Alejandro Escudero, *University of Seville (Spain)*
José Guadix, *University of Seville (Spain)*
Antonio Hidalgo, *Polytechnic University of Madrid (Spain)*
Mohammed Khadem, *Sultan Qaboos University (Oman)*
Kim LaScola Needy, *University of Arkansas (USA)*
Rui Lima, *University of Minho (Portugal)*
Adolfo López-Paredes, *University of Valladolid (Spain)*
Corrado lo Storto, *University of Naples Federico II (Italy)*
Elvira Maeso, *University of Malaga (Spain)*
Jesús Muñuzuri, *University of Seville (Spain)*
Dennis L. Oates, *Postal Operations and Engineering. FedEx SmartPost (USA)*
Renato de Oliveria Moraes, *ABEPRO (Brasil)*
Luis Onieva, *University of Seville (Spain)*
Raul Poler, *Polytechnic University of Valence (Spain)*
Douglas R. Rabeneck, *Operations Workforce Optimization Group. Accenture, LLP (USA)*
Jayant Rajgopal, *University of Pittsburgh (USA)*
Francisco Soares Másculo, *ABEPRO (Brasil)*
Janet Twomey, *Wichita State University (USA)*

Program Committee

Members:
Afonso Paulo, *University of Minho (Portugal)*
María del Mar Alemany Díaz, *Universidad Politécnica de Valencia (Spain)*
Anabela Alves, *University of Minho (Portugal)*
Carlos Andrés Romano, *Universidad Politécnica de Valencia (Spain)*
Pablo Aparicio Ruiz, *Universidad de Sevilla (Spain)*
Madalena Araujo, *University of Minho (Portugal)*
Sidnei Araújo, *Universidade Nove de Julho (Brazil)*
Debora Azevedo, *Universidad de Vale do Rio dos Sinos (Brazil)*
Gilson B. A. Lima, *Federal Fluminense University (Brazil)*
Ana Barbosa-Povoa, *Instituto Superior Tecnico (Portugal)*
Sakine Batun, *Middle East Technical University*
Bopaya Bidanda, *University of Pittsburgh (United States)*
Alexandre Biz, *Universidade Federal do Parana (Brazil)*
Raimundo José Borges de Sampaio, *Pontifical Catholic University of Paraná (Brazil)*
Andrés Boza, *Universitat Politècnica de València*
Javier Carrasco, *Universidad Politécnica de Madrid (Spain)*
Francisco Campuzano-Bolarín, *Universidad Politécnica de Cartagena (Spain)*
Manuel Cardós Carboneras, *Universidad Politecnica de Valencia (Spain)*
Sílvio Carmo-Silva, *University of Minho (Portugal)*
Ricardo Chalmeta, *Universitat Jaume I (Spain)*
Ernesto Cilleruelo, *Universidad del País Vasco (Spain)*
Joao Climaco, *University of Coimbra (Portugal)*
Yuval Cohen, *Tel-Aviv Afeka College of Engineering (Israel)*
José Antonio Comesaña Benavides, *Universidad de Vigo*
Ramon Companys, *Universidad Politécnica de Cataluña (Spain)*
Albert Corominas, *Universidad Politécnica de Cataluña (Spain)*
Pablo Cortés, *Universidad de Sevilla (Spain)*
Vera Mariza Costa, *Uniara – Centro Universitário de Araraquara (Brazil)*
Anna M.Coves, *Universidad Politécnica de Cataluña (Spain)*
Llanos Cuenca, *Universidad Politécnica de Valencia (Spain)*
Jorge Cunha, *University of Minho (Portugal)*
José Carlos Curvelo Santana, *Nine July University (Brazil)*
María VictoriaDe la Fuente, *Universidad Politécnica de Cartagena (Spain)*
David De la Fuente, *University of Oviedo (Spain)*
Ricardo Del Olmo, *Universidad de Burgos (Spain)*
Isabel Fernandez, *Uniovi (Spain)*
Carlos Gouvea, *UNISOCIESC (Brazil)*
Carmen De Nieves Nieto, *Universidad Politécnica de Cartagena (Spain)*
Fernando Deschamps, *Pontificia Universidad Católica de Puerto Rico (Brazil)*
José Dinis-Carvalho, *Universidade do Minho (Portugal)*
Alfonso Duran Heras, *Universidad Carlos III de Madrid (Spain)*

Sofia Estelles Miguel, *Universidad Politécnica de Valencia (Spain)*
Alejandro Escudero, *Universidad de Sevilla (Spain)*
Arturo J.Fernández González, *Universidad de Vigo (Spain)*
Paula Ferreira, *Universidade do Minho (Portugal)*
Cristiano Fontes, *Universidade Federal da Bahia (Brazil)*
Enzo Frazzon, *Universidad Federal de Santa Catarina (Brazil)*
Jesús García Arca, *Universidad de Vigo (Spain)*
Germán Gemar, *Universidad de Málaga (Spain)*
José Manuel Galán, *Universidad de Burgos (Spain)*
Jose P.Garcia-Sabater, *Universidad Politécnica de Valencia (Spain)*
Pedro Gomez-Gasquet, *Universidad Politécnica de Valencia (Spain)*
Gonzalo Grau Gadea, *Universidad Politécnica de Valencia (Spain)*
José Guadix Martín, *Universidad de Sevilla (Spain)*
José Hermosilla, *UNIARA (Brazil)*
Cesareo Hernandez, *University of Valladolid (Spain)*
Antonio Hidalgo, *Universidad Politécnica de Madrid (Spain)*
Eloy Hontoria, *Technical University Cartagena (Spain)*
Segismundo Izquierdo, *Universidad de Valladolid (Spain)*
Antonio José dos Santos, *Centro Universitário Tupy – UNISOCIESC (Brazil)*
Emilia Kohlman Rabbani, *University of Pernambuco (Brazil)*
Eliane Lago, *Universityof Pernambuco (Brazil)*
Carlos Lima, *UNIMEP – Methodist University of Piracicaba (Brazil)*
Rui M.Lima, *University of Minho (Portugal)*
Adolfo Lopez-Paredes, *University of Valladolid (Spain)*
Wagner Lucato, *Universidade Nove de Julho (Brazil)*
Amaia Lusa, *Universitat Politècnica de Catalunya (Spain)*
Virgilio Machado, *FCT/UNL (Portugal)*
Elvira Maeso, *Universidad de Málaga (Spain)*
Julien Maheut, *Universidad Politécnica de Valencia (Spain)*
Anna Bella Manalang, *De La Salle University (Filipinas)*
Miguel Ángel Manzanedo del Campo, *Universidad de Burgos (Spain)*
Rui Marcal, *Pontificia Universidad Católica de Puerto Rico (Brazil)*
Macarena Marchante-Lara, *Universidad de Málaga (Spain)*
Carme Martínez Costa, *Universitat Politècnica de Catalunya (Spain)*
Francisco Masculo, *Paraiba Federal University (Brazil)*
Carlos Mataix, *Universidad Politécnica de Madrid (Spain)*
Manuel Mateo, *Universidad Politécnica de Cataluña (Spain)*
Ana M.Mejías, *University of Vigo (Spain)*
Carlos Alberto Mendes Moraes, *University of Vale do Rio dos Sinos (Brazil)*
Valéria Miccuci, *CASNAV*
Mehran Misaghi, *UNISOCIESC (Brazil)*
Guillermo Montero, *Universidad de Sevilla (Spain)*
Renato Moraes, *University of São Paulo (Brazil)*
Francisco Moreira, *University of Minho (Portugal)*
Josefa Mula, *Universitat Politècnica de València (Spain)*
Giovanni Mummolo, *Politecnico di Bari (Italy)*

Jesús Muñuzuri, *Universidad de Sevilla (Spain)*
Manuel Nunes, *University of Minho (Portugal)*
Jose Oliveira, *Universidade do Minho (Portugal)*
Antonio Olmedo, *Universidad de Málaga (Spain)*
Luis Onieva, *Universidad de Sevilla (Spain)*
Angel Ortiz, *CIGIP-UPV (Spain)*
Javier Pajares, *University of Valladolid (Spain)*
Rafael Pastor
Guilherme Pereira, *University of Minho (Portugal)*
Fabio Pereira, *Universidade Nove de Julho (Brazil)*
Carina Pimentel, *University of Aveiro (Portugal)*
Edson Pinheiro de Lima, *Pontifical Catholic University of Parana (Brazil)*
Claudio Luis Piratelli, *UNIARA (Brazil)*
Raúl Poler, *Universitat Politècnica de València (Spain)*
José Carlos Prado Prado, *Universidad de Vigo (Spain)*
Jayant Rajgopal, *University of Pittsburgh (EEUU)*
Prida Romero, *Universidad Carlos III (Spain)*
Alfonso Redondo Castán, *Universidad de Valladolid (Spain)*
Imma Ribas, *Universidad Politécnica de Cataluña (Spain)*
Eduardo Rocha Loures, *Pontifical Catholic University of Parana (Brazil)*
José Rodrigues, *UNESP (Brazil)*
Diego Ros McDonnell, *UPCT (Spain)*
Antonio Ruiz Molina, *Universidad de Málaga (Spain)*
Rashed Sahraeian, *Shahed University (Iran)*
Jose Salles, *UNINOVE (Brazil)*
Ângelo Sant'Anna, *University of Sao Paulo (Brazil)*
José I.Santos, *Universidad de Burgos (Spain)*
Javier Santos, *Tecnun – University of Navarra (Spain)*
Marival Segarra-Oña, *Universitat Politècnica de Valencia (Spain)*
Miguel Sellitto, *Unisinos (Brazil)*
Ricardo Silva, *UFPB (Brazil)*
Rui Sousa, *University of Minho (Portugal)*
Ana Suárez Sánchez, *University of Oviedo (Spain)*
Lourdes Sáiz Bárcena, *Universidad de Burgos (Spain)*
Claus Sørensen, *Aarhus University (Denmark)*
Jose Telhada, *University of Minho (Portugal)*
Dolores Tous Zamora, *Universidad de Málaga (Spain)*
Lorna Uden, *Staffordshire University, (UK)*
Guilherme Vaccaro, *UNISINOS – University of Sinos Valley (Brazil)*
Ton Van der Wiele, *Rotterdam School of Management (Netherlands)*
Maria Jose Verdecho, *Universidad Politécnica de Valencia (Spain)*
José Valério de Carvalho, *Universidade do Minho (Portugal)*
Milton Vieira Junior, *UNINOVE/ ABEPRO (Brazil)*
Liane Werner, *UFRGS (Brazil)*

Topics

Strategy and Enterpreneurship

- Economics Engineering.
- Enterprise Engineering.
- Entrepreneurship.
- Global Operations and Cultural Factors.
- Operations Strategy and Performance Management.
- Social Responsibility, Environment and Sustainability.
- Business Administration and Strategic Management.
- Economic and Financial Management.
- Technological and Organizational Innovation.

OR, Modelling and Simulation

- Computer and Information Systems.
- Modeling and Simulation.
- Operations Research.
- Quantitative Methods.
- Scheduling and Sequencing.
- Multiagent Systems and Agent Based Modelling.

Logistics, Production and Information Systems

- Supply Chain and Logistics.
- Transportation and Physical Distribution.
- Lean Production and Management.
- Production Planning and Control.
- Production Systems Design and Management.
- Reliability and Maintenance.
- Information Systems and Information Communications and Technology -ICT-.

Quality and Product Management

- Quality Management.
- Product Management.
- Sustainability and Ecoefficiency.
- Industrial Marketing and Consumer Behavior.

Knowledge and Project Management

- Knowledge Management.
- Innovation Management.
- Project Management.
- Risk Management.

Service Systems

- Healthcare Management.
- Human Factors and Ergonomics.
- Emergencies and Disaster Management.
- Service Systems.

Education

- Industrial Engineering & Operations Management Education.
- Innovation in Education and Professional Skills.

Abstracts Index

Full Paper

009 Quality Knowledge Integration: a Brazilian comparison analysis

Maruyama U

Úrsula Maruyama (✉ e-mail:ursula.maruyama@cefet-rj.br; maruyama.academic@hotmail.com)
Dpto. de Ensino e Administração (DEPEA). Centro Federal de Educação Tecnológica – Celso Suckow da Fonseca (CEFET-RJ)av. Maracanã 229, bloco E, 1 andar, Maracanã - Rio de Janeiro/RJ,Brazil. Cep.20.271-110.

Abstract: This study associates the idea of knowledge integration through quality management systems (QMS) proposed by Marques et al (2013). Therefore, the descriptive research method combines multiple case studies. As the foundation for this research two works of XXXIII National Meeting of Production Engineering (ENEGEP) were used. The selected companies are from different segments and have in common the quality management use into their processes. Through qualitative analysis, based on national and international literature, companies were compared in their quality management systems composition. The results indicate that regardless of management systems maturity degree, it is important to invest in knowledge organization integration and information on quality.

Keywords: Quality Management System; Knowledge Management; Foreign Trade; Consumer goods industry; ISO 9001.

1 Introduction

Due to market competitiveness, organizations have sought to use management tools to achieve their strategic objectives. From the use of quality strategic perspective in production processes, human resources and services improved result in market differential (Collis and Montgomery, 1995; Bateman and Snell, 1998). Any delay in this process affects the bottom line, causing losses in the company cash flow.

Connecting quality to production processes means that there is loss and costs reduction involved. However, the use of the strategic knowledge concept should not be exclusively intuitively and without adequate use of a particular theoretical framework. In this context, elements of the Quality Management System literature are presented. Therefore, one question may arise: How to compare qualitatively the integration of quality management knowledge in different segments?

In order to answer this question, this work aims to:

- Identify components of quality management system in foreign trade company case study;
- Identify components of quality management system in consumer goods industry case study;
- Compare the applicability of an integrated quality knowledge system by analyzing these corporations' qualitative data

The background methodology research is exploratory and descriptive (Flick, 2004) as to explicit and seek a greater understanding of the problem researched, as well as it was based on multiple case study (Yin, 2001).

This paper was conducted in three stages: the first comprised a literature review to search for relevant information on the themes related to management integrated systems and quality management systems; the second, identified quality management variables in two 2013 ENEGEP case studies; the third and final phase compared both cases in adapted quality knowledge integration table (Marques et al, 2013) qualitative analysis.

2 Management & Quality Management Systems

The importance of knowledge is recognized in business and academic communities. One milestone in holistic quality management is the Malcolm Baldrige National Quality Award inception in 1987, leading to an even stronger interest among organizations from all sectors (Ahire et al, 1996). In Brazil, a more specialized approach to quality management took shape from the Foundation for the National Quality Award (FPNQ), founded in 1991.

Among the norms, stand out those of ISO 9000, published in 1987, which were translated and published in Brazil by ABNT, in 1990. The current version, published in 2008, showed no significant changes from the previous version, but introduced an important concept: the process approach.

ISO 9001 adoption is voluntary, but the organization which decides to adopt it must continually improve a quality management system (QMS) meeting the standards requirements. QMS, as developed by ISO, focuses on the critical factors giving sustainability to organizations management, rather than the philosophical and theoretical foundations of management by itself. Consequently, the QMS applies to any organization, regardless of size, sector of activity and complexity of the business (Marques et al, 2013).

3 Case 1: quality approach at Excom foreign trade company

Excom International Advisory Limited is a foreign trade company strategically located in Rio de Janeiro city: close to major Brazilian ports and international airports. The company established in 2003, also has subsidiaries in the United States employing approximately 90 people.

Gronroos (2003) states that it is not only by technical quality that a company will achieve success and meet competition, in turn, what needs to be done is to provide better services in which functional quality is highlighted. Knowledge about goods quality, however, is insufficient to understand service quality. Three well-documented characteristics of services – *intangibility, heterogeneity, and inseparability*– must be acknowledged for a full understanding of service quality (Parasuraman et al, 1985).

The Excom case study presented the process of calculating benefits accounts and identifying improvements for the time reduction to satisfy charging customer groups. The application of Six Sigma DMAIC (*define-measure-analyze-improve control*) to quality control was important in these terms. The need of clients' database standard model was crucial to reduce time flaws calculation and subsequent charge transmission.

Import and export processes in the last quarter of 2012, corresponding to 381billed cases were analyzed. From those, 80% compound bill delay and lack of documents. The project team analyzed through nominal group technique (NGT) to discuss the issue and evaluate multiple alternatives in order to reach a consensus and thus prioritize them. The GUT analysis (gravity-urgency-trend) on the problems possible causes showed that 63% represents controllable variable causes at Excom.

One of the main actions to be taken in the short term is to adjust target time for billing. Another important factor which will allow customer receipt optimization is to send documents scanned with charged bill by e-mail. Yet, for this initiative to be implemented it must be negotiated with customers.

Quality tools applications allowed the company to formulate a proposal to reduce the calculation time and shipping charges to its customers as well as specify the criteria for specific customers bringing greater outcomes and profitability. The cost process study allowed the variability reduction and their contribution to performance indicators enhancement, thereby contributing to meet the costumers'quality needs.

4 Case 2: applying quality in reducing costs of PGB production

PGBX is a multinational consumer goods company founded in the 1800s, spread all over the world (170 countries). The Brazilian production unit studied is located in Rio de Janeiro with 450 employees. In 2012, International PGBX recorded$83.68 billion in sales. Fortune magazine awarded a top spot on its list of "Global Top Companies for Leaders", and ranked the company in the "World's Most Admired Companies" list.

The case is based on a production unit in which its great challenge is offering consumers quality products at the lowest possible price. In order to achieve executive’s goals, production sites receive a great pressure to reduce their direct and indirect costs. This cost reduction, in PGBX's vision means 'zero loss'. Whereas, is not only considered as loss what was wasted, but also everything which does not add value to the end consumer.

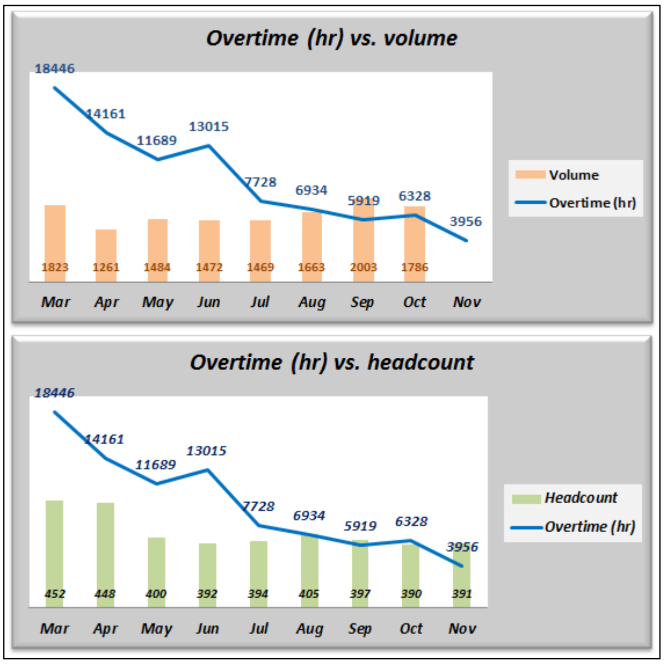


Fig. 1 PGBX overtime work analysis screen
Source: Guerin et al (2013)

As soon as someone joins into PGBX, he/she receives training focusing on the understanding of PGBX's improvement culture, as well as the importance of each employee in doing everything in his/her power to contribute for continuous enhancement. This contribution tracked by *kaizen*, which records employees’ initiative and allows theirs results tracking.

Among these opportunities, overtime was considered the selected variable to be referred to intervention study aiming at reducing their costs. Once identified basic points to be worked out, a survey was conducted, based on the PDCA (*plan-do check-act*), and then the project started in March 2011. The human resources cost was the most significant, representing approximately 35% of the site total cost. In the PGBX survey, it was found that 17% of cost information concerning persons was due to overtime.

After a year of project the main results were reported. Tracking systems were based on consultations on SAP system and HR System. The obtained results were as follows:

Table 1 PGBX case study results analysis

GOAL	Case 2 (PGBX)
Overtime employee average	From 160 hours to 70 hours (56,3% reduction)
Production unit total overtime	From 18,000 hours/mo to 7,000hours/mo (61% reduction)
Legal matters risk management	Was cut by half
Cost savings	First year: R$ 1,5 million (USD 600,000) annually
‘Best practices’	Brazilian operations became international benchmarking

It was concluded that apparently, there is no barrier to overtime project implementation in different segments. However, so that it can be implemented, there must be a culture of leadership, a clear and objective communication with employee sand, essentially, an automated control point system.

5 Quality Knowledge Integration

According to Powell (1995), Total Quality Management (TQM) success appears to depend critically on executive commitment, open organization, and employee empowerment, and less upon such TQM staples as benchmarking, training, flexible manufacturing, process improvement, and enhanced measurement. Those can be easily correspondent to ISO QMS, a quality knowledge integration sample.

ISO QMS main virtues identified are: (a) the broad involvement of stakeholders;(b) its generic character, to be applicable to all types, sizes and branches of organizations interested in the subject; (c) voluntary compliance; (d) the optional certification, performed through audits; (e) concern for continuous improvement meaning a mechanism to encourage continuous learning (Marques et al, 2013).

5.1 The National Conference of Production Engineering

The National Conference of Production Engineering (ENEGEP) is a national event organized annually by ABEPRO - Brazilian Association of Production Engineering. The conference gathers academic professionals working in

Production Engineering community: researchers, teachers and students, entrepreneurs, consultants, engineers, and administrators. It constitutes one of the main Brazilian promoters of technical and scientific production in the area.

In addition, ENEGEP was consolidated as a forum for relevant Production Engineering discussion in national issues. Besides, the conference promotes sharing of academic knowledge with the productive sector. Thus, ENEGEP becomes unique opportunity for efforts integration of those who work in this vital area for development. The event also seeks a continuous link of the academic community with society.

5.2 ENEGEP Quality Knowledge Integration table analysis

In order to visualize both ENEGEP case 1 and case 2 contribution do Quality Management Systems, they were organized in the table as follows:

Table 1 Quality Knowledge Integration table based on ENEGEP case studies

ABNT NBR ISO 9001:2008 (ISO QMS)	**Case 1 (Excom)**	**Case 2 (PGBX)**
4.QUALITY MANAGEMENT SYSTEM		
4.1.General requirements	Y	Y
4.2.Documentation requirements	Y	Y
6.RESOURCES MANAGEMENT		
6.1. Resources supply	N	N
6.2. Human resources	Y	Y
6.3. Infrastructure	N	Y
6.4. Work environment	Y	Y
7.PRODUCT COMPLETION		
7.1. Product/service completion planning	Service	Service
7.2. Costumer related processes	External	Internal
7.3.Design and development	N	N
7.4.Procurement	N	N
7.5. Service production & supply	Indirect	Direct
7.6. Measurement & monitoring equipment control	Y	Y

Adapted from Marques et al (2013)

Comparing qualitatively the contributions from each case, it is possible to verify similarities between them. On the other hand, there are a few differences worth to note, such as: while case 1 does not necessarily deploys infrastructure as relevant factor, in case 2, was crucial do determine overtime gaps mapping; costumer related process in case 1 are directly related to external client, while case

2 represents internal demands; as in regard to service production & supply, case 1 indirectly affects organizations performance whereas case 2 directly bound to operational productivity.

6 Final considerations

For effective management means, the concept of quality as a strategic tool needs to be absorbed in all employees thinking and acting, from the strategic to the operational level. As a consequence, quality value in organizational culture is attained. Therefore, quality should have a strategic background, but it effectively achieves actual goals when is practiced by tactical and operational levels.

ISO QMS standardized fulfill an important role of guiding organizations first steps of those that had no managerial or technical expertise in this area. This could be observed in Excom, quality management case. Still, ISO QMS also represents a great deal contribution to well-established companies as it occurred to PGBX operations in Brazil.

Given the lack of structured approaches integrating and ordering the growing body of knowledge management, the recent biggest challenge is how to translate the principles of knowledge management in structural elements and management processes, so that parties obtain more precise guidelines to direct their efforts.

Based on this premise, this paper presented elements of Marques et al (2013) feasibility of designing a system for knowledge management in the mold of quality management systems recommended by ISO using two quality management case studies from different sectors.

7 References

ABNT. (2008) NBR ISO 9001:2008: Sistemas de gestão da qualidade: requisitos.

Ahire, S. et al (1996) Development and validation of TQM implementation constructs. Decision Sciences, winter, v.27, n.1, pp. 23-31.

Bateman, T. S; Snell,S. (1998) Administração: construindo vantagem competitiva. São Paulo: Atlas.

Collis, D. ; Montgomery, C. (1995) Competing on Resources: Strategy in the 1990s. *Harvard Business Review*. Jul/Aug, pp.118-128.

Figalo, W. et al (2013) Proposta para abordagem da qualidade no comércio exterior: estudo de caso da empresa Excom. *XXXIII Encontro Nacional de Engenharia de Produção* – ENEGEP. A Gestão dos Processos de Produção e as Parcerias Globais para o Desenvolvimento Sustentável dos Sistemas Produtivos. Salvador, BA, Brasil, 08 a 11 de outubro de 2013.

Flick, U. (2004) *Uma introdução à pesquisa qualitativa*. Porto Alegre: Bookman.

Fortune.(2013) *Fortune's List of World's Most Admired Companies*. August 7, 2013. Available at: http://money.cnn.com/magazines/fortune/most-admired/2013/list/?iid=wma_sp_full

Gronroos, C. (2003) *Marketing, Gerenciamento e serviços*. 2º ed. Rio de Janeiro: Elsevier.

Guerin, S. et al (2013) Aplicando a qualidade na redução dos custos produtivos: um estudo de caso sobre a redução de hora extra em uma empresa de grande porte. *XXXIII Encontro Nacional de Engenharia de Produção* – ENEGEP. A Gestão dos Processos de Produção e as Parcerias Globais para o Desenvolvimento Sustentável dos Sistemas Produtivos. Salvador, BA, Brasil, 08 a 11 de outubro de 2013.

Marques, A. et al (2013) Gestão do conhecimento: em busca da integração. *XXXIII Encontro Nacional de Engenharia de Produção* – ENEGEP. A Gestão dos Processos de Produção e as Parcerias Globais para o Desenvolvimento Sustentável dos Sistemas Produtivos. Salvador, BA, Brasil, 08 a 11 de outubro de 2013.

Parasuraman, A. et al (2013) A conceptual model of service quality and its implications for future research. *Journal of Marketing*, fall, v.49, pp.41-50.

Powell, T. (1995) Total Quality Management as competitive advantage: a review and empirical study. *Strategic Management Journal*, v.16, n.1, pp.15-37.

Yin, R. K. (2001) *Estudo de caso: planejamento e métodos*. São Paulo: Bookman.

012 ESCOs Formation as key factor for smart cities: Spain case analysis

Morcillo Bellido J, Prida Romero B

Jesús Morcillo Bellido (✉ e-mail: morcillo@ing.uc3m.es)
Escuela Politécnica Superior. Área de Ingeniería de Organización. Universidad Carlos III de Madrid. Avenida de la Universidad nº 30, 28911 Leganés (Madrid)

Bernardo Prida Romero (✉ e-mail: bprida@ing.uc3m.es)
Escuela Politécnica Superior. Área de Ingeniería de Organización. Universidad Carlos III de Madrid. Avenida de la Universidad nº 30, 28911 Leganés (Madrid)

Abstract: Cities have reached such a magnitude that they represent platforms for wealth, employment and competitiveness creation but also involve an enormous amount of complexity that emphasized their management challenges. Cities evolution is a trend towards development of more efficient and livable cities called "Smart Cities", where key topics are linked to how efficiently they use resources. This document describes the development in Spain of Energy Service Companies (ESCOs), a type of organization focused on promoting and managing projects related to the efficient use of energy, being their business success linked to energy savings achieved by their clients. Outcome of this study provide information of interest to understand current development of ESCO projects in Spain, barriers they faced and how collaboration between organizations can facilitate energy efficiency management, which is linked to future development of “Smart Cities” initiatives.

Keywords: Smart Cities, ESCO, collaborative relationship, services management, collaboration.

1 Population movement to cities

Half World's population lives currently in cities. European Union (EU), during the last decades it has moved from a situation in which fifty percent of the population was living in cities at 1950 to more than seventy seven percent in 2010, and with an estimation of eighty five percent in 2050 (Caragliu et al, 2011). Challenge is to be able to develop more livable ecosystem than today for such a huge population.

Cities authority vision should move beyond traditional way of managing problems, it is not enough to regulate traffic, collect garbage or lighting public roads, but they should be the focus on getting a better quality of life for citizens. They are becoming "socio-economic corporations" managers and they need vision and long term strategies where relevant issues are not only linked to construct nice bridges, public offices or rail stations for posterity, but cities where citizens could live better in terms of environment, safety, mobility, access to information, ...etc.

Moreover, cities absorb a big amount of resources, including which is probably more scarce and difficult to generate in the city itself: energy. Cities consume over three-quarters of World's energy and this trend certainly has a limit. Based on this situation, many initiatives, although somehow scattered, related to service efficiency improvement emerged within cities and European Union (UE) has included plans in its strategic agenda 2020to promote actions focused to cities, referred as “Smart Cities”. Idea is to turn cities into sustainability platforms in a broad sense (economic, environmental and social) through plans to achieve higher energy efficiency and extending communication networks. This study is focus on "Smart Cities" development and a novel practice in Spain that is rapidly gaining relevance: emergence of new types of partnerships between organizations to optimize energy management.

2 Methodology

To carry out this prospective study, in an area still no too much developed, authors have mainly used qualitative research methods (interviews and study of good practices)that Eisenhardt (1989), Gummenson (1991) and Yin (1994) advise as appropriate for the exploration of innovative aspects in organizational management. Information has been obtained mainly through: i) in-depth interviews with senior corporate managers from organizations strategically oriented to energy efficiency and focused new business models development in European Smart Cities projects, ii) Analysis of "good practices" both in “Smart Cities” and “not Smart Cities” based on information provided by Spanish National Association of Energy Efficiency (ANESE) associate´s top responsible. This study seeks to understand to what extent Smart Cities have solid foundations to support their development on efficient use of energy, based of new collaboration models through so called Energy Efficiency Companies (ESCO).

3 What does Smart City mean?

Term “Smart City” was often used to describe projects related to improving communications infrastructure and information technology in cities. The relationship between communication networks development and economic growth indicators has been studied by authors like Roller and Wavermann (2001) and other authors emphasized high relevance of human capital role and education as levers for cities development (Glaeser and Berry,2006). Some studies have attempted to characterize Smart Cities as: i) areas for urban and business development with capabilities to attract new business (Shapiro, 2008), ii) place where community learns, innovates and people use technology to improve their quality of life (Coe et al, 2001; Abreu et al, 2008). Caragliu et al (2011) study defines "Smart Cities" as those where investments in human and social capital are managed besides efficient public services (such as transportation, communication network, etc.), supporting a balanced economic growth through proper and efficient use of resources both in public administration and private entities.

Growing number of cities wanted to be recognized as Smart Cities, so it is necessary to establish assessment criteria to recognize them, and one of the most accepted classifications was developed by Giffinger and Gudrun (2010), including criteria as competitiveness, people capabilities, citizen participation, transports, communications, environment and quality of life. Many projects related to city´s development have attempted to be classified as "smart", and Spanish cities are not an exception. Among others, projects listed in Table 1 represent this trend.

Table 3: Some relevant Smart Cities projects. Source: own elaboration

Country	Year	Objetives
Abu Dhabi (UAE)	2006	30% electricity saving in University area
Estockhom	2007	Mobility and energy saving project
Málaga (Spain)	2009	20% energy saving. Electric vehicle project
Songdo (South Korea)	2009	New city based on efficient resources use
Valladolid y Palencia (Spain)	2010	Energy, mobility and recycling projects
Búzios-Rio de Janeiro (Brasil)	2010	City planned to be a best practice on efficiency
Barcelona (Spain)	2010	Projects focus on mobility and communication
Paredes (Portugal)	2011	New project for a very efficient new city
Madrid (Spain)	2011	Mobility, communication and energy efficiency
Proyecto *OutSmar*t (Santander (Spain) and others)	2011	European Union Project including: waste management, water, transport and lighting

Malaga city has been a pioneer in this movement and has put big efforts to develop projects which have brought a high level of recognition among those cities considered as Smart Cities. For years this kind of “smart” projects development was more a result of local initiatives than a country or regional coordinated strategy, however the European Commission (EC) recently established these practices should be integrated into EU 2020 strategy.

4 European Union strategy for Smart Cities

EU has announced a European Innovation Partnerships (EIP), with the intention to mobilize key innovation stakeholders. To avoid approaches and efforts dispersion, the plan is focused on energy management efficiency and city transport improvement: production and urban energy use, cities transportation/mobility and communication systems. This plan try to encourage partnerships development to catalyze progress through new practices and models, finding ways to merge into comprehensive and multidisciplinary solutions to achieve better efficiency, better use of resources and obtain meaningful greenhouse emissions reduction. Ultimate goal is that European cities would become places with an advanced social and environmental progress and economic growth engines with a holistic sustainability (economic, social and environmental) view. To minimize opportunistic behavior risk it have been included some rules: i) solutions must be sufficiently robust and flexible enough to integrate future technologies, ii) It should not be introduced any additional market barrier from any particular manufacturer, iii) companies willing to work on these projects must be open to share information with others, even competitors, during project development. It involves "ecosystem test model" generation, where cities and companies, under sponsorship and supervision of the UE, will test and evaluate different solutions. This movement is framed within the overall strategy of European re-industrialization, since industry could be supported by this plan on their vital fight for global technological leadership. In the initial phase, initiative seeks to implement and demonstrate existing solutions in energy and communications areas at certain cities. These pilot projects should encourage strategic alliances formation by innovative companies acting in any of the three indicated areas and interested in joining the project. These companies should establish partnerships agreements with interested cities and local companies to implement solutions.

5 Energy as competitiveness factor in cities and Energy Service Companies (ESCOs) formation

Availability of abundant energy at low prices has fueled global economic growth during twentieth century. This resource could be in the coming decades the biggest limiting factor to keep world quality of life, and this situation is somehow related to Thomas Malthus thoughts (1798) when he wrote on high risk involved in the population growth within limited land suitable for cultivation. Industrial Revolution generated in England – and then in the rest of Europe - new economic activities that avoid then this potential problem and maybe we need now another revolution in the energy field.

Thus in recent years there have been companies entering into agreements with other organizations to optimize their energy management, ensuring service level, improving integral costs far better than acting alone. These companies are called "Energy Service Company (ESCO)" and they invest in more efficient technologies and installations, maintain them and eventually fund, seeking maximum cost efficiency and ensuring agreed service level (Vine, 2005). As Hartley (2005) points out, these practices constitute a type of "horizontal collaborative innovation". As mentioned before, UE major goal is to identify successful business models that can be adapted to local circumstances, stimulate innovation and create local jobs. This view fits with models like those developed around ESCOs (Bertoldi, 2006) so they can contribute significantly to Smart City projects implementation. Also ESCOs could capitalize their capabilities for efficient collaboration with complementary partners to extend their business to other technologies beyond energy management. Understanding Spanish ESCOsdevelopment and barriers it can anticipate difficulties and be useful for further initiatives developed under Smart Cities umbrella.

6 Energy Service Companies development in Spain

ESCO organizations operate in Europe and United States to respond to something that is sorely needed: energy costs reduction based on more efficient use. ESCO are seen as part of conceptual models of "extended enterprise" where what matters is not if a specific chain link is very efficient but if whole chain is as efficient and competitive as possible.

The EU Directive 2006/32/EC on energy services, established framework for this type of companies in Europe: i) it sets energy efficiency targets for coming years, ii) define ESCO type companies management model, iii) encourage service payment should be based on energy efficiency targets achievement, iv) It promotes financing agreements with financial institutions, v) it recommends to Public Sector to create best practices. In Spain, Law RD 6/2010 and RD 3/2011, regulate ESCO company standards and conditions for operation. Final agreements present several combinations depending on the type of contract agreed between parties. Typically, an ESCO is the main integrator responsible for the management and coordination of all the elements within energy project.

It should be point out that this business model based on collaboration between organizations to achieve savings in energy management could be traced in Spain over thirty years ago when, still without specific legal regulations, it began initial projects around energy co-generation. From cases studied in this research, most frequent services offered in Spain include lighting, air conditioning, operations and co-generation. Savings will depend on specific application area (shopping malls, hospitals, hotels, universities, offices, roads lighting, etc.) and also in technology (main savings are expected in lighting and air conditioning). Potential savings range could be from 15% to 40%, and value will depends both on the baseline and applicable technology. Currently, most common projects are conducted in urban road lighting, hospitals and shopping malls and Spanish partners select ESCOs based on proven records in project experience and appropriate technology.

7 ESCO model agreements in Spain

As mentioned, type of agreement in Spain varied from project to project and it depends on negotiation between parties but they used to be based on specific service levels and potential savings. However, we can distinguish two main types of agreements structures: i) energy supply agreements, where client pays for the useful consumed energy at certain agreed price. Energy efficiency measures are usually limited to energy supply to building or installation and client pays to ESCO a certain value based on the electricity invoice minus an agreed percentage of savings,ii) agreement on energy performance, service payment is based in energy efficiency improvements against contract objectives, keeping agreed service level. Regarding how to formalize agreements, usually it isa formal contract between partners in which it will indicate how savings will be distribute among parties. Generally contracts include client, ESCO and a financial institution to support project financing, and two main types of contractors are distinguished in Spanish practice: a) guaranteed savings contract, in this case a certain saving amount is guaranteed to client whenever client operations remain within agreed limits. Investments are usually carried out by the client and support financial risk. If the real savings are below guarantee level, ESCO must support the difference. There is usually no contractual agreement between ESCO and financial institution but they require technical commitments and economic compliance to guarantee project execution, b) shared savings contract, on this case real savings are shared between ESCO and client. Investments are done by ESCO and transferred to client at the end of the contract and it is agreed a fix payment to ESCO including amortization, maintenance fee and a variable compensation linked to real saving gotten.

8 Barriers faced by ESCO in Spain

From in-depth interviews to companies operating in the sector and checked with other participants in the study, it has been identified following barriers to further ESCO development in Spain:

- Financial and economic barriers. Since energy price is still not considered expensive enough by companies, pressure to recover investment in short term (2-4 years) gives very limited applicability to technological actions.
- Legal Barriers. There are important legal difficulties for contracts execution with public entities in public-private tenders. RDL 8/2010 law interpretation in line with Spanish Government extraordinary measures to reduce public debt is so complex in term of what could be considered as deficit that is blocking many ESCO projects when public entities are involved. Accounting treatment of these types of commitments make these contracts very unclear. Also, private sector has difficulties to adapt contracts to specific client requirements. Contracts need to include many clause related to operational details and it is not easy to translate into legal norms.
- Clients lack of knowledge. As with any new business model, clients distrust of something they do not know enough. Also limited availability of successful references hinders their development. Dissemination of good practice is something that would help significantly to grow.
- Distrust. It is generated to ESCO by opportunists clients who interpret this business model is based on an external organization who will take over energy efficiency responsibility in their processes - and associated risk - with no responsibility on their side.

9 Conclusions

EU interest for Smart Cities development clearly indicate a route for development of different types of ESCO projects, as an innovative model linking collaborative initiatives between organizations (public and/or private) to achieve significant savings in energy consumption. In the case of Spain, the steady increase in energy prices in recent years is an additional incentive for these projects development, as far as economic impact of energy savings will compensate prices increases. Also, many ESCO projects could be self-financing, because savings are huge enough to pay the amortization of the required investments, operating expenses and ESCO margin in an affordable timeframe (1-3 years). Public institutions, such as town halls, need to be very efficient to reduce public deficit and energy management has become a priority. Agreements with ESCO organizations able to manage and achieve net savings between 40 and 70 percent of consumption are being implemented, like for public roads lighting. In the private sector important companies, well known for their best practices in process management, are beginning to realize that improvements in operational processes (design, manufacturing, transportation, etc.) may have a limit, so some of them are applying efficiency practices to other relevant resources as energy using ESCO projects. Interest shown by the EU in the development of Smart Cities could be an important lever to speed up project implementation, since ESCO mean a pillar for energy efficiency. In fact, it would be very difficult to be a Smart City without achieving significant savings in this area, which are more easily achievable with ESCOs implementation. However, it could concluded Spanish ESCO market is still not getting expected level of development due to reasons like: i) low energy efficiency permissibility in organizations is still high, since there is not a broad sense of real impact in the bottom line, ii) limited incentive for improvements, iii) widespread ignorance of the benefits achievable through ESCOs, iv) difficulties in the Public Administration to find legal ways for public projects affordable without being counted as additional public debt. From this analysis, it can be inferred that ESCO projects are a good tool to achieve energy efficiency goals in line with Smart Cities focus. In Spain, ESCO projects are being implemented gradually however potential applicability of ESCO project is still very huge and promising, probably much higher than initially identified and with important savings potentially achievable.

10 References

Abreu M et al (2008).Absorptive capacity and regional patters of innovation. Research Report 8/11 London: Department of Innovation, Universities and Skills

Association of Energy Service Companies (2012). Association presentation. Madrid

Bertoldi P et al(2006). Energy service companies in European Countries: current status and strategy to foster their development. Energy Policy, 34:1818-1832

Caragliu C et al (2011). Smart Cities in Europe. Journal of Urban Technology, 18 (2):65-82

Coe G et al (2001). E-Governance and smart communities: a social learning challenge. Social Science Quarterly, pp 23-37

Eisenhardt K M (1989). Building theories from case research. Academy of Management Review, 14 (4): 532-550.

European Commision (2012).Smart Cities and communities- European innovation partnership

Florida, R (2002) Bohemia and Economic Geography. Journal of Economic Geography, 2: 55-71

Giffinder R, Gudrun H (2010). Smart Cities: an effective instrument for the positioning of cities. Architecture, City and Environment, pp 7-25

Glaeser E L, Berry C R (2006). Why are smart places getting smarter?. Taubman Center, Policy Brief 2006. Cambridge, M.A.

Gummesson E (1991). Qualitative methods in management research. London: SAGE Publications Ltd.

Hartley J (2005). Innovation in governance and public services: past and present. Public Money and Management, 25(19): 27-34

Malthus T (1798).An essay on the princiles of population. Penguin, NY

Mohr S et al(2012). Manufacturing resource productivity. McKinsey Quarterly, June 2012: 20-25

Nijkamp P (2010). E Pluribus, Region Direct, 2(3): 56-65

Roller L-H, Wavermann L (2001). Telecommunications Infrastructure and economic development: A Simultaneous Approach. American Economic Review, 91(4): 102-117

Shapiro J M (2008). Smart Cities: quality of life, productivity, and growth effects of human capital. The Review of Economics and Statistics, pp 304-335

Vine E (2005). An international survey of energy service company (ESCO) industry. Energy Policy,33: 691-704

Yin R K (1994). Case Study Research: Design and Methods. London: Sage Publication

015 Collaborative approach for single source risk mitigation

Franconetti C, Ortiz A

Patricia Franconetti (✉ e-mail: pfranconetti@gmail.com)
Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). Universitat Politecnica de Valencia. C/ vera S/N, 46022 Valencia

Ángel Ortiz
Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). Universitat Politecnica de Valencia. C/ vera S/N, 46022 Valencia.

Abstract: Single source procurement can improve the supply chain productivity and its overall potential capacity to undertake future challenges. However, partners are exposed to numerous potential risks associated with treachery, technological incapacity and collaboration unwillingness. Supply chain risk management process is explained in order to introduce how it can reduce risk likelihood and economic impact of four main risks associated with this supplier dependence. This is important because not only the buyer is exposed, all the partners that are downstream can suffer the consequences of single supplier production stoppage or inadequate capacity, its inability to conform specifications or shipment delays due to third party logistics services. But there are solutions to prevent these problems based on process interoperability, leasing of assets or knowledge and the development of collaborative quality assurance programs that can prevent the consequences.

Keywords: Supply chain risk management, Collaborative environment, Single sourcing.

1 Introduction

With the economy globalization, today's supply chains (SC) are becoming not only more efficient, but also riskier, due to numerous chain links among partners and third parties that are prone to breakdowns, disruptions, bankruptcies, and disasters. These risks affect not only business processes or operations (i.e. disruptions, delays, poor quality) but also finances (i.e. dubious investments, costs augment, insufficient cash-flows) and the supply chain as a whole (i.e. brand image loss). The goal of supply chain risk management process (SCRMP) is to reduce the economic loss caused by risk major events (RME) and now is a mature knowledge area thanks to the work of researchers and practitioners (Tang and Musa, 2011).

However, risk management is not a solved problem, there are new challenges continuously because global supply chains are usually slow to respond to changes. Managers have a risk management vision based on controls and barriers and probably it was enough to reduce their “in-house” risk up to now, but a collaborative approach can resolve the risks within the SCwith mutual benefit of all partners (Ritchie and Brindley, 2007).

In a simplified way, SCRMP is subdivided into the identification, assessment and reduction of risks, but it is not a simple task because SC are complex entities that interact in a global market. There is a considerable amount of specific works about this methodology, for instance Tummala and Shoenherr (2011) can be an excellent example for further reading about the methodology. However, the basic concepts will be outlined to understand the discussion about sourcing risk reduction.

This work is focused on risk reduction due to its practical implications for practitioners and it deals with the case study of single sourcing procurement because of it is very interesting for collaborative environments that could take advantage of this alliance with a strategic supplier while have a greater number of tools against risk thanks to collaboration.

2 Single Sourcing vs Multiple Sourcing

The first step is to understand why some companies are increasingly interested in the single sourcing (SS). From an instinctive standpoint, it seems more appropriate redundant sourcing, but different studies show that SS has some advantages.

Initially, SS popularity has been growing due to just-in-time (JIT) philosophy. To eliminate waste and to emphasize value- added activities, one of the purchasing objectives is to ensure that the orders are placed at the right amount, at the right time, and at the right place with the right quality. To accomplish this task a manufacturing facility must maintain an excellent working relationship with its suppliers (Zeng, 2000). In theory it is an excellent idea, but it has some practical drawbacks. The multiple-sourcing strategy plays one supplier against another, and the competition among the suppliers is intense, then the buyer has the opportunity to receive lower prices and reduced shipping costs. But this approach also has limitations because it is mandatory to find several suppliers committed to achieve the necessary technology and expertise level, with forecasting abilities and quality assurance competencies (Berger et al, 2004). Table 1 summarizes outcomes of single sourcing procurement strategy.

Therefore it is important to think about how many suppliers are the best. Probably both strategies are valid because the success depends on the establishment of proper business rules. The authors are going to focus on SS strategies based on loyalty and trust through a real long-term collaboration with a single source.

Table 1 Summary of single sourcing procurement features

Advantages	Disadvantages
Buyers perspective	
Improved communication to prevent risks.	Disruptions and poor sourcing quality cause major difficulties
Possibility of designing a collaborative quality assurance system	The relationship must be a real collaboration based on loyalty and trust
Collaboration to redesign products and business process to add value	Financial stability of supplier is crucial
Suppliers perspective	
It is easier to establish plans due to information sharing.	Without competition the vendor may attempt to cut costs
It is an opportunity to make new investments and acquire new skills	Service/product specifications must be clearly defined in contract

3 Supply Chain Risk Management Process

It has been introduced the basis of the Supply Chain Risk Management Process (SCRMP), now it will be remarked the contingency plans relevance and their relationship with the supply chain governance.

Basically SCRMP is a continuous improvement cycle that starts with the risk identification phase, see figure 1. To carry out this phase two tools are needed: an inventory of potential risks and the repository of business rules.

There are excellent works about risk taxonomy construction like Tang and Musa (2011) or Wu et al (2006) a brief summary of the main risks that these authors cite is shown in table 2.

But it is not enough only to understand the possible risks, the other important elements of the identification process are business rules (BR). A BR is a statement or parameter that defines or constrains some aspect of the business (performance goals, planning rules, sourcing rules, maintenance rules, BOMS and approved providers or return policies) and is generally used in decision-making. They are intended to influence the outcomes of operating the SC and they can be applied to people, processes, corporate behavior and computing systems in an organization. They are put in place to help the organization achieve its goals.

Table 2 Main operational risk and its connection with sources of risk

RISK TRIGGERS	RELATED RISK EVENT
Inaccurate demand forecast	Financial incapability, Quick response inability, Inventory rupture
Excessive fluctuation of prices and costs	Financial incapability, Sharp loss of process performance.
Operational/Manufacturing stoppage	Quick response inability, Inventory rupture
Supplier inability to conform specifications	Low quality materials flow, Sharp loss of process performance
Inappropriate business process capacity	Order delivery delays, Quick response inability
High rate of material obsolescence	Inventory rupture, Sharp loss of process performance
Shipment disruptions or delays	Order delivery delays, Inventory rupture
Late modifications of service conditions	Sharp loss of process performance

Fig. 1 Relationship between Supply Chain Risk Management Process and Business rules

Hence, the identification and evaluation phase consist on examining the present SC configuration and performance measurements, then it will be estimated the future behavior taking into account the current BR in order to quantify the potential economic loss of the potential risk.

At this point, SCRMP is crucial because it has to propose an action plan to reduce the likelihood and/or the economic loss of the main RMEs, see figure 2. There are three basic strategies for managing risk that depend on the risk attitude of managers. Risks can be avoided, prevented or mitigated and each approach has advantages and drawbacks (Cucchiella and Gastaldi, 2006). Avoidance strategies try to eliminate the root causes of risk deferring investment, outsourcing or promoting partner-growing programs. They can be very long term effective, but if risk occurrence is close they won't be able to avoid the economic loss. At mid-term prevention strategies attempt to reduce the likelihood of the RMEs, the best-known strategy is based on the quality control but others based on sharing information or assets can be very interesting. Finally, in the melee against risk, it is assumed that RME will occur and for this reason safety barriers and alternative ways are prepared to reduce the economic loss.

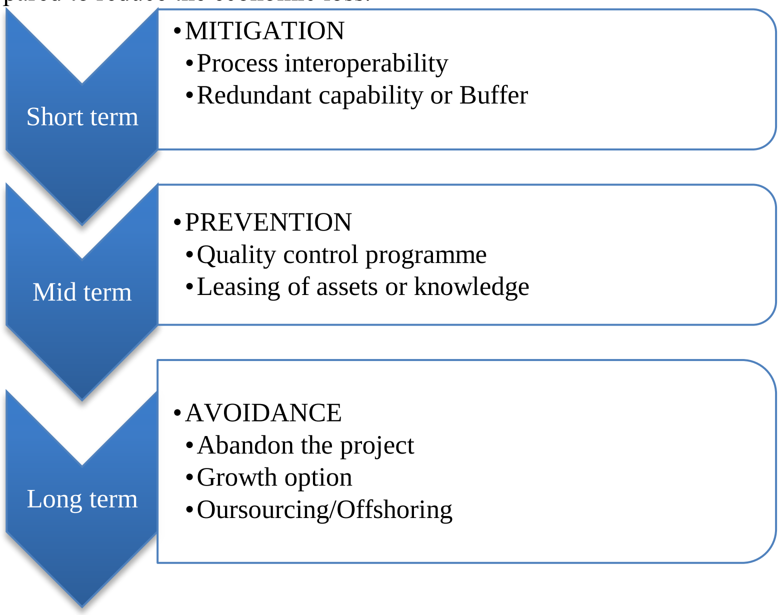


Fig. 2 Action planning process for risk managing

Now that the problem is known and the risk management tools have been established, it is time to propose the approach to manage the single source procurement risk.

4 Collaborative approach for single source risk management

Single sourcing procurement is a decision that restricts some specific risk management strategies. However, it is not an insurmountable obstacle if the relationship between supplier and buyer is based on real collaboration. Considering the partnership model of D. M. Lambert (2008) it is assumed that previously both sides agree that there are potential drivers that justify this managerial complexity under normal conditions (assets/costs efficiency, customer service, marketing advantage…). Therefore, according with Lambert, risk management should develop the partnership components to treat risks when SC is operating under abnormal conditions. From the operational standpoint there are four main sourcing risk triggers that must be addressed:

Partners' manufacturing stoppage

This risk can have a huge impact:

- On the buyer if sourced products are key components for the final product
- On the supplier if these orders represent a high percentage of its production.

In both cases the partner can be indefinitely delayed due to SC disruption. Few preventive strategies are available in this case, although the development of fast recovery strategies or redundant manufacturing capacity can help to prevent risk spreading (Blackhurst et al, 2005). If partners assumed this risk cannot be prevented, the mitigation actions should aim at sharing the risk through compensation funds or safety stocks.

Partners' inadequate capacity

The buyer is using a high percentage of the single source production capacity, thus supplier cannot absorb a higher demand or provide a quick response to late modifications. If the likelihood of occurrence is low, business process interoperability between supplier and buyer and joint planning, in order to transfer part of the work in progress to the buyer, can be a preventive solution. In other case, the buyer should consider whether it is better to support the supplier so it can grow (Tang and Tomlin, 2008).

Partners' inability to conform specifications

This trigger is related to the product quality and it can have two different components. On one hand, the supplier/buyer may have troubles for controlling the performance and quality of their business processes. On the other hand, the problem may be that it is unable to fulfill the order because it lacks the necessary knowledge or technology. Preventive measures include here the development of long-term quality assurance collaborative programs and the leasing of assets or knowledge. Whereas to undertake risk mitigation tasks the development of early-warning, that allow partners to inform about the performance loss of some business process, can be very interesting to eliminate poor quality inventory.

Shipment disruption or delays

The cause of delivery delay may be internal or external to the supply chain. If the cause is internal, it will certainly be due to one of the aforementioned risks. Therefore, here only the external cause is explained. Third party logistics providers can be risky not only due to its intrinsic business process risks but also due to intermodal transport risks at ports, taxes or customs. Avoidance strategy can be implemented using a proper supplier selection process. It is crucial to contract external stakeholders that have quality assurance certification programs.

5 Conclusions

Single source (SS) procurement is a strategic decision that can have a positive effect on the supply chain efficiency thanks to a productivity improvement and overall growth potential. However, it also exposes partners to risks if information is not shared and all the allies work together to overcome potential risks.

Supply chain risk management process is a suitable method to reduce risk, ie their occurrence likelihood and / or economic impact, if all members follow it with rigor, discipline and transparency in order to formulate business rules.

In the case of SS strategy there are four sourcing risks to which all the partners are vulnerable: supplier production stoppage or inadequate capacity, its inability to conform specifications or shipment delays due to third party logistics services. In all these cases, even if the solution is not simple, there are strategies based on process interoperability, leasing of assets or knowledge and the development of collaborative quality assurance programs that can prevent the consequences.

6 References

Berger PD, Gerstenfeld A, Zeng AZ (2004) How many suppliers are best? A decision-analysis approach. Omega 32: 9–15

Blackhurst, J., Craighead, C.W., Elkins, D. and Handfield, R.B. (2005) An empirically derived agenda of critical research issues for managing supply- chain disruptions. Int. J. Prod. Rese. 43: 4067 - 4081.

Cucchiella F, Gastaldi M (2006) Risk management in supplychain: a real option approach, J. Manuf. Techn. Manag. 17:700-720

Lambert D. M, Editor, Supply Chain Management: Processes, Partnerships, Performance, Third Edition, Sarasota, FL: Supply Chain Management Institute, 2008, p. 21.

Ritchie B, Brindley C (2007) Supply chain risk managementand performance: A guiding framework for future development. Int. J. Oper. Prod Man. 27:303-32

Tang O, Musa SN (2011) Identifying risk issues and research advancements in supply chain risk management. Int. J. Prod Econ 133:25–34

Tang, C. and Tomlin, B. (2008) The power of flexibility for mitigating supply chain risks. Int. J. Prod. Econ. 116 (1): 12 - 27.

Tummala R, Schoenherr T (2011) Assessing and managing risks using the Supply Chain Risk Management Process (SCRMP). Suppl. Chain Manag. 16: 474–483

Wu T, Blackhurst J, Chidambaram V (2006) A model for inbound supply risk analysis. Computers in Industry 57:350–365

Zeng A Z, (2000). A synthetic study of sourcing strategies. Ind. Manag. Data Systems . 100: 219-226

018 Capacity increases in bottleneck processes: Case of study of its applicability to the carbon steel distribution transport process

Lobato Carral C, Andrés Romano C

Lobato Carral, Clemente (✉ e-mail: clelocar@doctor.upv.es)
Dpto. de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia

Andrés Romano, Carlos (✉ e-mail:candres@omp.upv.es)
Dpto. de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia

Abstract: Increased income in organizations can be achieved through new investments in non-current assets, outsourcing of services and/or capacity increases in bottleneck processes. Investing in new assets hinders investment in other, more profitable assets. Outsourcing reduces the managing control over processes, making it more difficult to guarantee value proposals. In contrast, increasing the capacity of bottleneck processes does not freeze relevant funds while at the same time allowing organizations to retain control over process management. In the specific case of the distribution business, where spreads are reduced as compared to financial requirements, cost reduction becomes key and even critical. In addition, lead times in the distribution business demand very tight lead targets –not in terms of accurate delivery dates, but in terms of reduction of total lead time. In fact, this is one of the value proposals that distinguish steel distributors from steel producers. To reduce those lead times, distributors have mainly two options: either they incorporate more extensive transport services, leading to reduced income statement results, or they reduce the cycle of the transport process through process analysis and improvement, for which no capital is needed.

Keywords: Bottleneck, SMED, Process, Carbon steel, Construction.

1 The importance of internal operations

The involvement of in-house operational teams is key to achieve an adequate financial-equity structure in organizations. The connection between both lies in the succession of cause-effect relationships between operational work and customer sales. Operative processes promote the transformation of accounted goods into customer balance. Inventories translate into money only if customers consume the goods provided by the company.

For their part, customers will consume the products or services provided by the company if –and only if- they perceive a greater value than that offered by competitors. In Strategy Theory, this is called ‘Value Proposal’ and can be briefly described as the value offered by a company leading a given customer to buy from that company as opposed to other companies. Depending on the type of business, value proposals will differ.

It is those value proposals that operational teams seek to secure and improve by optimizing internal operations. Internal processes are oriented towards ensuring that the customer will opt for the product provided by the company in its purchase decision.

Clearly, the achievement of optimal operational procedures must be supported by people trained to efficiently develop the functions assigned to them in line with the organization’s strategy.

Our case study concerns the distribution of carbon steel goods, where there is a wide diversity of weights and sizes and goods are usually handled with magnets, chains and/or slings made of various robust materials. In any case, order preparation, as well as loading and unloading cannot be carried out manually and require significant process times in some cases.

2 Analysis of the transport process: Case Study

The analysis developed in this case study is based on the fact that the involved company had identified the transport process as a bottleneck process of the system and, consequently, as the process that limited the capacity of the company to extend its sales.

Firstly, the real restrictions of the process were identified. Subsequently, actions were oriented towards exploiting those restrictions with the aim of abolishing all aspects that hinder or reduce the capacity of the analyzed process and thus increasing it. The system as a whole and all decisions taken were streamlined with the steps taken on those restrictions.

How does saturation of the transport process affect the company’s results? Figure 1 below presents a cause-and-effect diagram of the incidence on results. First and foremost, saturation of the transport process leads to customer dissatisfaction due to undelivered items. Secondly, it leads to the perception that it is better to abstain from biding than to get an order potentially leading to customer dissatisfaction. From the point of view of the financial-equity structure, we are thus confronted with a limitation on the “Receivables” account and, therefore, with reduce probabilities of converting the inventory to cash. In other words: the assets are less liquid. Consequently, the capacity of the transport process must be increased in order to achieve more valuable assets.

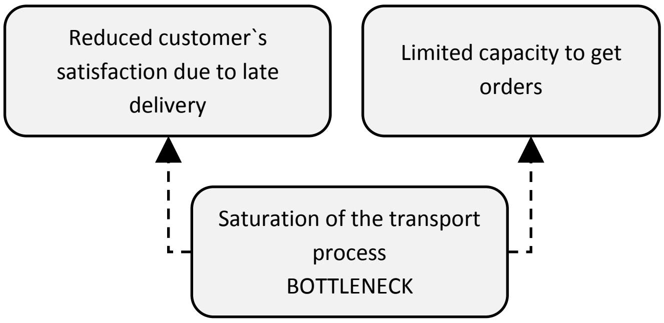


Fig. 1 Cause-effect of the bottleneck process "transport saturation"

Solutions to decongestion the transport process are linked to three aspects: outsourcing the service (expenses), incorporating new trucks (non-current assets) or increasing the capacity by improving the process..

3 Initial Measurement of the process

Table1 shows the initial values for the period January-March 2010:

Table 1 Initial values

		Initial Values 2010			
		Jan	**Feb**	**Mar**	**Total**
Unit	**Days**	19	20	22	61
Tonne	**Sales**	2.071	2.767	3.020	7.858
Unit	**Customers with sales**	672	722	764	719
Unit	**Delivery notes**	2.241	2.710	3.047	7.998
Unit	**Delivery notes lines**	5.060	6.175	6.999	18.234
Unit	**Delivery notes on time**	1.990	2.367	2.675	7.032
€	**Transport expenses**	36.308	46.304	49.881	132.493
	RATIOS				
t/day	**Sales**	109,0	138,4	137,3	128,8
DN/day	**Delivery notes (DN)**	117,9	135,5	138,5	131,1
Unit	**Customers with sales**	672,0	722,0	764,0	719,3
€/t	**Transport expenses**	17,5	16,7	16,5	16,9
%	**Service levels**	88,8%	87,3%	87,8%	87,9%

4 Identifying and exploiting limitations

The transport process can be subdivided in following tasks or milestones, represented in Figure 2 “Transport process cycle”.

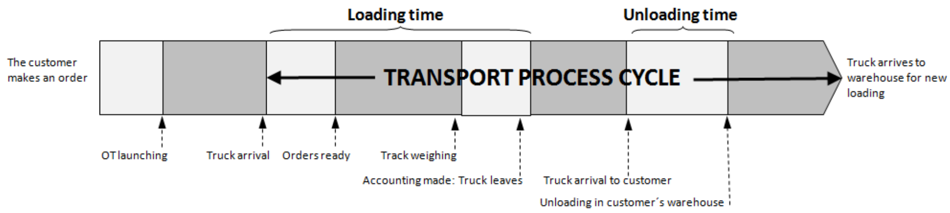


Fig. 2 Transport process cycle

Generally speaking, the effectiveness of the truck will depend on two aspects. Firstly, it depends on the transport programming, so that its management and the route planned are in line with the objective of delivering the highest amount of orders at the lowest cost, ensuring that the company meets the commitments made to customers. Secondly, it depends on the transport itself, understood as the period in which the truck is in service and thus with the aim of reducing downtime. The truck must be in service and stop only for loading and unloading. Such downtimes should be reduced as much as possible in order to achieve the maximum number of deliveries. Consequently, restrictions that increase downtime should be analyzed in order to abolish –or at least reduce- them.

4.1 The loading time

The loading time is the most significant of the downtime periods that negatively affect transport efficiency. The analysis of this this task led to the identification of a series of root causes shown in Figure 3.

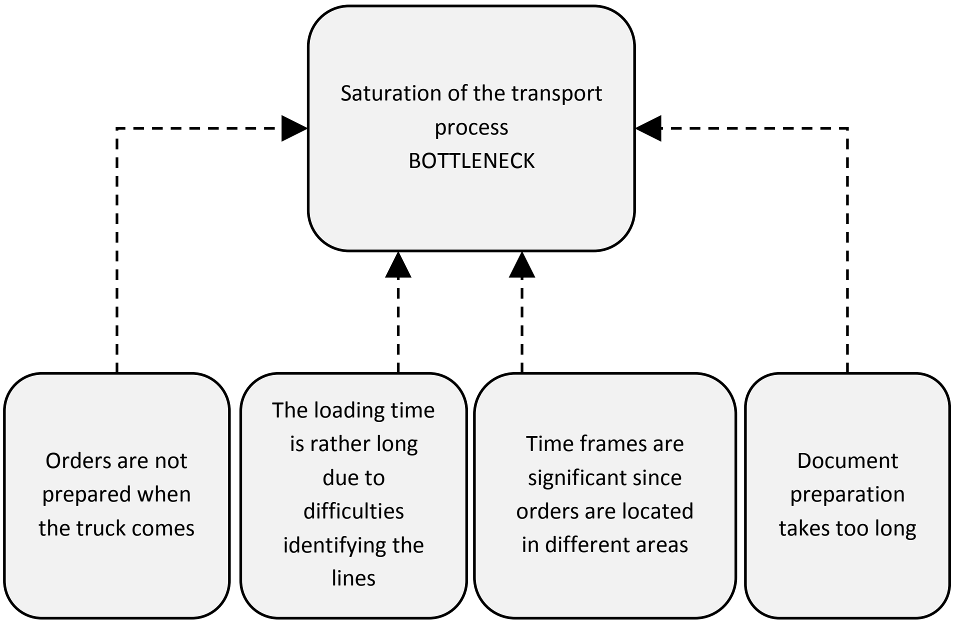


Fig. 3 Diagram of root causes leading to longer loading times

- **Orders are not prepared when the truck comes**. Indeed, many orders that should be loaded in the truck waiting on the loading dock are not prepared. However, there are many prepared orders not foreseen for immediate loading or even not foreseen for that day. Orders are prepared on the basis of their reception date. Consequently, as the transport manager gets more clarity on the expected truck arrival times, the order preparation schedule should be re-defined. The target: all orders for the following loading must be ready when the truck comes.

- **The loading time is rather long due to difficulties identifying the lines.** The picking area is divided in 3 different buffers according to areas defined as North, Middle and South. Each area comprises 5 or 6 specific routes. In other words: Inside the order lines buffer for the North area there are 6 different loads, all mixed up. Considering that each buffer comprises between 40 and 50 order lines, one must seek the order lines for the next loading in each of them. To improve this task, two measures were taken. Firstly, we decided to assign an operator to unify each loading as soon as the arrival of the next truck was known, so that this task did not have to wait until the actual arrival of the truck. In a second stage, goods were separated by specific route in each buffer, so that the identification label –consistently with that aim- would already identify the route in question within the buffer. When moving the goods between the preparation and the picking areas, they were left directly in the corresponding sub-buffer. When the truck arrives, identification is faster, since it has been prepared in advance.

- **Time frames are significant since orders are located in different areas of the warehouse.** Although 90% of the order lines are located in the picking area, the remaining 10% is in other working units, such as the structural, cut-to-length sections. An all-in-one loading in one single dock is much more simple and leaves less room for delays.
- **Document preparation takes too long.** Various documents are needed before the truck can leave the warehouse, being the main ones delivery notes and quality certificates. Could orders be weighed before the truck arrives? The answer to this question is positive, since the warehouse is equipped with hook scales that allow for orders to be weighed while they are being lifted with the bridge crane.

The need to prepare the documents before truck arrival also applies to delivery notes.

We see that the changes introduced are based on what can be called "*the order of factors*", rather than modifying those factors. Using the SMED terminology, certain tasks that were previously executed as internal tasks and that took place while the truck was waiting at the warehouse (flow A in Figure 4), started to be executed as what they were: external tasks, since they can well be executed while the truck is on route (flow A in Figure 4).

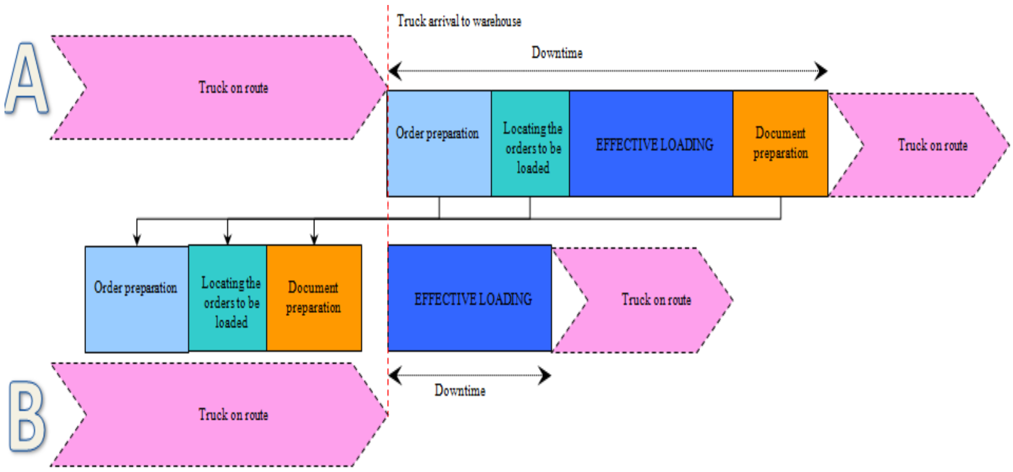


Fig. 4 Changes to the transport cycle

The one resource that should not be wasted through downtime is the truck. Consequently, all decisions should be subject to it being in service as long as possible. To achieve this, all functions that can be carried out while the truck is delivering the goods should be carried out in advance: prepare the orders, move the goods to be loaded towards the dock, prepare the documents, etc.

4.2 The unloading time

Although the unloading does not take place at once –since there are several customers- the sum of all unloading times leads to inefficiency in the transport process, since the truck has to stop during all of them. As shown in Figure 5, the analysis of this task indicates following root causes:

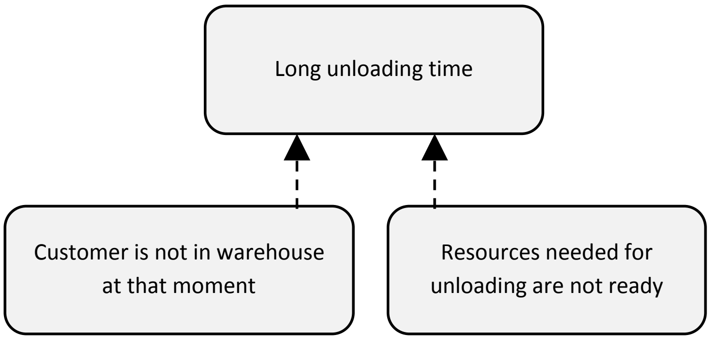


Fig. 5 Cause and effect of unloading time

- **The customer's warehouse is not open when the truck arrives.** This first aspect could apply to any time of the day, but it is most frequent during lunchtime as well as at opening and closing times in the morning and evening. Whatever the timing, telephonic contact with customers as soon as their warehouse becomes the next one in the route is essential. Since unloading times are subject to statistical fluctuations and multiple potential incidents, the time frame of arrival to the next customer is known when the unloading of the previous customer is completed. For this reason, we introduced the "call the next destination" approach, in which the truck driver communicates the customer the expected time of arrival and consistently takes a decision to reduce downtime to a minimum.
- **The warehouse's resources are not ready when the truck arrives.** This case is similar to the ones described in the loading time section. The "call the next destination" approach is used to remind the customer that the preparation tasks should be carried out while the truck is on route to their warehouse instead of starting them when the truck arrives: available room, ready operators, handling tools at hand, etc.

5 Measuring the process after improvements

Table 2 shows the values measured after introducing the changes discussed as compared to initial values:

Table 2 Values after the improvements as compared to initial values

		Initial Values				Values After Improvements			
		Jan	Feb	Mar	Total	Apr	May	Jun	Total
Unit	Dias	19	20	22	61	20	21	23	64
Tonne	Ventas	2.071	2.767	3.020	7.858	2.950	2.712	2.997	8.659
Unit	Customers with sales	672	722	764	719	736	754	794	761
Unit	Delivery notes	2.241	2.710	3.047	7.998	2.789	3.113	3.489	9.391
Unit	Delivery note lines	5.060	6.175	6.999	18.234	6.199	7.169	7.929	21.297
Unit	Delivery notes on time	1.990	2.367	2.675	7.032	2.499	2.874	3.195	8.568
€	Transport expenses	36.308	46.304	49.881	132.493	44.322	39.665	42.177	126.164
	Ratios								
t/day	Sales	109,0	138,4	137,3	**128,8**	147,5	129,1	130,3	**135,3**
DN/day	Delivery notes	117,9	135,5	138,5	**131,1**	139,5	148,2	151,7	**146,7**
Unit	Customers with sales	672,0	722,0	764,0	**719,3**	736,0	754,0	794,0	**761,3**
€/t	Transport expenses	17,5	16,7	16,5	**16,9**	15,0	14,6	14,1	**14,6**
%	Service levels	88,8%	87,3%	87,8%	**87,9%**	89,6%	92,3%	91,6%	**91,2%**

The different ratios defining the process improvements evolved as follows:

- **Sales (t/day):** From 128.8 t/day to 135.3 t/day_ +5%
- **Delivery notes DN/day):** From 131.1 DN/day to 146.7 DN/day _ +11.9%
- **Number of customers with sales**: From 719.3 to 761.3 _ +5.8%
- **Transport expenses:** From €16.9 to €14.6 _-13.6%.
- **Service levels:** From 87.9% to 91.2% _ +3.3%

6 Conclusions and teaching considerations

In transport processes, like in any other process, there is scope for improvement provided that the analysis is based in a sequence of steps taking the identification of bottlenecks and capacity-restricting tasks as the starting point. As continuous improvement is implemented as the right path to achieve an optimal financial-equity structure, results become more incremental. The first introduction of improvements can lead to very positive results, but results should always be quantitative. What cannot be measured, cannot be managed, since the veracity of the actions taken remains unknown.

In our case study, results were highly positive. Continuous revision of the tasks and actions and what we have called "the order of factors" can lead to continuous improvements and should become the operative management approach on principle.

7 References

Alonso Mollar, Eduardo (2004) ABC de las Finanzas. CeaC técnico Empresa.

Cosimo Chiesa De Negri (20029 Fidelizando para fidelizar. Ediciones Universidad de Navarra S.A.

Robert S. Kaplan, David P. Norton (September 1996) The Balanced Scorecard: Translating Strategy into action. Harvard Business Review Press

Robert S. Kaplan, David P. Norton (January/February 1996) Using the Balanced Scorecard as a Strategic Management System. Harvard Business Review

Enrique Teixidó, Andrés Parreño (1997) Reingeniería de procesos y costes ABC/ABM: introducción al Management del Denominador. ConsultingAdim

Eliyahu M. Goldratt (1984) La Meta, Un proceso de mejora continua. Ediciones Diaz de Santos

Eliyahu M. Goldratt (1994) No es cuestión de suerte. Ediciones Diaz de Santos

Robert S. Kaplan, David P. Norton (January/February 1992) The Balanced Scorecard: Measures that drive performance. Harvard Business Review

Alonso García, Angel (1997) Conceptos de Organización Industrial Editorial Marcombo, S.A.

036 A practical tool for computing base stock levels following an ABC classification

Babiloni E, Cardos, M, Guijarro E, Palmer, M E

Eugenia Babiloni Griñón (✉ e-mail:mabagri@doe.upv.es)
Dpto. de Organización de Empresas. Universitat Politècnica de València, Camino de Vera s/n, 46022, Valencia. Spain

Abstract: This paper provides a tool to select the best method to compute the base stock level, *S*, given a target Cycle Service Level, *CSL*. It is assumed that inventories are managed by the periodic (R, S) system assuming lost sales and discrete demands. Under these assumptions, we find four methods to compute S: the approximated *Classic*, *PI, PII*, and the *exact*. Given that the exact method is very complex, it is important to know under which conditions it is possible to use one of the approximated methods and the risks of using any of them. We show that it is possible to identify regions where the approximate methods show similar performance and characterize them in suitable maps to help managers to determine the best method to compute base stock levels depending on: (1) demand characteristics of the item, (2) the lead time and the review period and (3) the target service level. The results are presented by using an implementation of how to use the results using an ABC classification of items.

Keywords: Inventory; Stock level; Cycle Service Level; ABC classification.

1 Introduction

The design of an inventory system starts with an analysis of the characteristics of items to be managed. This analysis has a twofold purpose: (1) to identify the relative importance of the item in order to define, for instance, the service level the item should reach and (2) to chose the best forecasting and stock policy. For (1), ABC classification is widely used as shown (Fogarty et al. 1991), (Silver et al. 1998) or (Teunter et al.,2010). For (2), categorization strategies of the demand pattern of the item seem to be an appropriate approach that is commonly used in practice. However, to the best of our knowledge, there is no similar approach for selecting the best method to determine the control parameters of an inventory policy, and this paper focuses on this lack.

This paper focuses on the traditional periodic review, base stock policy, when the periodic review, R, is predefined. The control procedure is that every R periods of time, enough is ordered to raise the inventory position to the base stock level, S. Furthermore, this research assumes the realistic case of discrete demands and focuses on the *lost sales* case, i.e. demand that it is not satisfied is lost. For a long time, inventory research has focused on systems where unmet demand is backordered. This is mainly because backordering models are easier to formulate and simpler to analyze [see (Hadley and Whitin, 1963), (Zipkin, 2008) and (Bijvank and Vis, 2011)]. However, there are many real life situations where customers are impatient and will go to other sources to satisfy their need as shown (Hadley & Whitin 1963), (Silver, Pyke, & Peterson 1998) and (Thomopoulos, 2004) or in sectors such as retailing or commodity markets, where the unfulfilled demand is lost and unrecorded as shown (Agrawal and Smith, 1998), (Johansen, 2005) and (Bijvank and Vis, 2012). These are some of the reason because of there are an increasing interests in developing new researches for the lost sales case.

This paper uses the *cycle service level*, *CSL*, which indicates the fraction of cycles in which there is not stock outs, to determine the base stock level of the stock policy. In the literature it is found four methods to compute the *CSL* in a discrete context the approximated *Classic*, *PI*, *PII* methods and the *exact* method (Cardos and Babiloni,2011). Once a target fill rate is defined by the company, we can use one of these four methods to compute the base stock. *Classic* and *PII* are close formulas. However *PI* and the *exact* require iterations. Furthermore to find the base stock using the *exact* method requires computing S-times the transition matrixes to find the probability of every on-hand stock level at the beginning of the replenishment cycle. Therefore the exact method is the most complex and time-consuming of the *CSL* methods, and this is one of the facts that motivate this paper. (Babiloni 2009)carries out a large experiment in order to identify under which conditions it is possible to use one of the approximate methods (*Classic*, *PII* or *PI*) instead of the *exact* one. The objective of this paper is to show how the results of (Babiloni 2009)can be used in practical environments. In that sense and following an ABC classification of items, we propose two dimension maps where zones of homogeneous performance of the approximate methods there are identified. For every of these zones and every type of item, we suggest the most efficient method to compute the stock level, S.

The rest of the paper is organized as follows. Section 2 dedicates to explain presents the reference framework for selecting the efficient method to compute base stock levels. Section 3 presents an example of how the reference framework can be used in practical environments using an ABC classification. Finally, Section 4 summarizes the most relevant conclusions of this research.

2 Reference framework to select the efficient method to compute *S*

Results of (Babiloni 2009) reveals the underlying model behind the performance of the approximate methods *PI*, *PII* and *Classic* and identifies zones showing an homogeneous performance when they are used to compute base stock levels. Table 1 present a summary of the type and amount of relative errors arising from using any of the approximate method in every zone. This homogeneous zones are limited delimited by the *CSL*, the squared coefficient of variation, CV^2, and the average demand during the review period plus the lead time, μ_{R+L} and the symmetry coefficient,M3.·At this point it is important to explain the meaning of having classification errors type 1 (*CE1*) and type 2 (*CE2*). When the relative error is negative the approximate method gives a base stock level which is greater than the exact one, i.e. $S_{approx}>S_{exact}$, and therefore the system reaches the target *CSL*. In this case, there is not impact in the service level of the system, although may cause an increase of the average stock level over the time and the total costs of the system. This type of classification error is named as *CE1*. On the other hand, if the relative error is positive, the approximate base stock level is lower than the exact one, i.e. $S_{approx}<S_{exact}$, which means that the system is not reaching the target *CSL* which it is designed for. This type of classification error is called *CE2*.

Table 1 contains all the relevant information to select or to evaluate risks that arise from using *classic*, *PII* or *PI* to compute *S*. The practical purpose of this reference framework is as decision tool. In this sense it may assist managers to select the most simple and accurate method to compute the base stock level of an item or item categories depending on its CV^2, μ_{R+L}, *M3* and the target *CSL*. The following Section illustrates how it can be use in practice.

3 A practical application to compute base stock levels following an ABC classification

This Section illustrates how to use the results from Table 1 following an ABC classification based on the criticality of items. According to this, we assume that: A items are the most strategically important for the business, so the objective when managing these items could be to avoid stock outs while maintaining a high *CSL*; B items requires lower *CSL* and some stock out risk may be accepted to reduce the complexity on the determination of the base stock levels; and C items show the lowest *CSL* and less criticality.

Table 1. Relative errors per homogeneous zones in the estimation of base stock levels

CV²	μ_{R+L}	***CSL***	***M3***	***Classic (%)***		***PII (%)***	***PI (%)***
				CE1	***CE2***	***CE1***	***CE1***
≤ 0.133	1.61 - 2.49	—	—	0.29	9.86	20.94	19.34
0.133 - 0.38	1.61 - 2.49	—	—	0.00	23.60	24.55	21.11
≤ 0.28	≤ 1.61	—	—	0.00	70.34	10.06	5.77
0.28 - 0.57	≤ 1.61	—	—	0.00	90.48	24.13	7.25
0.38 - 0.66	1.61 - 3.30	—	—	0.00	50.96	31.96	20.94
> 0.57	≤ 1.61	—	—	0.00	100.0	49.43	3.69
> 0.66	1.61 - 3.30	—	—	0.00	95.17	53.13	21.45
0.21 - 0.38	2.49 - 3.30	≤ 0.72	—	3.68	8.95	36.32	32.63
≤ 0.21	2.49 - 3.30	≤ 0.72	—	14.31	0.51	35.33	34.11
≤ 0.38	2.49 - 3.30	> 0.72	—	2.44	5.19	16.24	16.24
≤ 0.72	3.30 - 3.89	0.87 - 0.97	—	0.00	4.64	9.29	9.02
≤ 0.72	3.30 - 6.66	≤ 0.87	—	32.66	0.46	46.74	46.02
0.72 - 0.99	3.30 - 6.66	≤ 0.97	—	3.65	29.41	55.88	45.41
≤ 0.74	> 3.30	> 0.97	—	4.08	0.67	4.74	4.71
> 0.74	> 3.30	> 0.97	—	13.00	10.70	23.20	21.10
≤ 0.72	3.89 - 6.66	0.87 - 0.92	—	6.44	0.15	14.20	14.06
≤ 0.72	3.89 - 6.66	0.87 - 0.92	—	14.35	0.29	22.55	22.55
> 0.99	3.30 - 6.66	≤ 0.97	—	—	94.24	76.97	46.36
—	> 6.66	0.87 - 0.97	≤ -1.32	5.64	—	5.64	5.64
—	> 6.66	≤ 0.87	—	81.01	0.21	82.15	82.11
—	> 6.66	0.87 - 0.97	> -1.32	41.39	0.48	42.84	42.76

According to these assumptions, we suggest a maximum percentage of misclassified *CE1* and *CE2* per node and a target *CSL* per type of item (Table 3). Then, for example for a items we select the simpler method that shows *CE1*≤25% and *CE2*≤1% for each node. Note that the risk of falling into unexpected stock outs is given by the *CE2* (it underestimates the exact value of *S* and therefore the policy is not reaching the target *CSL*) whereas the *CE1* errors entails the risk of increasing unnecessarily the base stock level. We proceed in the same way for B and C items. The results of this example are summarized graphically in Figure 1, Figure 2, Figure 3, Figure 4 and Figure 5.

Figure 1 applies to A items when the target *CSL*>0.97. As expected, when μ_{R+L} rates are low, *PI* appears for high CV^2 and *PII* for low CV^2. The *classic* method is the best option when the demand rate increases and CV^2<0.746. Note that in this map the *exact* method is not required in any node.

Figure 2 focuses on A items when 0.90≤*CSL*≤0.97. In this cases, when μ_{R+L}>6.66 the *exact* method is required to fulfill the limits.

Table 2. Values for the target *CSL*, percentage of *CE1* and EC2 based on an ABC classification (example)

Category	Target *CSL*	*CE1*	*CE2*
A	*CSL*≥0.90	≤25%	≤1%
B	0.75≤*CSL*≤0.90	≤50%	≤10%
C	*CSL*≤0.75	≤100%	≤30%

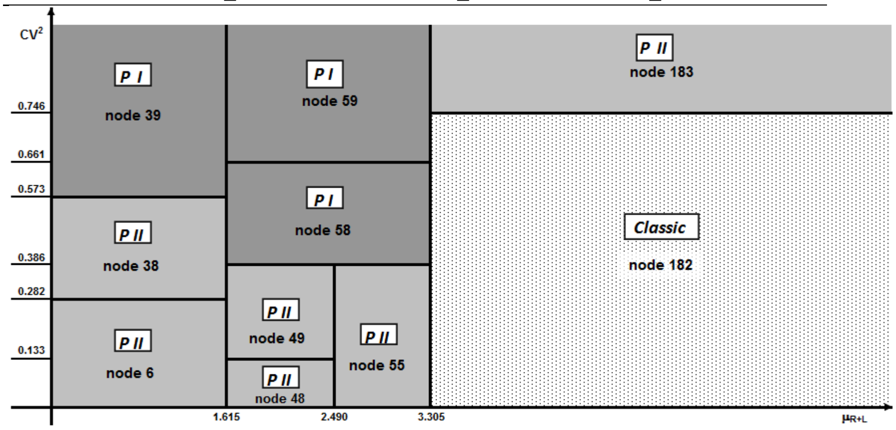


Figure 1. Methods to compute *S* for A items when *CSL*>0.97 (example)

Figure 3 and Figure 4 are dedicated to B items when 0.875≤*CSL*≤0.90 and 0.70≤*CSL*<0.875 respectively. Since the percentage of misclassified cases allowed is greater than that for A items, the suggested methods to compute *S* are also mathematically simpler. Therefore, the presence of the *classic* method is more evident, even for a wide range of CV^2values.

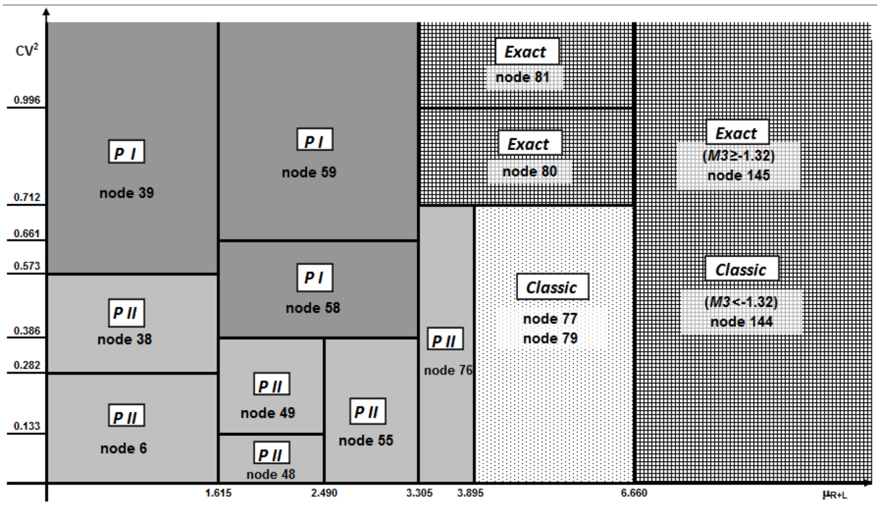


Figure 2. Methods to compute S for A items when $0.90 \leq CSL \leq 0.97$ (example)

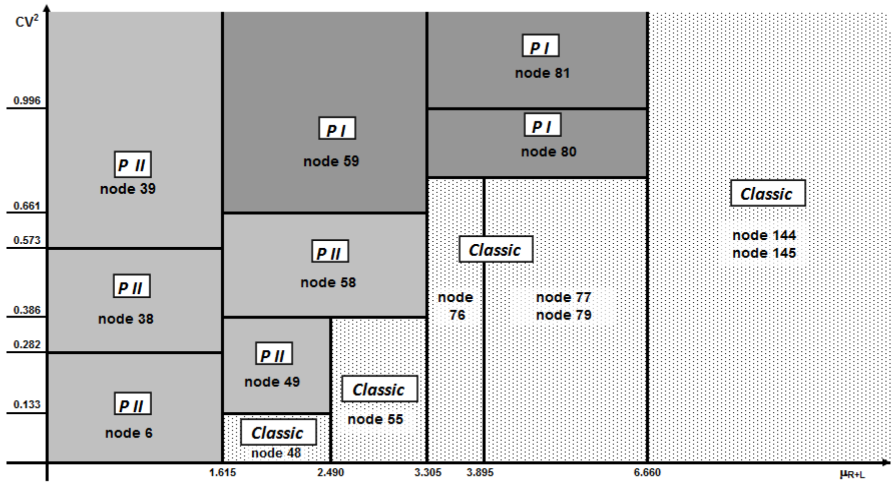


Figure 3. Methods to compute S for B items when $0.875 \leq CSL \leq 0.97$ (example)

Finally, Figure 5 is dedicated to C items. As expected, *PII* is required for low demand rates and high CV^2, and the *classic* one as the demand rate increases. Given that we allow any value of *CE1* the *exact* and *PI* method are not selected for this category.

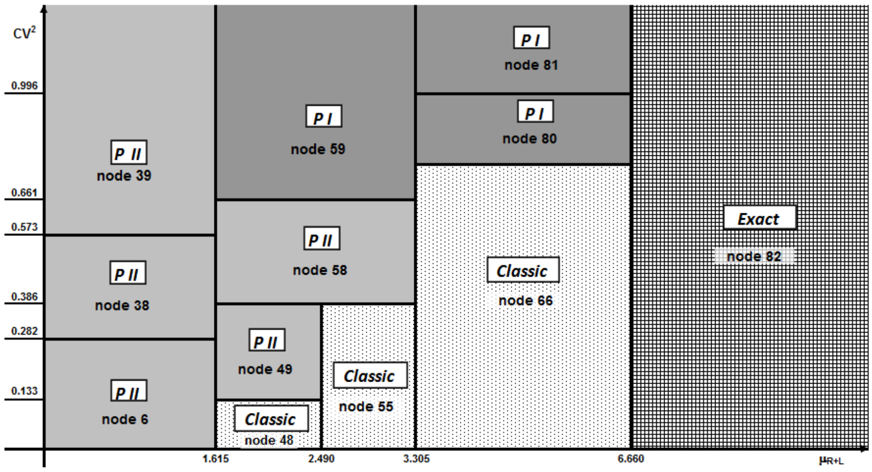


Figure 4. Methods to compute *S* for B items when 0.75≤*CSL*≤0.875 (example)

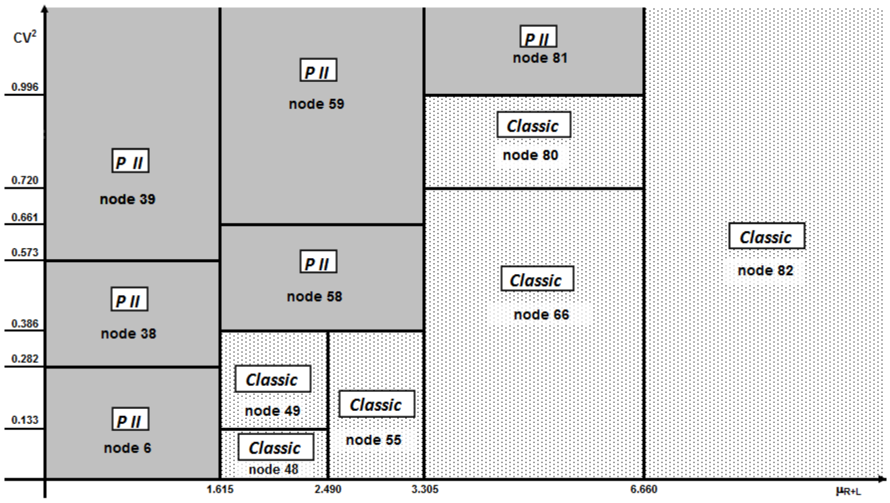


Figure 5. Methods to compute *S* for C items (example)

4 Summary and conclusions

This paper focuses on how to compute the base stock level of an item or item category given a target *CSL* when demand follows any discrete distribution function and the inventory is periodically reviewed in a lost sales context. In practical environments, the results of this research will help managers in the decision making process of selecting the best method to estimate base stock levels. This decision is a trade-off between the complexity of the method since and the risks from using them. In this sense, risks associated to adopt any decision in terms of relative deviations between exact and approximate base stock levels are also addressed in this paper.

Section 3 presents an example of how managers can use the results presented in Table 1 to create suitable maps where representing which method, *exact* or approximate, will be the efficient one in every homogeneous zone depending on an ABC classification.

5 References

Agrawal, N., Smith, S.A. 1998. Estimating negative binomial demand for retail inventory management with unobservable lost sales. Naval Research Logistics, 43, (6), 839-861.

Babiloni, E. 2009. Una metodología para la estimación eficiente del stock de referencia en políticas de revisión periódica con demanda discreta. Tesis Doctoral Disponible en RIUNET. Universitat Politècnica de València. Departamento de Organización de Empresas.

Bijvank, M., Vis, I.F.A. 2011. Lost-sales inventory theory: A review. European Journal of Operational Research, 215, (1), 1-13.

Bijvank, M., Vis, I.F.A. 2012. Lost-sales inventory systems with a service level criterion. European Journal of Operational Research, 220, (3), 610-618.

Cardos, M., Babiloni, E. 2011. Exact and approximate calculation of the cycle service level in periodic review inventory policies. International Journal of Production Economics, 131, (1), 63-68.

Fogarty, D.W., Blackstone, J.H., & Hoffman, T.R. 1991. Production and Inventory Management, Second Edition ed. Cincinnati, Ohio, South-Western Publishing Co.

Hadley, G. & Whitin, T. 1963. Analysis of Inventory Systems Englewood Cliffs, NJ, Prentice-Hall.

Johansen, S.G. 2005. Base-stock policies for the lost sales inventory system with Poisson demand and Erlangian lead times. International Journal of Production Economics, 93, (4), 429-437.

Silver, E.A., Pyke, D.F., & Peterson, R. 1998. Inventory Management and Production Planning and Scheduling, Third Edition ed. New Jersey, John Wiley & Sons.

Teunter, R.H. et al. 2010. ABC Classification: Service Levels and Inventory Costs. Production and Operations Management, 19, (3), 343-352.

Thomopoulos, N. 2004. Demands, Backorders, Service Level, Lost Sales and Effective Service Level. Journal of Business & Economics Research, 2, (11), 87-92.

Zipkin, P. 2008. Old and New Methods for Lost-Sales Inventory Systems. Operations Research, 56, (5), 1256-1263.

037 Application of Classification and Regression Trees on the selection of methods to compute stock levels

Guijarro E, Babiloni E, Cardos M, Albarracín J M

Eugenia Babiloni Griñón (✉ e-mail:mabagri@doe.upv.es)
Dpto. de Organización de Empresas. Universitat Politècnica de València, Camino de Vera s/n, 46022, Valencia. Spain

Abstract: This paper focuses on the estimation of base stock levels based on the service approach for the periodic review, base stock system (*R, S*). This paper considers one *exact* and three approximate methods to compute *S* based on a target *CSL*: *classic*, *PI* and *PII.* We assume that demand follows any discrete distribution function. We carry out an extensive experiment whose results are analyzed by using Classification and Regression Trees methodology. As a result we find zones of similar performance of the approximate methods and represent them in a novel space of representation delimited by the coefficient of variation of demand and the average demand over the revision period plus the lead time. Finally we summarize all the information in a two dimension charts with the aim of helping managers in the decision making process of determining the best method to compute *S*.

Keywords: Inventory; periodic review; lost sales; cycle service level, base stock, classification and regression Trees.

1 Introduction

One of the traditional problems in inventory management consists of how to compute accurately the base stock level in a periodic review inventory system. It can be used the cost approach and trying to find the optimal policy that minimizes the total costs of the system [(Huh et al., 2009)]. However the out-of-stock cost is difficult to quantify and eventually is dependent on both the item and the industrial environment. Another approach focuses on setting a target service level and computing the base stock that guarantees its achievement. As (Bijvank and Vis, 2012) point out this service approach is useful when a service level restriction is imposed by the replenishment process and is easier to define a target service level than all the costs. To implement the service approach first of all it is required to select the service measure. This paper use the cycle service level, *CSL* (1-

stockout probability), mainly due to two reasons. In practical environments the *CSL* can be used to classify items on an ABC bases in order to minimize total costs [(Teunter et al., 2010)]. In fact, the *CSL* criterion is more restrictive in terms of service than the fill rate. The second and more important reason is about the difference between sales and demand. Sales are equivalent to the satisfied demand of an item. However demand includes sales and also unmet demand which is not recorded or even known in most sectors such as the retailing or commodity markets (Sloot et al., 2005). Therefore, when unmet demand is unknown, the *CSL* is more appropriate as service measure than the fill rate. This reasoning is especially relevant when the unmet demand is lost as we assume in this paper. (Karlin and Scarf 1958) show that characterizing the optimal policy when lost sales occurs is difficult, whereas backordering models are easier to formulate and simpler to analyze (Bijvank and Vis, 2011).

The classic definition of the *CSL* indicates the probability of no stock out per replenishment cycle [(Chopra and Meindl 2004)]. A stock out is defined by (Silver et al. 1998) as the moment when the on-hand stock drops to zero. Hence, the *CSL* can be expressed as the fraction of cycles in which the on-hand stock does not drop to zero. However this definition neglects the probability of no demand during a cycle. For these reasons (Cardos and Babiloni, 2011) suggest computing the *CSL* as the fraction of replenishment cycles in which non-zero demand is completely satisfied by the on-hand stock. Following this definition, they suggest one exact method, which is time-consuming and requires a sound mathematical background to use it, and two approximate methods (named *PI* and *PII*) to compute the *CSL*. Despite (Cardos and Babiloni, 2011) show deviations from using the classic, *PI* and *PII* methods when computing the *CSL*, unanswered questions are how they perform when computing base stock levels and when they can be used.

To accomplish the objective we carry out an extensive experiment with the aim of finding the simplest and most accurate method to compute the base stock level. For that purpose we use Classification and Regression Trees (denoted by CART in the rest) [see (Breiman et al. 1984) for details]. The application of CART allows identifying when the approximate methods perform well, i.e. compute exactly the base stock level or when the exact method is required. We find areas of similar performance of the classic, *PI* and *PII* that can be explained by some variables.

The rest of the paper is organized as follows. Section 2 dedicates to the determination of base stock levels, including notation and assumption, methods for determining them and the details of the numerical experiment. Section 3 focuses on the application of the CART and its interpretation.

2 Determination of base stock levels

2.1 Notation and assumptions

This paper considers the traditional periodic review, order up to level (*R, S*) system that launches a replenishment order every *R* units of time of sufficient magnitude to raise the inventory to the base stock, *S*. We focus on a single item and consider that the constant review interval has been previously determined. In the rest we assume that: (i) time is discrete and is organized in a numerable and infinite succession of equi-spaced instants; (ii) the lead time is constant; (iii) only one outstanding replenishment order is launched within any period; (iv) backlogged demand is not allowed; (v) the replenishment order is added to the inventory at the end of the period in which it is received, hence these products are available for the next period; (vi) demand during a period is fulfilled with the on-hand stock at the beginning of the period; and (vii) the demand process is considered stationary, i.i.d., and defined by any discrete function. Note that assumption (iii) is widely used in the common derivation of policies for the lost sales assumption [(Hill and Johansen,2006)]. Notation in the rest of the paper is as follows:

- S = base stock level (units),
- R = review period corresponding to the time between two consecutive reviews and replenishment cycle corresponding to the time between two consecutive deliveries (time units),
- L = lead time for the replenishment order (time units),
- z_t = on-hand stock at time *t* from the first replenishment (units),
- D_t = total demand during *t* consecutive periods (units),
- $f_t(\cdot)$ = probability mass function of D_t
- $F_t(\cdot)$ = cumulative distribution function of D_t
- $\delta(\cdot)$ = function to compute base stock levels of which domain is the target *CSL*

2.2 Methods

In a continuous demand context the determination of base stock levels based on a target cycle service level constrain consists of solving $\delta(CSL) = S$. However, in a discrete demand context $\delta : \mathbb{N} \mapsto \mathbb{N}$ and therefore the problem turns on finding the minimum stock level that guarantees the achievement of the target *CSL:*

$$\begin{aligned} &Min\ S \\ &subject\ to \\ &\delta(CSL) \le S \quad \forall S \in \mathbb{N} \quad CSL \in [0,1] \end{aligned} \tag{1}$$

As the introduction section points out, we find four methods to compute $\delta(\cdot)$: *Classic*, *PII*, *PI* and *Exact*. When $\delta(\cdot) \equiv classic$ and $\delta(\cdot) \equiv PII$ the restriction of the model (1) is a closed-form expression as $S_{classic} \le F^{-1}{}_{R+L}(CSL)$ and $S_{PII} \le F^{-1}{}_{R+L}\left(F_R(0) + (1 - F_R(0)) \cdot CSL\right)$ respectively. However, in the case of $\delta(\cdot) \equiv PI$ and $\delta(\cdot) \equiv exact$ we need to solve it iteratively:

$$PI = \sum_{z_0=1}^{S} f_L(S - z_0) \frac{F_R(z_0) - F_R(0)}{1 - F_R(0)} \xrightarrow{thus} S_{PI} \le PI^{-1}(CSL)$$

$$Exact = \sum_{z_0=0}^{S} P(z_0) \frac{F_R(z_0) - F_R(0)}{1 - F_R(0)} \xrightarrow{thus} S_{Exact} \le Exact^{-1}(CSL)$$

Note that the case of $\delta(\cdot) \equiv exact$ is still more complicated since we need to know the probability of every on-hand stock level at the beginning of the cycle: $\overline{P(z_0)} = \left(P(z_0 = 0), P(z_0 = 1), \ldots, P(z_0 = S)\right)$. Given that the convergence of the probability transition matrix, $\overline{\overline{M}}_{(s+1)\times(s+1)}$, between the on-hand stock level at the beginning of the replenishment cycle to its ends leads to the exact value of the vector $\overline{P(z_0)}$ [see (Cardos and Babiloni,2011) for mathematical details], the number of iterations and the size of $\overline{\overline{M}}$ depend on *S* and for this reason the computation of the stock level turns very time-consuming (specially for high values of *S*). Therefore, it seems very convenient from a practical point of view to know when *PI*, *PII* and the *classic* method perform accurately for estimating base stock levels.

2.3 Definition of data and details of the numerical experiment

Table 1 presents the set of parameters selected as entry data in this experiment. To select parameters for each distribution we focus on considering the four demand categories suggested by (Syntetos et al.,2005), i.e. smooth, lumpy, intermittent and erratic. The experiment considers every feasible combination of these values per factor leading to 115,941 different cases. For each case we obtain four policies: (R, $S_{classic}$), (R, S_{PII}), (R, S_{PI}), (R, S_{Exact}). The experiment has been programming using JAVA language and will be available upon request.

Table 1. Entry Data

Factor			Values
Demand distribution			
Poisson(λ)	λ	=	0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 0.9, 1, 1.25, 1.5, 1.75, 2, 2.5, 3, 4, 5, 7, 10, 15, 20
Bin(n, θ)	n	=	1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 15, 20
	θ	=	0.01, 0.05, 0.1, 0.15, 0.25, 0.5, 0.75, 0.9, 0.95, 0.99
NegBin(r, θ)	r	=	0.05, 0.1, 0.2, 0.25, 0.3, 0.4, 0.5, 0.75, 0.9, 1, 1.25, 1.5, 1.75, 2, 2.5, 3, 3.5, 4, 5
	θ	=	0.1, 0.15, 0.25, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 0.99
Inventory system			
Target *CSL*		=	0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 0.99
Review Period, *R*		=	2, 3, 4, 5, 7, 10, 15, 20, 30
Lead time, *L*		=	1, 3, 5, 7, 10, 15, 20

2.3 Definition of data and details of the numerical experiment

Table 1 presents the set of parameters selected as entry data in this experiment. To select parameters for each distribution we focus on considering the four demand categories suggested by (Syntetos et al.,2005). The experiment considers every feasible combination of these values per factor leading to 115,941 different cases. For each case we obtain four policies: (R, $S_{classic}$), (R, S_{PII}), (R, S_{PI}), (R, S_{Exact}).

3 Application of CART to the results and sumary

Classification and Regression Trees are used to predict membership of cases in the classes of a categorical dependent variable from their measurements on one or more segmentation variables. Therefore its main goal is to predict or explain responses of the categorical dependent variable. The application of CART to analyze our experimental results has the purpose of identifying under which conditions an approximate method (*classic*, *PI* or *PII*) is accurate enough to estimate base stock levels. For every of the 115,941 cases we define a categorical dependent variable (denoted *EM* from "*Efficient Method*" in the rest) which indicates the simplest $\delta(\cdot)$ that leads to the exact base stock level. From a mathematical point of view, the *classic* is the simplest method, followed by *PII* and *PI*. Note that the *exact* method will be selected as *EM* if none of the approximate methods fulfils the condition. In order to choose the independent variables that will explain the model, we select those relating to the simplifications assumed in the derivation of the approximate methods. Specifically we choose: the random variable, the squared coefficient of variation of demand sizes (*CV^2*), the average inter-demand interval (*p*), the skewness (*M3*), the target *CSL*, the review period (*R*), the lead time (*L*), and the average demand during *R*+*L* (μ_{R+L}).

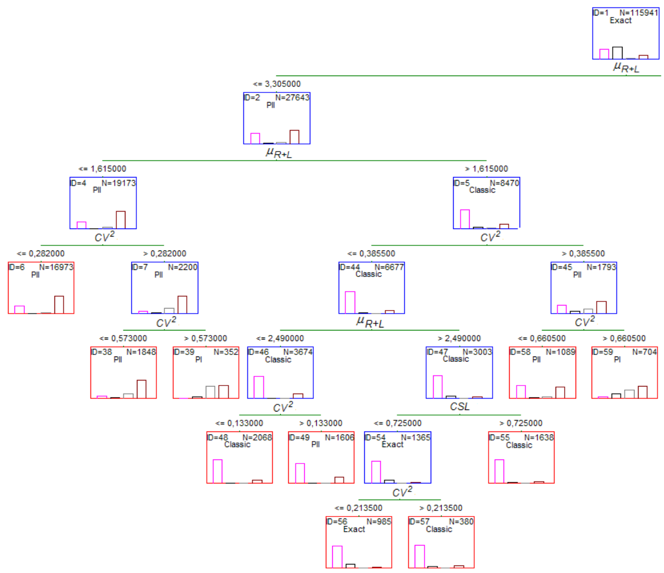


Fig. 1. Left branch of the CART for the most efficient method to compute *S*

Our analysis is carried out by using the software STATISTICA. The resulting CART (see Figure 1 and Figure 2) has 18 intermediate nodes and 21 final nodes. Each node shows: an identity number (ID); the number of cases the node has; the predicted *EM*; and the histogram of the cases where, from left to right, the classic, exact, *PI* and *PII* methods are observed as *EM*. For example, node 48 points out that the *EM* is the classic for 2,068 cases in which $CV^2 \leq 0.133$ and $1.615 < \mu_{R+L} \leq 2.490$. Regarding the independent variables, only CV^2, *M3*, μ_{R+L} and the target *CSL* become segmentation variables. Basically, the tree splits into two main branches. The left branch (Figure 1) includes the 27,643 cases which fulfill $\mu_{R+L} \leq 3.305$, with the CV2, the μ_{R+L} and the *CSL* as segmentation variables. The right branch of the tree (Figure 2) includes the rest of the cases.

For a better understanding and applicability of the results, Figure 3 and Figure 4 show a graphical representation of the final nodes of CART for *CSL*>0.97 and *CSL*≤0.97 respectively. A quick look into Figure 3 and Figure 4 reveals a pattern about how the segmentation variables affect the choice of one of the four methods as *EM*. Whenever the *CSL*>0.97 (See Figure 3) and the $\mu_{R+L} \leq 3.305$, the classic method is chosen only for very small CV^2 values, *PII* for intermediate CV^2 values and *PI* for the highest CV^2 values. In general, when the μ_{R+L} decreases a more complex method is required for high CV^2 values. On the other hand, for $\mu_{R+L}>3.305$ and $CV^2 \leq 0.72$ the *classic* method appears as the most efficient one and the *exact* for $CV^2>0.72$. Figure 4 ($CSL \leq 0.97$) shows a similar pattern for low μ_{R+L} rates. However, the *exact* method seems to be the best option when the μ_{R+L} increases. Note that nodes 6, 38, 39, 48, 49, 58 and 59 are independent of the *CSL* and therefore they appear in both figures.

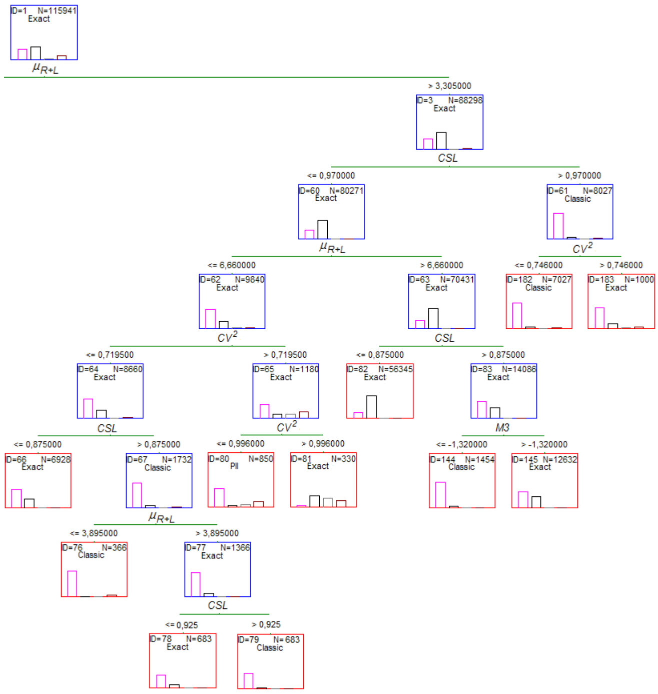


Fig. 2. Right branch of the CART for the most efficient method to compute *S*

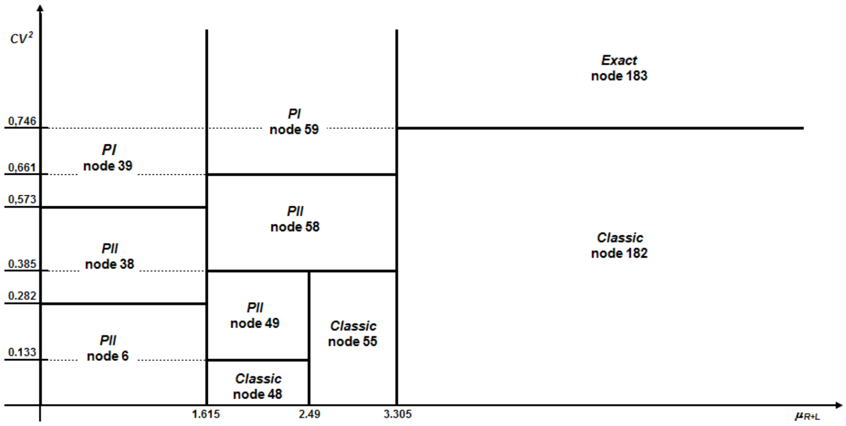


Fig. 3. Graphical representation of CART final nodes for *CSL*>0.97

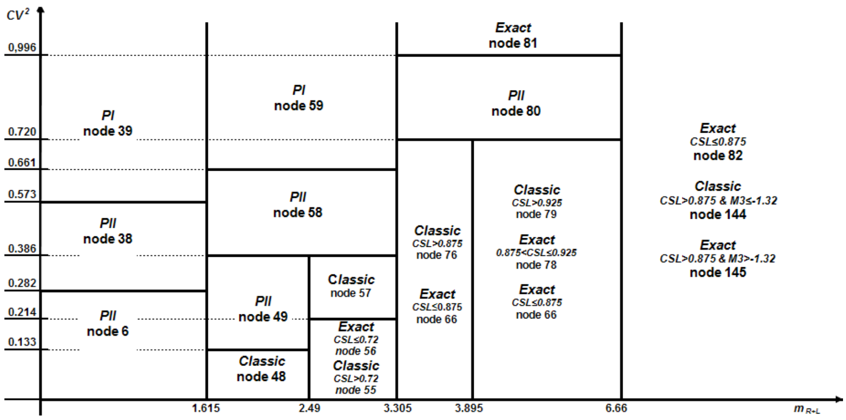


Fig. 4. Graphical representation of CART final nodes for *CSL*≤0.97

5 References

Bijvank, M., Vis, I.F.A. 2011. Lost-sales inventory theory: A review. European Journal of Operational Research, 215, (1), 1-13.

Bijvank, M., Vis, I.F.A. 2012. Lost-sales inventory systems with a service level criterion. European Journal of Operational Research, 220, (3), 610-618.

Breiman, L., Friedman, J., Stone, C., & Olshen, R. 1984. Classification and Regresion Trees United States of America, Chapman & Hall.

Cardos, M., Babiloni, E. 2011. Exact and approximate calculation of the cycle service level in periodic review inventory policies. International Journal of Production Economics, 131, (1), 63-68.

Chopra, S. & Meindl, P. 2004. Supply Chain Management, 2nd Edition ed. Pearson. Prentice Hall.

Hill, R.M., Johansen, S.G. 2006. Optimal and near-optimal policies for lost sales inventory models with at most one replenishment order outstanding. European Journal of Operational Research, 169, (1), 111-132.

Huh, W.T. et al. 2009. Asymptotic Optimality of Order-Up-To Policies in Lost Sales Inventory Systems. Management Science, 55, (3), 404-420.

Karlin, S. & Scarf, H. 1958. Studies in the Mathematical Theory of Inventory and Production Stanford University Press, Stanford, CA.

Silver, E.A., Pyke, D.F., & Peterson, R. 1998. Inventory Management and Production Planning and Scheduling, Third Edition ed. New Jersey, John Wiley & Sons.

Sloot, L.M. et al. 2005. The impact of brand equity and the hedonic level of products on consumer stock-out reactions. Journal of Retailing, 81, (1), 15-34.

Syntetos, A.A. et al. 2005. On the categorization of demand patterns. Journal of the Operational Research Society, 56, (5), 495-503.

Teunter, R.H. et al. 2010. ABC Classification: Service Levels and Inventory Costs. Production and Operations Management, 19, (3), 343-352.

043 Mathematical modelling of uncertainty in non-homogeneous lots

Alemany MME, Grillo H, Mundi I, Poler R

María del Mar Eva Alemany Díaz (✉ e-mail: mareva@omp.upv.es)
Centro de Investigación de Gestión e Ingeniería de Producción. Dpto de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022, Valencia.

Hanzel Grillo Espinoza (✉e-mail: hangries@upvnet.upv.es)
Centro de Investigación de Gestión e Ingeniería de Producción. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022, Valencia.

Isabel Mundi (✉e-mail: mamunsan@doctor.upv.es)
Doctoral School.Universidad Politécnica de Valencia. Camino de Vera S/N, 46022, Valencia.

Raúl Poler (✉ e-mail: rpoler@cigip.upv.es)
Centro de Investigación de Gestión e Ingeniería de Producción. Dpto de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022, Valencia.

Abstract: There are manufacturing contexts where units of the same finished good (FG) in lots are non-homogeneous. Sometimes, this lack of homogeneity in the product (LHP) originates several qualities of a FG in the same lot, meanwhile other times units of the same FG with different attributes (subtypes) appear. The result is that each lot of a FGis composed by homogeneous sublots of different subtypes. Due to the LHP inherent sources of uncertainty, the finally size of each homogeneous sublot will be only known when produced and classified. This aspect becomes a problem when customers should be served with homogeneous units of the same FG. In this paper, the definition of customer classes and a set of fuzzy constraints are proposed to model the uncertainty in non-homogeneous lots. The incorporation of these constraints will improve the customer service level and the company performance by the properly sizing of non-homogeneous lots.

Keywords: Uncertainty; Fuzzy; Lack of Homogeneity in the Product; Customer Classes; Mixed Integer Linear Programming.

1 Introduction

The lack of homogeneity in the product (LHP) is defined as the lack of uniformity required by the customer in the products.LHP causes the non-homogeneity of FGs as regards certain attributes that are relevant to customers (Alemany et al., 2013).LHP becomes a problem when customers order several units of the same FG and require homogeneity among them. In order to comply with the homogeneity specifications, LHP companies include some classification stages for sorting units of the same FGs into homogeneous subsets (subtypes). The classification criteria of an FG into subtypes depend on each sector. Indeed, the LHP in lots appears in very different sectors in several ways. For instance, the LHP origin in Fruit Supply Chains is mainly due to the non-uniformity of the raw materials (the fruit obtained directly from the nature). Because customers require homogeneity among the units of the same FG in their orders, there are several classification (sorting and grading) activities located in different points along the productive process with the aim of eliminate waste and classify fruits into several qualities based on different attributes.The main attributes for sorting and grading fresh fruit are size, weight, ripeness, damage, color, shape and firmness.

These LHP characteristics complicate the system management in different ways. 1) The customer homogeneity requirement introduces new constraints to be accomplished, complicating the identification not only the optimal solution but also a feasible one. 2) After each classification stage, the quantity of each subtype in the production lots will be only known after production has finished and FGs have been classified. Therefore, companies with LHP will face a new kind of uncertainty: the uncertainty in the homogeneous quantities of each subtype that will be available in the planned production lots. In this paper, the modeling of the LHP uncertainty in lots by means Fuzzy Sets is proposed. As it is described in section 4, when modeling this type of LHP uncertainty, it is necessary to apply the Fuzzy Theory to dependent technological coefficients. Up to our knowledge, the uncertainty modeling by fuzzy sets has been limited to independent fuzzy coefficients. Therefore, this aspect constitutes one of the main contributions of this paper.

2 Background literature

Uncertainty refers to “the unpredictability of environmental or organisational variables that have an impact on corporate performance. A variety of uncertainty factors affect distinct organizations in different ways. In fact, supply chains (SCs) with lack of homogeneity in the product (LHP) have unique characteristics with inherent sources of uncertainty that have a great impact on customer service level. Most SC planning research (Gupta et al., 2003) models SC uncertainties with probability distributions, which are usually predicted from historical data. However, probability distributions deriving from past evidence are not always available or reliable (Mula et al., 2010). Therefore whenever statistical data are unreliable, or are not even available, stochastic models may not be the best choice. The Fuzzy Set Theory and the Possibility Theory may be simpler, less data-demanding alternatives than the Probability Theory to deal with SC uncertainties

(Peidró et al., 2010). The Fuzzy Set Theory provides a means for representing uncertainties and is a marvelous tool for modeling the kind of uncertainty associated with vagueness, with imprecision, and/or with lack of information on a particular element of the problem at hand. For LHP contexts, the unpredictable characteristics of the raw materials and/or the existence of uncontrollable productive factors, make the knowledge of the homogeneous quantities of each subtype available in future planned lots imprecise. Furthermore, sometimes it is not feasible or very costly to measure them reliably being correct the use of fuzzy sets.

3 Modelling Context

The objective of this research is to address the modelling of LHP uncertainty in production lots for planning purposes. Some assumptions are made when modelling this situation. As regards the productive/supply stage, it is assumed the existence of parallel resources that are able to process/supply several FGs. Units of the same FG with different attributes (subtypes) appear in each lot. Therefore, each FG lot is assumed to be composed by several homogeneous sublots of different subtypes.

As regards the demand stage, it is worth stressing that LHP becomes a managerial problem because of the customers' homogeneity requirements. Therefore, LHP introduces a new customized aspect in the order proposals: the homogeneity type required among the ordered products. The customer may require uniformity between components of a product (pearls on a necklace) or between units of the same product (ceramic tiles) or between different products in the order (chairs and a dining table).In this paper it is assumed that customer requires homogeneity among units of the same FG without specifying the subtype, i.e. the only LHP constraint is that all the units of each FG in the order will be homogeneous, not being relevant from which subtype the order is completed.

On the other hand, the way of modelling the customer demand primarily depends on the model purpose. For planning purposes, the demand is usually expressed as forecasts of product families or FGs. But, when modelling the LHP in production lots at the planning level, the homogeneity requirement in the demand should be incorporated in some manner with the aim of better sizing the lots on each productive resource.Note that the order size becomes a very relevant LHP factor because the larger the orders size, the more difficult will be to meet the uniformity requirement among all their units.For these reason, in this paper a novel way of modelling the customer demand is introduced at the planning level: by means of the forecasted number of customer order classes. Each customer order class is characterized to request a similar order quantity (size) of a FG.

4 LHP modelling in production lots

In this section, a general way of modelling the above LHP characteristics for planning purposes is shown. It is worth stressing that this formulation does not represent a model itself, but it can be embedded and adapted in a particular planning model. Let us assume the existence of parallel resources (*l*) that are able to supply/process some FG (*i*), being the *Il(i)* the set of FG (*i*) that can be processed on each productive resource (*l*). Suppose that each production lot (MP_{ilt}) of FG (*i*) on productive resource (*l*) ina time period (*t*) is composed by different homogeneous sublots($MPBeta_{\beta ilt}$) of specific subtype (β).

Assume $B_{\beta ilt}$to be the fraction of each lot of a FG (*i*) processed on a production line (*l*) that can be considered as a homogeneous sublot of subtype (β)in time period (*t*). An example of this situation is shown in Figure 1 where it is assumed a lot of 3000 m^2 (*MP*) with three subtypes (β=*1,2,3*). The values of $B_{\beta ilt}$for this lot are considered to be: 0.7, 0.2 and 0.1. These fractions originate three homogeneous sublots ($MPBeta$) of 2100 m^2, 600m^2 and 300 m^2, respectively.

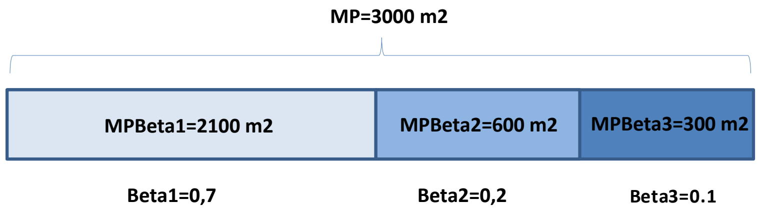


Fig. 1 Splitting of a non-homogenous lot into homogeneous sublots.

At this point, some characteristics related to the $B_{\beta ilt}$parameters should be stressed. As it can be observed, the subindices of $B_{\beta ilt}$ allow that different percentages of homogenous sublots can exist for each FG depending on the resource and time period. On the other hand, the sum of $B_{\beta ilt}$must be equal to 1, because the union of all homogeneoussublotsmust match theoveralllot. That is, there is a dependency among the beta parameters that can be expressed in the form of equation (1). Finally, it should be highlighted that the value of each $B_{\beta ilt}$is not deterministic because its value is dependent on the raw material characteristics and/or the uncontrollable productive factors.

$$\sum_{\beta} B_{\beta ilt} = 1 \qquad \forall\, l, i \in Il(l), t \tag{1}$$

- **Deterministic LHP modelling in production lots**

In this section, the set of constraints that can be taking into account to model the LHP in production lots are described. Constraint (2) defines the size of each homogeneous sublot ($MPBeta_{\beta ilt}$) based on the quantity to be finally supplied/produced (MP_{ilt}) of each FG (i) on each resource (l) and time period (t) and its corresponding homogeneous fraction ($B_{\beta ilt}$). For production planning contexts, the MP_{ilt} represents the main decision variable and $MPBeta_{\beta ilt}$ is a derived variable from the first one and the $B_{\beta ilt}$ coefficient.

$$MPBeta_{\beta ilt} = B_{\beta ilt} * MP_{ilt} \qquad \forall\, \beta, l, i \in Il(l), t \tag{2}$$

Taking into account the homogeneous sublots at the planning level follows the objective of better sizing the lots on each resource in each time period with the aim of accomplishing with customers' homogeneity constraints. Therefore, the lot size (MP_{ilt}) should be defined in such a way that the derived $MPBeta_{\beta ilt}$ can fulfil an integer number of a combination of customer orders of class k ($NKLBeta_{\beta ilkt}$) (3). The parameter $ordq_{ik}$ in constraint (3) represents the average order size of FG *i* of customer order class *k*.

$$MPBeta_{\beta ilt} = \sum_{k} NKLBeta_{\beta ilkt} * ordq_{ik} \qquad \forall\, \beta, l, i \in Il(l), t \tag{3}$$

Finally, the way of formulating the customer demand at the planning level (4) should be consistent with constraint (3), being necessary to forecast the number of orders (nk_{ikt}) of customer class (*k*) requesting FG (*i)* in period (*t*).

$$d_{ikt} = nk_{ikt} * ordq_{ik} \qquad \forall\, i, k, t \tag{4}$$

- **Modelling the LHP uncertainty in production lots**

As previously mentioned, the coefficients $B_{\beta ilt}$ in Equation (2) are not deterministic parameters because the size of the homogenous sublots in relation to the overall lot size in the production plan depends on uncontrollable productive factors and/or raw material characteristics. Therefore, they are considered as fuzzy numbers ($\tilde{B}_{\beta ilt}$) where the fuzziness is represented by the tilde "~" meaning that they can change in a near region of an initial value. For example, let's assume that some $B_{\beta ilt}$ is deterministic with a value of 0.4; in this case, tilde ~means that $\tilde{B}_{\beta ilt}$ is about 0.4. When $\tilde{B}_{\beta ilt}$ is considered a fuzzy number, the constraint (2) is expressed as the fuzzy constraint (5).

$$MPBeta_{\beta ilt} = \tilde{B}_{\beta ilt} * MP_{ilt} \qquad \forall\, \beta, l, i \in Il(l), t \tag{5}$$

There is a body of literature on models including fuzzy coefficients, and a well-known one is the Possibility Theory. Peidró et al. (2010) describe how the expected EV value of a fuzzy number $\tilde{z}$ can be expressed as a half point within its expected interval just as the following equation (6) shows, where E1 and E2 are the lower and upper values of the expected interval:

$$EV(\tilde{z}) = \frac{E_1^z + E_2^z}{2} \tag{6}$$

Fuzzy constraints require the membership functions, even when uncertainty is included in their technological coefficients. There are several options of membership functions to describe a fuzzy number z_i. Pedrycz (1994)mention the common use of basic fuzzy triangular and trapezoidal membership functions. This author shows them as basic functions used to represent fuzzy numbers in linear models.

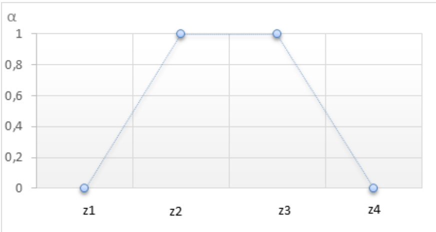


Fig. 2 Trapezoidal fuzzy number $\tilde{z}$

If the fuzzy number $\tilde{z}$presents a trapezoidal membership function as in Figure 2, its expected interval can be calculated as expressed in (7), where z1 and z4, represent the lower and upper limits of the interval, respectively, and z2 and z3 represent its intermediate numbers. In trapezoidal membership function terms (see Fig. 2), alpha (α) represents the degree to which the curve progresses toward limits z2 and z3.

$$EI(\tilde{z}) = [E_1^z, E_2^z] = \left[\frac{z_1 + z_2}{2}, \frac{z_3 + z_4}{2}\right] \tag{7}$$

If the perspective of Peidró et al. (2010), is applied to the fuzzy number beta in constraint (5), it is possible to convert the original LHP Fuzzy Constraint (5) into an auxiliary crisp alpha-parametric Constraints (8) and (9) by considering the fuzzy coefficients$\widetilde{B}_{\beta ilt} = (B1_{ilt}^{\beta}, B2_{ilt}^{\beta}, B3_{ilt}^{\beta}, B4_{ilt}^{\beta})$. α represents the degree of feasibility of the solution obtained.

$$MPBeta_{\beta ilt} \geq \left[\frac{\alpha}{2}\left(\frac{B3_{ilt}^{\beta} + B4_{ilt}^{\beta}}{2}\right) + \left(1 - \frac{\alpha}{2}\right)\left(\frac{B1_{ilt}^{\beta} + B2_{ilt}^{\beta}}{2}\right)\right] * MP_{ilt} \quad \forall \beta, l, i \in IL(l), t, \alpha \in [0,1] \tag{8}$$

$$MPBeta_{\beta ilt} \leq \left[\frac{\alpha}{2}\left(\frac{B1_{ilt}^{\beta} + B2_{ilt}^{\beta}}{2}\right) + \left(1 - \frac{\alpha}{2}\right)\left(\frac{B3_{ilt}^{\beta} + B4_{ilt}^{\beta}}{2}\right)\right] * MP_{ilt} \quad \forall \beta, l, i \in IL(l), t, \alpha \in [0,1] \tag{9}$$

A new aspect when modelling LHP uncertainty in the beta coefficients consists in ensuring that they all sum just one. Because they represent the fraction of a homogeneous sublot in the master plan, the sum of the homogeneous sublots integrating a lot will equal the corresponding lot in the master plan. The most evident way is to model this aspect by adding one constraint forcing the sum of the betas to be equal to one. However, when the beta coefficients are considered fuzzy, they are represented by membership functions and do not, therefore, take a unique value. After several proofs, a decision was made to model this aspect by means of Constraint (10), which was obtained by summing Constraints (5) and by taking into account that $\sum_{\beta} \widetilde{B}_{\beta} = 1$. Constraint (10) ensures that the beta coefficients are adjusted within their membership function to sum up to one and that the quantity assigned to the different customer orders classes does not exceed the overall quantity of lots in the master plan.

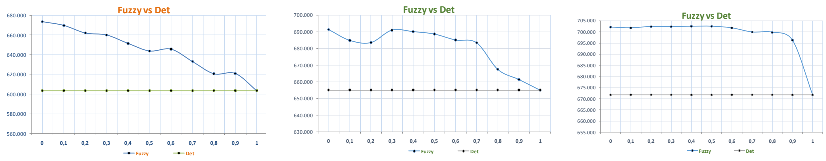
$$MP_{ilt} = \sum_{\beta} MPBeta_{\beta ilt} \qquad \forall\, l, i \in Il(l), t \tag{10}$$

All the literature consulted about Fuzzy Set Theory assumes the independence of the fuzzy technological coefficients. As mentioned earlier, in LHP productive contexts, each planned lot is divided into homogeneous sublots of different subtypes. To model this aspect, technological coefficients representing the fraction of a lot that will be considered homogeneous are defined. However, these fractions are not independent because they should always sum up to one; i.e. the sum of all the homogeneous sublots will be equal to the original planned lot. We have no knowledge of any research that has dealt with fuzzy interdependent coefficients; therefore their modeling represents one of the main contributions of this paper

Finally, the equivalent auxiliary crisp constraints that model LHP uncertainty in production lots are the following:(8), (9), (10), (3) and (4).

4 Conclusions

The above constraints have been included into a particular planning model whose objective function was to maximize profits. Three LHP scenarios have been defined all assuming the existence of three sublots (Figure 3) that differ in the relative size of echsublot. For each LHP scenario, the equivalent crisp model of the fuzzy model has been solved from α=0 to α=1 with increments of 0.1 (Figure 3). Two relevant conclusions can be deduced from these experiments: 1) the fuzzy approach always provides better results than the deterministic one and 2) the more balanced the homogeneous sublots, the more horizontal the α-curve is. The decision-maker should choose one value of α in order to obtain a specific solution. Because the α-parameter represents the different degrees of feasibility, if the decision-maker sets a high degree of satisfaction of the constraints (with α close to 1), the feasible solution set becomes smaller, consequently the optimal objective value worsens. So, the decision-maker has to find a balanced solution between two objectives in conflict: to improve the objective function value and to improve the degree of satisfaction of the constraints. From the figure 2, it can be deduced that the more balanced the homogeneous sublots a higher improvement of the objective function is achieved with minor risk, i.e. with a high degree of feasibility (α closer to one).



β1= 0.7, β2= 0.2, β3=0.1 β1= 0.5 β2= 0.3, β3=0.2 β1= 0.4 β2= 0.3, β3=0.3

Fig. 3 Representation of the profit versus the α-value for the three LHP scenarios.

As future research lines, a method should be applied to choose the most satisfactory α-value. Finally, though it seems that the fuzzy approach outperforms the deterministic one, the real profit and customer service level of the two approaches should be compared once planned lots be finally produced and classified and the real size of each homogeneous sublot were known.

5 References

M.M.E. Alemany, F.-C.Lario, A. Ortiz, F. Gomez(2013) Available-To-Promise modeling for multi-plant manufacturing characterized by lack of homogeneity in the product: An illustration of a ceramic case, Appl. Math. Model. 37 3380–3398.

A. Gupta, C.D. Maranas, Managing demand uncertainty in supply chain planning,(2003) 2nd Pan Am. Workshop Process Syst. Eng. 27 1219–1227.

J. Mula, D. Peidro, R. Poler, (2010) The effectiveness of a fuzzy mathematical programming approach for supply chain production planning with fuzzy demand, Integrating Glob. Supply Chain. 128 136–143.

D. Peidró, J. Mula, M. Jiménez, M. del Mar Botella(2010) A fuzzy linear programming based approach for tactical supply chain planning in an uncertainty environment, Eur. J. Oper. Res. 205 65–80.

W. Pedrycz, Why triangular membership functions?(1994) Fuzzy Sets Syst. 64 21–30.

044 A Mixed Integer Linear Programming Model for the Order Promising with Customer Segmentation

Alemany MM E, Ortiz A, Boza A, Fuertes-Miquel V S

María del Mar Eva Alemany Díaz (✉ e-mail: mareva@omp.upv.es)
Centro de Investigación de Gestión e Ingeniería de Producción. Dpto de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022, Valencia.

Ángel Ortiz Bas (✉e-mail: aortiz@cigip.upv.es)
Centro de Investigación de Gestión e Ingeniería de Producción. Dpto de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022, Valencia.

Andrés Boza García (✉e-mail: aboza@omp.upv.es)
Centro de Investigación de Gestión e Ingeniería de Producción. Dpto de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022, Valencia.

Vicente Samuel Fuertes-Miquel (✉ e-mail: vfuertes@gmmf.upv)
Departamento de Ingeniería Hidráulica y Medio Ambiente. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022, Valencia.

Abstract: Supply chains that cannot fulfill all customer demand should implement decision rules about the allocation of the Available-To-Promise (ATP) quantities. The objective is to avoid more profitable customer orders cannot be served because ATP has been assigned before to less profitable ones. In this paper a MILP model for the order promising (OP) in manufacturing environments characterized by the lack of homogeneity in the product (LHP) is proposed. This model defines different customer order classes based on their size. Using this customer segmentation, a novel decision rule is implemented that pretends to maximize the probability of serving future incoming orders with homogeneous units.

Keywords: Order promising; Lack of Homogeneity in the Product; Customer segmentation; Mixed Integer Linear Programming.

1 Introduction

During the order promising (OP), the company response to customers about the possibility of accomplishing with their requests, usually in terms of ordered quantities and due dates. Quite often the OP is an on–line task, being necessary to execute on a first-come-first-served (FCFS) basis. Thus, there is a high chance that a less lucrative order books components or finished goods that later on could be assigned to a more lucrative order (Fleishmann and Meyr, 2003). This is of special relevance in shortage situations when supply is lower than demand and not all customer demand can be fulfilled (Kilger and Meyr, 2008).In order to realize higher profits, it may be useful to implement decision rules when committing orders like to prioritize orders and/or customers based on their profit, loyalty, etc. Another extended practice is the allocation planning. That means that in a first step, the Available-To-Promise(ATP) quantities are held back in anticipation of later arriving, more profitable orders even if a less profitable order already requests this stock. In a second step, and based on this allocated ATP and predefined consumption rules, the ATP is assigned to the different customer/order classes. In this paper, a MILP model is developed to promise orders in make-to-stock (MTS) manufacturing environments with Lack of Homogeneity in the Product (LHP).

2 Problem Description

Traditionally, the homogeneity of different available units of the same FG to be promised to customers has been assumed. This homogeneity characteristic has allowed the accumulation of uncommitted FG availabilities (ATP) from different resources and time periods to satisfy the same customer order. However, this homogeneity assumption is not valid for manufacturing contexts with Lack of Homogeneity in the Product (LHP). LHP contexts are characterized by the existence of units of the same FG that differ in some characteristics (subtypes) that are relevant for the customer. LHP appears in certain industries like ceramics, textile, etc. These firms are obliged to classify lots of the same FG into different subsets of homogeneous quantities (subtypes). For instance, in the fruit sector, there are several classification activities with the aim of eliminating waste and classifying fruits into several qualities based on attributes like size or weight. Because different subtypes of the same FG cannot be used to promise a specific customer order, the typical way of calculating the accumulated ATP will not be valid. Furthermore, the real homogeneous quantities available of the same FG to be promised to customers are not known until their production has finished. Therefore, it is necessary to anticipate as much as possible the future availability of homogeneous quantities (subtypes) to serve customers with the quantities and homogeneity level required on time. When discrete ATPis defined in terms of subtypes (ATP-LHP), different ATP-LHP subtypes cannot be mixed to serve the same customer order. For this case, the choice of reserving ATP from a specific homogeneous subtype of a FG affects subsequent promises, being necessary to define ATP-LHP allocation rules. Alemany et al. (2013) proposes an allocation rule consisting of reserving the quantity ordered for the most adjusted ATP-LHP homogeneous quantity. In this paper, the proposed model defines customer order classes based on the ordered quantity (order size) and takes as an input the forecast of each customer order class by period. Finally, an allocation decision rule is implemented that consists of reserving the ATP-LHP to customer orders in such a way that with the remaining ATP-LHP it will possible to serve the maximum number of forecasted customer order classes. This can be considered a look-ahead rule that pretends to reduce the negative effects of the myopic nature derived from the FCFS policy.

3 MILP Model for the OP with Customer Segmentation

In this section a MILP model that considers customer segmentation for promising orders in LHP environments, dubbed as CS-LHP-OPP, is proposed. The nomenclature of the model is defined in tables 1 and 2.

Table 1 Nomenclature: indices, sets and parameters

Indices			
o	Customer order proposals to be promised	p	Production plants
i	Finished goods (FGs)	l	Production lines (productive resources)
b	Existing subtypes of all the FGs	t	Time buckets
c	Customer order class	s	Iteration (model execution interval)

Sets	
Os(s)	Set of customer order proposals to be promised in iteration s.
Os(i)	Subset of customer order proposals from Os(s) re-questing some quantity of FG i
I	Set of all the FGs i requested in the customer order proposals of Os(s)
I(o)	Set of FGs i that are requested in customer order proposal o
B(i)	Existing subtypes of FG i belonging to I
Lp(p)	Set of manufacturing lines l that belong to production plant p
Il(l)	Set of FGs that can be processed by production line l
NCI(i)	Set of customer order classes of FG i

Parameters	
ta_o	Arrival date of customer order proposal o
dd_o	Due date of customer order proposal o
q_{io}	Requested quantity of FG i in customer order proposal o
ns_o	Number of order lines (FGs) within customer order proposal o
p_o	Profit of order o
hc_{io}	Inventory holding costs of quantity qio per time period
bc_o	Backlogging cost of customer order proposal o per time period delayed
rc_o	Cost of rejecting customer order proposal o

$rmax_o$	Maximum delay allowed for customer order proposal o in relation to its due date.
$atp0_{ib}$	Not yet assigned existing stock of subtype b of FG I to any customer order.
atp_{iplt}	Not yet assigned supply of FG i produced on manufacturing line l of production plant p.
$qmed_{ic}$	Average size of customer order class c of FG i.
α	Weigth provided by the decision maker to the possibility of serving future incoming orders with homogeneous units (α<1)
pci_{ic}	Average profit of customer order class c of FG i.
rci_{ic}	Cost of rejecting a forecasted customer order class c of FGi per time period delayed
fic_{ict}	Forecasted number of customer orders of FGi belonging to class c in period t.

Table 2 Nomenclature: Decision Variables

UST_o	Binary variable with a value of 1 if customer order proposal o is served, and a value of 0 otherwise
US_{io}	Binary variable with a value of 1 if FG i in customer order proposal o is served, and a value of 0 otherwise
DDR_o	Real delivery date of customer order proposal o (integer)
AD_{io}	Number of time periods before due date dd_o that is assigned an ATP quantity of FG i during period t to customer order proposal o (integer)
RD_{io}	Number of time periods after due date dd_o that is assigned an ATP of period t quantity of FG i to the customer order proposal o(integer)
RDT_o	Number of time periods after the due date customer order o is served (integer)
DDF_{io}	Time period at which the requested quantity q_{io} of FG i of customer order o has been reserved(integer).
YA_{io}	Binary variable with a value of 1 if the requested quantity of FG i in customer order proposal o involves reserving an ATP quantity before its due date (i.e., AD_{io}>0)
YR_{io}	Binary variable with a value of 1 if the requested quantity of FG i in customer order proposal o involves reserving an ATP quantity after its due date (i.e., RD_{io}>0)
$U0_{iob}$	Binary variable with a value of 1 if the requested quantity of FG i in customer order proposal o (qio) is completely served by atp0ib, and a value of 0 otherwise
U_{ioplt}	Binary variable with a value of 1 if the requested quantity of FG i in customer order proposal o (qio) is completely served by atpiplt, and a value of 0 otherwise
$UATP0_{ib}$	The updated atp0ib after committing the customer order proposals of iteration s (Os(s)) (continuous)
$UATP_{iplt}$	The updated atp_{iplt} after committing the customer order proposals of iteration s (Os(s)) (continuous)
$NCI0_{icb}$	Number of orders belonging to customer class c that could be served from the remaining ATP (UATP0) of subtype b of FGi when the decision of committing orders proposals in iteration s (Os(s)) have been made (integer)
NCI_{icplt}	Number of orders belonging to customer class c that could be served from the remaining ATP (UATP) of FGi from production line l of plant p when the decision of committing orders proposals in iteration s (Os(s)) have been made (integer)
$NCInv_{iclpt}$	Number of orders from customer class c that could be served from remaining ATPs (UATPs) previous to period t.
$RUATP0_{ib}$	Remaining quantity of the ATP quantities of subtype b belonging to FGi after the

	decision of promising real customer order proposals of Os(s) and also the expected ones of each customer classes (NCI0) (continuous)
$RUATP_{iplt}$	Remaining quantity of the ATP quantities of FGiprocessed in production line l of manufacturing plant p in period t after the decision of promising real customer order proposals of Os(s) and also the expected ones of each customer classes (NCI) (continuous).
$RNCI_{ict}$	Not served forecasted orders of FGi from customer class c in period t (integer).
$NCVE_{iclpt}$	Number of orders from customer class c that could be served in period t for accomplishing with the forecasted number of orders belonging to each customer class.

The model assumes the existence of several production plants (p) with several processors in parallel (l) (production lines) manufacturing under an MTS strategy. Due to the raw material and productive factors, it is assumed that quantities produced at each production line and period will not be homogeneous, not being possible to mix them to serve the same customer order. Each order is composed by several order lines requesting a quantity of a specific FG for a due date. A customer order will be served only if all its order lines can be served. The objective function (1.1) aims to maximize the profits made from the committed orders during iteration s. The last objective function term is multiplied by a factor $\alpha<1$ that reflect the importance provided by the decision maker to the fact of taking into account possible future incoming orders.

Constraint (1.2) establishes that the actual updated ATP-LHP of subtype b of FG i is equal to the initial ATP-LHP (t=0), less the amounts of this ATP-LHP, which were reserved to commit the orders in iteration s. Constraint (1.3) is analogous to (1.2) but for the planned ATP-LHP. Constraint (1.4) establishes that the order line of FG i, belonging to order o, is served if the quantity requested by this order line is allocated with a single subtype (real or planned), otherwise it is not served. Constraints (1.2), (1.3) and (1.4) ensure homogeneity in the reserved units in order to serve all the order lines. Constraint (1.5) indicates that for order o to be served, it is necessary for all the order lines i integrating this order o to be served. Otherwise, if only one is not served, then the order cannot be served; that is, it is rejected. Constraint (1.5) acts in the opposite way; in other words, if the order is not served, it is senseless to serve any of its order lines separately. Through constraints (1.6) to (1.10) the allocation rule of ATP-LHP to customers orders in iteration s is implemented Constraints (1.6) and (1.7) forces to serve the real customer orders from the ATP-LHP quantities in such a way that with the updated ATP-LHP(UATP) will be possible to serve an integer number of future customer classes. That is, when several possibilities exist to promise the current customer order proposals in iteration s, the CS-LHP-OPP model provides a solution taking into account not only the profits from the current commitments but also the possibility of serving incoming customer orders in the future. Constraints (1.8) and (1.9) calculate the number of each customer order class that will be possible to be served ($NCVE_{iclpt}$) based on the number of customer orders of the same class that can be served from the UATPs of the same period (NCI_{icplt}) and those accumulated from previous periods ($NCInv_{icplt}$). Because the objective function takes into account not only the current customer order proposals served and not served, but also those that will be not served (RNC_{ict}) it is necessary to define the constraint (1.10).Constraint (1.11) calculates the delay (RD_{io}) or the advance (AD_{io}) of each order line of FG i in relation to the due date of its order o (dd_o), and depending on whether this order is served or not. If this order is not served, then none of its lines is served given Constraint (1.5); consequently, neither delays nor advances are calculated. In the objective function, only the penalty appears for not serving the order. When an order line of FG i in order o is served from atp0, that is t=0, then the advance is dd_o. On the one hand, Constraint (1.12) indicates that the advance cannot be longer than the due date and forces the associated binary variable to take a value of 1 when there is an advance. On the other hand, Constraint (1.13) obliges binary variable YA_{io} to be zero when there is no advance. Constraint (1.14) indicates that the maximum delay cannot be longer than the maximum one permitted for this order ($rmax_o$). At the same time, if there is a delay for an order, the associated binary variable YR_{io} takes a value of 1. Constraint (1.15) makes binary variable YR_{io} take a value of 0 if there is no delay. Constraint (1.16) is employed to ensure that there may be a delay or an advance, or neither, in the delivery of an FG i in a specific order, but not both at the same time.Constraint (1.17) implies that the delay in order o equals the maximum delay of the order lines composing it because the order cannot be served until all the order lines are reserved. Constraint (1.18) ensures the impossibility of delaying order o if any of its order lines is delayed. Constraint (1.19) forces a situation in that a delay in an order cannot exceed the maximum delay established for this order (should this order be served). If the maximum delay permitted is equal to zero for all the orders, then this is a specific case in which serving with delays is not allowed. Constraint (1.20) defines the actual date (DDR_o) on which order o is to be delivered, which is the due date, plus the delay in order o. Through Constraint (1.21), the real reservation date of order line i of customer order proposal o is defined. The difference between the real order date (DDR_o) and the reservation date ($DDR_o - DDF_{io}$) provides the number of time periods and the quantity of the order line (q_{io}) is stored, which allows a precise calculation of the holding costs. An equivalent model without customer segmentation is obtained by removing constraints 1.6-1.10.

Table 3 Model: Objective Function and Constraints

Objective Function

$$Max[Z] = \sum_{o \in Os(s)} p_o * UST_o - \sum_{o \in Os(s)} rc_o * (1 - UST_o) - \sum_{o \in Os(s)} bc_o * RDT_o - \sum_{o \in Os(s)} \sum_{i \in I(o)} hc_{io} (DDR_o - DDF_{io}) + \\ + \alpha \left(\sum_t \sum_i \sum_{c \in NCI(i)} \sum_p \sum_{l \in Lp(p)} pci_{ic} * NCVE_{icplt} - \sum_t \sum_i \sum_{c \in NCI(i)} rci_{ic} * NCI_{ict} \right) \tag{1.1}$$

Constraints

$$UATP0_{ib} = atp0_{ib} - \sum_{o \in Osi(i)} q_{io} * UO_{iob} \quad \forall i \in I, b \in B(i) \tag{1.2}$$

$$UATP_{iplt} = atp_{iplt} - \sum_{o \in Osi(i)} q_{io} * U_{ioplt} \quad \forall p, l \in Lp(p), i \in Il(l), t \tag{1.3}$$

$$\sum_{b \in B(i)} UO_{iob} + \sum_{p,l,t} U_{ioplt} = US_{io} \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.4}$$

$$\sum_{i \in I(o)} US_{io} = ns_o * UST_o \quad \forall o \in Os(s) \tag{1.5}$$

$$UATP0_{ib} = \sum_{c \in NCI(i)} qmed_{ic} * NCI0_{icb} + RUATP0_{ib} \quad \forall i \in I, b \in B(i) \tag{1.6}$$

$$UATP_{iplt} = \sum_{c \in NCI(i)} qmed_{ic} * NCI_{icplt} + RUATP_{iplt} \quad \forall p, l \in Lp(p), i \in Il(l), t \tag{1.7}$$

$$NCInv_{icplt} = \sum_{b \in B(i)} NCI0_{icb} + NCI_{icplt} - NCVE_{icplt} \quad \forall p, l \in Lp(p), i \in Il(l), c \in CI(i), t = 1 \tag{1.8}$$

$$NCInv_{icplt} = NCInv_{icplt-1} + NCI_{icplt} - NCVE_{icplt} \quad \forall p, l \in Lp(p), i \in Il(l), c \in NCI(i), t \geq 2 \tag{1.9}$$

$$\sum_p \sum_{l \in Lp(p)} NCVE_{icplt} = fic_{ict} + RNCI_{ict-1} - RNCI_{ict} \quad \forall i \in Il(l), c \in NCI(i), t \tag{1.10}$$

$$AD_{io} - RD_{io} = dd_o * UST_o - \sum_{plt} U_{ioplt} * t \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.11}$$

$$AD_{io} \leq dd_o * YA_{io} \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.12}$$

$$YA_{io} \leq AD_{io} \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.13}$$

$$RD_{io} \leq r\max_o * YR_{io} \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.14}$$

$$YR_{io} \leq RD_{io} \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.15}$$

$$YA_{io} + YR_{io} \leq 1 \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.16}$$

$$RD_{io} \leq RDT_o \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.17}$$

$$RDT_o \leq \sum_{i \in I(o)} RD_{io} \quad \forall o \in Os(s) \tag{1.18}$$

$$RDT_o \leq r\max_o * UST_o \quad \forall o \in Os(s) \tag{1.19}$$

$$DDR_o = dd_o * UST_o + RDT_o \quad \forall o \in Os(s) \tag{1.20}$$

$$DDF_{io} = dd_o * UST_0 - AD_{io} + RD_{io} \quad \forall o \in Os(s), \forall i \in I(o) \tag{1.21}$$

4 An illustrative example

To better understand the problem under study, assume the existence of three customer order classes with a $qmed_{io}$ equal to 15,50 and 120 units for just only one FG. Assume the arrival of four consecutive customer order proposals with the characteristics of Table 4. Suppose the existence of two manufacturing lines and three homogeneous ATPs quantities: 130 units on line 1 in t=1 (atp11), 65 on line

1 (atp12) and 50 units on line 2(atp22), both in t=2. If a FCFS policy is adopted for the OP, the model with customer segmentation (CS) will commit all orders except the first one (o1) (Table 4). This is because the model anticipates the arrival of a future incoming order (o2) more profitable than the first one (o1) and serving customer order o1 implies not serving the order o2. Furthermore, when committing customer o3, the model decides to serve it from atp12 because with the updated atp12 (atp12'=50) a future incoming order of 50 units could be served. In contrast when promising orders without customer segmentation (WCS), the myopic nature of the procedure makes that o1 will be accept, not being possible to commit o2 later. Additionally, the model WCS can provide a solution of reserving the o3 from the atp22 (atp22'=50-15=35) and the o4 from the atp12 (atp12'=65-50=15) not being possible to serve a future incoming order of 50 units from the atp12', being necessary to serve it from atp11' (atp11''=65) with higher holding costs.

Table 4 Model validation: An illustrative example

orders	q_{io}	dd_o	ta_o	CS		WCS	
				Is it seved?	Updated atp	Isitseved?	Updated atp
o1	15	1	1	NO		YES	atp11'=115
o2	120	1	1	YES	atp11'=10	NO	
o3	15	3	2	YES	atp12'=50	YES	atp22'=35
o4	50	3	2	YES	atp22'=0	YES	atp12'=15

5 References

M.M.E. Alemany, F.-C.Lario, A. Ortiz, F. Gomez (2013) Available-To-Promise modeling for multi-plant manufacturing characterized by lack of homogeneity in the product: An illustration of a ceramic case, Appl. Math. Model. 37, 3380–3398.

Fleischmann, B. andMeyr, H. (2003).Customer orientation in advanced planning systems", Supply Chain Management and Reverse Logistics, Berlin, pp. 297-321.

Kilger C., MeyrH., (2008). Demand Fulfilment and ATP, in: H. Stadtler, C. Kilger (Eds.), Supply Chain Management and Advanced Planning: Concepts Modelsand Case Studies, Springer-Verlag, Berlin Heidelberg, 2008, pp. 181–198.

047 High Involvement Work Practices in the Galician Business Environment

Fernández-Pérez R, Prado-Prado JC

Ruth Fernández Pérez (✉ e-mail:ruthfernandez@uvigo.es)
Grupo de Ingeniería de Organización (GIO). Dpto. Organización de Empresas y Marketing. Escuela de Ingeniería Industrial. Universidad de Vigo. C/ Maxwell. Campus Universitario As Lagoas-Marcosende, 36310Vigo.

Abstract: This paper studies the use of High Involvement Work Practices (HIWP) in the business environment in Galicia (Spain) and its relationship with organisational performance. A cluster analysis of data from a 2013 questionnaire suggests that the sample of 236 companies studied can be classified into two different groups according to their HIWP implementation level. Significant differences between clusters were found regarding the application of improvement methodologies, participation systems, or management systems, and also related to results. The cluster with the major extent of use of HIWP resulted to be the one with greater performance.

Keywords: High Involvement Work Practices; cluster analysis; competitive advantage; performance.

1 Introduction

It is commonly argued in the Human Resources Management (HRM) literature that High Involvement Work Practices (HIWP) provide employees with the required abilities, motivation and opportunity to participate (AMO) to enhance firm performance. Furthermore, their integrated use as a system (High Involvement Work System, HIWS) within the organisation leads to achieve a sustainable competitive advantage over time. Nowadays, even more than before, because of the fierce global competition, the ever-changing business environment, and crippling economic crises, any competitive advantage, however small, is welcome. Here it is the main reason why entrepreneurs should allocate resources to the appropriate management and encouragement of their workforce.

Most previous literature has mainly focused on either the relationship between HIWS and performance or the practices that constitute the system and its internal configuration. Following Gentleman et al. (1998), it seems appropriate to take a step back from the debate about the relationship between HRM and firm performance, in order to gain some perspective about where the nation's business stand in terms of the practices currently in use. This step back is taken in this paper.

The main aim of this paper is to find out the extent to which companies implement HIWP, to classify firms according to their implementation level of HIWP through a cluster analysis, and to highlight the characteristics which make the difference between them, including performance. For this purpose, it is examined the adoption of HIWP by analysing data gathered in a survey (2013) from a sample of 236 cross-industry companies located in Galicia (Spain).

To begin, it will be outlined the theoretical background to the research. In the next section, the applied methodology is briefly explained. Then, the main results of the study are presented, followed by the conclusions and future lines of research.

2 High Involvement Work Practices and Competitive Advantage

According to Barney (1991), the achievement of a competitive advantage relies on the management of firm's valuable resources; resources which are rare among competitors, i.e., imperfectly imitable, and without strategically equivalent substitutes. In the current business environment, traditional sources of competitive advantage such as natural resources, technology, or economies of scale, have become easier to imitate, especially when compared to a complex social structure such as an employment system.

With this in mind, HRM strategies, and particularly, HIWS are considered an important source of sustained competitive advantage (Becker and Gerhart 1996;Lado and Wilson 1994; Pfeffer 1995; Snell et al. 1996).

Currently, literature does not offer a consensus on what practices constitute the HIWS, or on how to structure or measure them (Combs et al. 2006; Gerhart 2012). These practices should increase employees' AMO. The result is greater job satisfaction, lower employee turnover, higher productivity, and better decision making, all of which help improve organisational performance.

In this study, after an extensive literature review, the authors have focused on the most commonly cited HIWP, a total of 31 practices. The following table shows the practices selected.

Table 1 High Involvement Work Practices considered in the study

HIWP category	Description
Involvement	Through formal mechanisms, employees are given the opportunity to suggest potential improvements to the way things are done in the organization

HIWP category	Description
	Improvements are made and problems are solved through formal working groups
	There are formal working groups in each different department within the organization
	Workers, through their own initiative, propose improvements to current practices and solutions to existing problems within the organization
	Responsibility and authority is delegated to workers to carry out their job
	Workers plan and carry out their tasks autonomously
	Workers monitor data related to quality, cost or task productivity at their own workstation
Training	The need for employee training and development is assessed periodically, and steps are taken when found to be necessary
	Employees receive training in problem solving techniques
	Training plans are in place so employees can learn how to carry out different tasks at alternative workstations (versatility)
	New employees receive formal training during their first year in the organization
	New employees receive formal training after one year with the organization
	Employees have received formal training over the past year with the organization
Selection and recruitment	The personnel selection process is planned, systematic, and done in an orderly manner
	The possibility for an in-house promotion is considered when a vacancy needs to be filled
	In-house promotions are based on workers job performance, not on seniority
	Formal evaluation of workers job performance is based on objective appraisal
Communication	Information about objectives, goals, policies, financial results etc. is formally communicated to workers via bulletins, emails, intranet and notice boards
	Employees meet periodically with supervisors to discuss any work related issues
	Employees complete periodic surveys on climate, attitude and job satisfaction
	Formal procedures are in place for the identification, treatment and resolution of employee complaints (grievance procedures)
Wages and rewards	The incentives system is linked to results
	Employees are offered social benefits (pension plans, healthcare, staff meals, etc.)
	Employees good performance is recognized through formal congratulations, prizes, 'employee or the month' awards, etc.
	A company profit sharing plan is in place for employees
	Employee salary is linked to workplace performance
Job definition	There are written procedures in place for each workstation which outline the tasks to be carried out, the area of responsibility, the interrelationship with other positions, and any other key aspect to satisfactory worker performance
	At each workstation, the procedures mentioned above are kept up to date
	Employees have easy access to procedures outlining their workstation tasks
	Workstations are designed for flexible task allocation, to allow for job rotation
	Employees are aware of the job performance evaluation criteria

As an example, other authors that have considered all these six HIWP categories in their studies are: Bayo-Moriones and Merino-Díaz de Cerio (2002); Camps and Luna-Arocas(2012); Datta et al.(2005); Evans and Davis (2005); Guest et al. (2003); Huselid(1995); Ichniowski et al. (1997); Martinez-del-rio et al. (2012); Way(2002); Youndt et al. (1996); Zacharatos et al. (2005).

This paper contributes to existing HIWS literature providing an analysis of the extent of HIWS implementation within organisations of more than 50 employees from different sectors in Galicia (Spain), which had never been done up to date. It is proposed a classification of the firms according to their implementation level of

HIWP through a cluster analysis. Then, clusters are characterised and different measures of performance are compared between them. Through this study, the authors wish to know the extent of HIWP implementation, if there is any characteristic that differentiates companies which have implemented HIWP from the rest, and if it is true that companies with greater HIWP implementation level have greater outcomes.

3 Methodology

A questionnaire was used to obtain the necessary data for the study. The questionnaire was validated by a group of five academics who are experienced in this field of study. Also, it was carried out a pre-test among a sample of 31 Galician companies. After making small changes, the questionnaire was sent to the senior managers of Galician companies with more than 50 employees. These companies were identified using the SABI (Analysis System of Iberian Accounts) database. The survey was sent in October 2013 to a sample of 839 companies, with reminders sent after one and three months.

The questionnaire was structured in three sections. The first part focused on describing the use of HIWP in the company. Companies were asked to evaluate on a five-point scale the degree of implementation of HIWP. Companies were also asked whether they had implemented any methodology or participation system aimed a continuous improvement, such as Lean Management or Improvement teams, and any management system based on standards such as ISO 9001, ISO 14001, etc. The second part sought to gather data related to different types of business results. Companies were asked to compare themselves to their major competitors in different aspects of performance in the last year on a five-point scale (1=much worse, 5=far better): turnover, absenteeism, productivity, sales volume, quality of the product or service delivered, delivery time, fulfilment of the delivery time, innovation in product or service development, innovation in processes, financial results, and competitive position. Finally, the third part of the questionnaire focused on characteristic information about the company (the number of years in business, their business activities, number of employees, etc.).

4 Results and Discussion

From the 839 questionnaires that were sent out to companies, 372 were completed and returned, and 236 of these were deemed to be valid (5.4% sampling error). Table 2 shows the classification of respondent firms by size and activity sector.

Table 2 Classification of companies by size and activity sector

Firm size	Primary sector	Secondary sector	Tertiary sector	Total
Medium (50-249 employees)	5	65	61	131
Large (> 249 employees)	1	72	32	105
Total	6	137	93	236

To know if it is possible to classify the sample according to the extent of HIWP implementation, cluster analysis was considered the best solution.

The variables to assess in the analysis were the mean values of the items of each HIWP category. Before performing the cluster analysis, data were examined in detail in order to detect the possible existence of multicollinearity and outliers. There was no need to standardize variables since all of them were measured on a five-point scale.

Following the stepwise procedure described by Hair et al. (1995)to diagnose the amount of multicollinearity present among variables, in the study there was no support for the existence of multicollinearity. Assuming a threshold value of the condition index in a range of 15 to 30, only two condition indices are above 15 but for no one of them their regression coefficients variance-decomposition matrix exceed the threshold value of .90.

Outliers were identified using the MahalanobisD^2 measure, which provides the distance in multidimensional space of each observation from the mean centre of observations. It also has statistical properties that allow for significance testing (Hair et al. 1995). In this sense, .001 was used as the threshold value for designation as an outlier. Five observations were detected with a significance level below .001. Three of these observations were deleted because of their low values. The two remaining observations, which had values more close to the threshold value (.00095 and .0009844), were also deleted, but only after checking that their elimination contributes to obtaining more consistent results in the cluster analysis.

After having verified the absence of multicollinearity and having deleted outliers, it was performed the cluster analysis in two stages. First, it was used a hierarchical method to establish the number of clusters and profile the cluster centres (centroids). Then, observations were clustered by a nonhierarchical method, with the cluster centres from the hierarchical results as the initial seed points. In this way, as Hair et al. (1995) argue, the advantages of the hierarchical methods are complemented by the ability of nonhierarchical methods to “fine-tune” the results by allowing the switching of cluster membership.

The hierarchical cluster analysis, using Ward’s method and the squared Euclidean distance, showed that the largest increase in the clustering coefficient occurs when going from two to one cluster. The percentage change in the clustering coefficient from two to one cluster is 98.27% while from three to two it decreases to 23.09%. According to this, the two cluster solution was selected.

For the nonhierarchical cluster analysis, the results of the previous cluster analysis were used as inputs. Compared with the hierarchical cluster analysis results, ten observations moved from one cluster to another. 104 companies belong to cluster 1 and 128 to cluster 2. Information essential to the interpretation and profiling stages is provided in Table 3.

Table 3 Group means and significance levels for two-group nonhierarchical cluster solution

Variable	Cluster 1	Cluster 2	F Ratio	Significance
Involvement	2.58	3.81	233.424	.000
Training	2.27	3.93	329.035	.000
Selection and recruitment	2.96	4.24	175.181	.000
Communication	2.10	3.77	303.408	.000
Wages and rewards	2.02	3.11	120.320	.000
Job definition	2.44	4.01	255.166	.000

As can be seen in the table, all variables exhibit significantly different patterns. Interpretation of the means of the clusters for these variables shows that cluster 1 is made up of companies with low levels in the implementation of HIWP. Cluster 2 is the opposite, with mean levels of implementation close to 4.

As a validity check on the cluster solution, a second nonhierarchical analysis was performed, this time allowing the procedure to randomly select the initial seeds. The results obtained were exactly the same. This proved their consistency.

To characterize the two groups of companies, the researchers examined company size and sector, and checked if there was in place any improvement methodology, participation system, or management system. Specifically, companies conforming cluster 2 have the following characteristics:

- 41.41% are large secondary sector companies, 73.61% of the total of companies with these characteristics in the sample
- 50% have three or more improvement methodologies implemented, the 87.67% of the total of companies with these characteristics in the sample
- 90.63% have one or more participation systems implemented, the 71.60% of the total of companies with these characteristics in the sample
- 54.69% have in place three or more management systems, the 70.71% of the total of companies with these characteristics in the sample

On the other hand, cluster 1 is made up of the opposite type of companies: medium tertiary sector companies (34.62%) which have none or nearly none methodology (79.81%), participation system (55.77%), or management system (54.81%) implemented.

Furthermore, T tests were conducted to determine whether there is a significant difference in performance levels between both groups. Results showed that in all performance items, in exception of absenteeism, the level of performance in cluster 2 is significantly higher than in cluster 1.

5 Conclusions

Previous studies in literature have established classifications of companies through cluster analysis according to their use of different HRM practices. Some of them have only focused on one industry (Arthur 1992; Macduffie 1995) and others have analysed different sector companies but achieved inconclusive results (De Menezes and Wood 2006; Gittleman et al. 1998). The present study contributes to existing HIWP literature by giving an updated view (2013) of the presence of HIWP in a sample of 236 Galician companies. Performing a cluster analysis allowed to distinguish and characterised two different groups of companies: those with high level of development of HIWP and those with low level.

From the results of the study it can be concluded that companies with higher levels of implementation of HIWP (cluster 2) correspond to large secondary sector companies which have implemented several improvement methodologies, participation systems and management systems. Also, it has been proven that these companies obtain better results compared to those with lower HIWP implementation level, i.e., cluster 1 companies.

The fact that the higher implementation rates of HIWP are found in companies with a greater number of employees owes to the necessity of establishing mechanisms for the management of a social complex structure. The level of complexity will rise in proportion to workforce size. As Gittleman et al. (1998) argue, difficulties of coordination that arise in larger firms may increase the need for changes in work organisation to improve communication and enhance employee involvement. In this sense, HIWP give companies a solution to manage this complexity.

Manufacturing industry has been a forerunner in defining and implementing HRM practices aimed at achieving greater performance. Thus, it is not surprising that large secondary sector companies have the highest HIWP implementation level and achieve better results.

The improvement methodologies, participation systems and management systems considered encourage the involvement of personnel in different ways. So, it makes sense that companies which have implemented them are those with the greatest HIWP implementation level.

This study has opened up different lines of research. In the short term, aspects that have not been treated in this paper will be pursued and analysed in future ones so as to give continuity and consistency to this study. For example, confirmatory factor analysis of HIWP scales to confirm the suitability of the items used and its structure, testing the hypothesis that states that HIWP leads to greater performance, and carrying out a more deeply research through case studies. In the long term, the researchers will look to solve the limitations of the study related to the sample's representativeness and its geographical extent.

6 References

Arthur JB (1992)The link between business strategy and industrial relations systems in American steel minimills. ILRReview45(3):488-506.

BarneyJ (1991) Firm resources and sustained competitive advantage.JOM17(1):99-120.

Bayo-MorionesA, Merino-Díaz De Cerio J (2002) Human resource management, strategy and operational performance in the Spanish manufacturing industry. Management 5(3):175-199.

Becker B, Gerhart B (1996)The impact of human resource management on organizational performance: Progress and prospects. AMJ 39(4):779-801.

Camps J, Luna-Arocas R (2012) A matter of learning: How human resources affect organizational performance. British Journal of Management 23(1):1-21.

Combs J, Liu Y, Hall A, Ketchen D(2006) How Much do High-Performance Work Practices Matter? A Meta-Analysis of their Effects on Organizational Performance.Personnel Psychology 59(3):501-528.

Datta DK, Guthrie JP, Wright PM (2005) Human Resource Management and Labor Productivity: does Industry Matter? AMJ48(1):135-145.

De Menezes LM, Wood S (2006) The reality of flexible work systems in Britain. IJHRM 17(1):106-138.

Evans WR, Davis WD (2005) High-performance work systems and organizational performance: The mediating role of internal social structure. JOM31(5):758-775.

Gerhart B (2012) Construct validity, causality, and policy recommendations: The case of high performance work practices systems. Human Resource Management Review 22(2):157-160.

Gittleman M, Horrigan M, Joyce M(1998) "Flexible" Workplace Practices: Evidence from a Nationally Representative Survey. ILRReview52(1):99-115.

Guest DE, Michie J, Conway N, Sheehan M (2003) Human resource management and corporate performance in the UK. BJIR41(2):291-314.

Hair JF, Anderson RE, Tatham RL, Black WC (1995) Multivariate data analysis with readings. Prentice Hall, New Jersey.

Huselid MA (1995)The impact of human resource management practices on turnover, productivity, and corporate financial performance. AMJ 38(3):635-672.

Ichniowski C, Shaw K, Prennushi G (1997)The effects of human resource management practices on productivity: A study of steel finishing lines.AER 87(3):291-313.

Lado AA, Wilson MC (1994) Human resource systems and sustained competitive advantage: A competency-based perspective. AMR 19(4):699-727.

Macduffie JP (1995) Human Resource Bundles and Manufacturing Performance: Organizational Logic and Flexible Production Systems in the World Auto Industry.ILRReview48(2):197-221.

Martínez-Del-Río J, Céspedes-Lorente J, Carmona-Moreno E (2012) High-involvement work practices and environmental capabilities: How HIWPS create environmentally based sustainable competitive advantages. Human resource management51(6):827-850.

Pfeffer J (1995) Producing sustainable competitive advantage through the effective management of people. The Academy of Management Executive 9(1):55-69.

Snell SA, Youndt MA, Wright PM (1996) Establishing a framework for research in strategic human resource management: Merging resource theory and organizational learning.Research in personnel and human resources management14:61-90.

Way SA (2002) High performance work systems and intermediate indicators of firm performance within the US small business sector.JOM28(6):765-785.

Youndt MA, Snell SA, Dean JW, Lepak DP (1996). Human resource management, manufacturing strategy, and firm performance.AMJ39(4):836-866.

Zacharatos A, Barling J, Iverson RD (2005) High-Performance Work Systems and Occupational Safety.Journal of Applied Psychology90(1):77-93.

050 Why the Importance of Intermodal Transport in Europe?

Estelles-Miguel S, Cardós M, Rius Sorolla G, Albarracin Guillem JM

Sofía Estellés Miguel (✉ e-mail: soesmi@omp.upv.es)

Manuel Cardós Carboneras (✉ e-mail:mcardos@doe.upv.es)

Gregorio Rius Sorolla (✉ e-mail:griuso@upv.es)

José Miguel Albarracín Guillem (✉ e-mail:jmalbarr@omp.upv.es)

Dpto. de Organización de Empresas. Universitat Politécnica de València. Edificio 7D-Camino de Vera S/N, 46022 Valencia.

Abstract: Present paper is part of a study on the current situation of the transport sector in Europe. This study shows the need for restructuring in the sector, because at present the volume of freiht traffic is such that any increase in traffic reduces its overall efficiency. The restructuring of the transport system, has been one of the objectives of the European Union for years. A diagnosis of the current situation of the transport system and its influence is presented in this paper, and how the Intermodal Transportation, may improve outcomes in it.

Keywords: Intermodal Transport, European Union, Short Sea Shipping, Freight Traffic, Service Level.

1 Introduction

First, we analyze separately the road, rail and Short Sea Shipping (SSS). We will study in depth the historical evolution of trade and modal pattern of traffic between European countries and between Europe and third countries for freight traffic.

Then, the main economic policy measures used by the European Union (EU) will be discussed, with the expected equilibration of the transport system or modal rebalancing. Undertaking an analysis of the supply of transport services within the UE, compiling statistics offered lines and service levees of these transmission lines.

Following an exhaustive comparison between the road and the SSS will be performed to determine if the same external costs are lower, partly because this is the basis of the incentive initiatives. It further analyzes in detail the characteristics of current modes for freight transport and economic aid to the modal transfer is described.

Finally, conclusions and suggestions for improvement will be obtained thereon.

2 Current Situation Diagnosis

This section describes the current situation in the sector of freight flows between countries of EU and from these to third closed countries. The analysis includes three main modes of goods transportation used: read, sea and rail.

Historically the European territorial model has been characterized by the territorial concentration in metropolitan areas, which lead to the goods flow is decentralized. To this must be added the trade and economic relations are maintained with third countries, not only increase the importance of the periphery.

On the contrary, the transport system is developed fairly centrally manages, as its structure is radial. The transport system designed, has not taken into account intermodal or freight traffic, with priority to meet the passenger traffic (Coca Castaño, P. and Colomer Ferrández, JV, 2010).

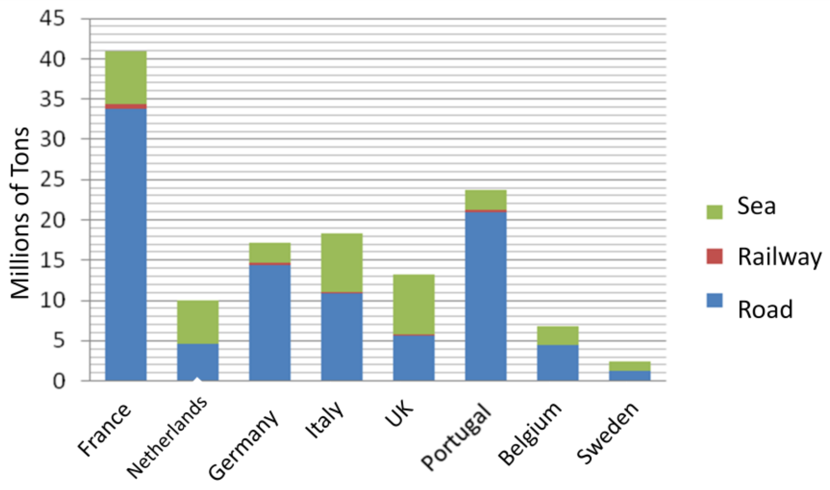


Fig. 1 Trade between Spain and other countries by means of transport used. Source: Own (Martinez Valiente, S. and Estelles-Miguel, S, 2013).

Another key factor in the development of the transport sector was the creation of the single market with EU formation has established a common policy on sustainable transport for all members. The goal of this policy is to create an efficient transport system that meets the needs of society in terms of economic, social and environmental terms. To this end, the European Commission is committed to the balance between modes of transport (Commission European, 1992, 2002 and 2011).

Currently, the freight system has large imbalances between different modes of transport. Road transport is the dominant mode with one bid difference with other media.

2.1 Road Transport

It has always been characterized by capillary, reach where other models can not do. Because of its adaptability condition both schedules and routes, has no competitor in the short and medium distances. The road freight sector is characterized by (Martinez Valiente, S. and Estelles-Miguel, S, 2013):

1. Highly fragmented market enterprise level.
2. Give a "door to door" service.
3. Wuick adaptability to technological changes.
4. Predominantly self-employed.

2.1.1 Evolution of the Sector

In Europe, the mode of transport par excellence of the past 40 years has been the road. This has captured the whole experienced growth at the expense of stagnation suffered by the railroad. Because it has more flexibility and accessibility than other means, greater integration, better adaptation to changes in demand and low tha shipment costs.

2.1.2 Future of the Sector

The road transport sector is in a state of uncertain future. For years it has enjoyed a predominance of use with respect to other modes of transport because their characteristics allow it to adapt more easily to change.

But given the congestion and the high social costs associated with their excessive use, the EU has been forced to establish a series of measures to discourage their use in favor of other more efficient means. In recent years, there has been a downward trend due largely to economic conditions experienced. But it is expected to continue due to the actions undertaken by the EU to promote intermodality transport, reaching a better service to the user and society (Commission European, 1995).

These measures are varied, but they all aim to end the hegemony of the road. Whether subsidizing alternative model, rail and maritime transport, or penalizing the use of roads by tolls, fuel taxes or movement restrictions on certain types of roads.

2.2 Rail Transport

At the present time the railway is one of the means of transport to which the EU seeks to prioritize, mainly in freight transport. Which has a rather archaic infrastructure, if used in the passenger transport (mainly in the high-speed trains) is compared.

By comparing the situation of rail transport between Europe and USA, we can see that while the volume of goods transported in Europe was drastically reduced in the USA increased due to the rapid adaptation of American railways to the needs of the industry (Martinez Valiente, S. and Estelles-Miguel, S, 2013).

Within the EU also appear important differences in the volume of goods transported by rail. Rail traffic of goods in Spain is 4%, far short of the EU average, the share is 15%.

2.2.1 Current status of the Sector

The corridors that connect Spain with Europe are characterized by the problem of different gauge. International connections require axes change operations or even transfer of the goods at border crossings. In addition does not exit a uniform structure gauge across countries, reducing interoperability. There are several different electrification systems between countries and even within them; this involves changing locomotives or use locomotives that may use different currents which increases the cost. Signaling systems, axle load, or length sidings are also varied, which does not help interoperability.

Others parameters related to infrastructure are (Directive 2001/12/CE):

- Congestion and lack of efficiency at terminals and border crossings.
- Improvement of infrastructure for access to ports.
- Interference with the shuttle in the vicinity of large cities and bottlenecks sections of single track.

Problems associated with model railway management (Directive 2001/14/CE):

- Lack of coordination between States in proceedings that affect international traffic corridors.
- Rules prioritization passenger friendly.

- The mixed freight difficult optimizing the use of the railway.
- Wide variations in tariff schemes for infrastructure use by sate.
- Lack of integration and coordination of rail to ports.
- Deficiencies in operations at border points.

2.2.2 Future of the Sector

For decades now, the EU has been working hard with the aim of promoting rail transport. Order to fulfill this goal has introduced various reforms, through various directives have been modified to suit the changing needs of the markets and the rail system. The revitalization of this sector requires competition between railway companies. To this requires:

- Homologations at EU level.
- A structure that works (strengthening infrastructure and management independence).
- Increased access to the rail network.
- Skilled workforce.

Rail transport is set to be one of the modes of transport of the future. In this match numerous studies (Commission European, 1992, 19998, 2002 y 2011), which provide for growth in demand for freight by rail between 3 and 4% you. Part of this growth is due to the growth of intermodal rail container traffic. That is why (Commission European, 2011) are found the following objectives:

- Achieve 50% transfer from road to rail and river.
- Core network of transport corridors TEN-T, ensuring efficient transfer between transport modes.
- High-speed rail network (triple the network length in 2030).
- Connect the rail network with airports and ports.
- Implement intelligent transportation management systems.

2.3 Short Sea Shipping

Europe has over 1.200 commercial ports along its coast, is one of the regions with the highest port density in the world. These concentrated volume of goods corresponding to 74% of EU trade with third countries. By 2030, the European

Commission foresees an increase in freight traffic of 50%, which is an opportunity for economic growth, for this to happen, the ports must be adapted to cope with this increased traffic (Commission European, 2011).

Among the most important requirements of shipping companies include, efficiency and operational similarity of the ports to simplify them scales and improving rail services to the hinterland[1].

At the present time, there has been a new modality in the maritime transport named Short Sea Shipping (SSS). This approach is being pushed very actively by the EU, which aims to develop and promote intermodal transport (García Menéndez, L and Feo Valero, M, 2010).

The SSS is "freight and passengers between ports in EU territory or between its ports and those in non-European countries with a coastline on the coastal seas around Europe. It includes any transport independent of load or service type. So almost includes all maritime traffic of origin or destination no transoceanic from European ports.

In practice, this method makes sense as active transport policy for its contribution to the formation of maritime-terrestrial door to door chains, and that except in exceptional cases, shipping can not provide these services itself, door to door. Shipping is therefore a solution to a certain section of the route, which will be necessary to supplement with terrestrial both in source and destination.

This is why the regular shipping services ro-ro (loading and unloading rolling) will acquire a special relevance. Road transport uses the sea as an alternative to the road, without eliminating the lorry or trailer, which facilitates the operations of embarking or disembarking (Martinez Valiente, S. and Estelles-Miguel, S, 2013).

The European Commission has taken the development of SSS, as an important element of the European transport policy, for different reasons (Commission European, 2011):

- To promote the overall sustainability of transport is a safe and friendly alternative to the environment.
- Facilitate communication between Member States and revitalize peripheral regions.
- Increase transportation efficiency to meet current and future demand generated by economic growth.

But there are drawbacks, due to its high initial investment and profitability in the long term also required to submit more documentation at ports (does not exist in many ports EDI[2] system).

1 Port influence area. This area needs good connections because since it exports are collected and imports are distributed.

2 Electronical Data Interchange

4 Conclusions

After the analysis, it is clear the need to reorganize the use of transport systems for intermodal, which is simply a rational action in the use of transport modes, but that requires a change in mindset.

The road is the most used means of transport and is saturated, this congestion is reflected in road traffic and the costs to society (accidents, emissions, noise, landscape deterioration, etc…). If the expected trend of increased volume of goods continues the road may not fully absorb this growth. It is therefore necessary that the rail and maritime modes develop their potential to achieve the desired modal shift.

Intermodality should not be considered a rivalry between modes of transport, but as a complementary before growing environmental requirements in the transport sector.

Therefore, one might think of the railway as an ideal complementary tool to the road. Both ways are terrestrial. The railroad is 3 times less polluting than road freight and unit distances for certain traffic can be more competitive. However, in the short/medium terms this type of transport is not a real solution given the complex and costly infrastructure needs.

For all these reason, the shipping is the only real alternative in the short term. Europe has a length of coastline and a large number of ports, which favors it when adopting a strategy of shipping.

In maritime transport, one must distinguish between the transport of long and short distance.

In the long-distance shipping (with Asia or America) for its characteristics of capacity does not have rival alternative. In the case of short distance, it is not only necessary involvement of ports, but requires coordination between them, which makes possible the existence of connectivity between them. The EU, aware of it, is responsible for coordinating and developing this strategy. For this purpose, it has various promotional programs, grants and incentive to help the development of this mode in operation.

So far, given the economic climate and the complexity of the changes, these programs have not yielded the expected results.

Thus, shipping is going through a necessary process of redefinition. It is justified by the benefit, lower economic and social cost, which generates as seen in the comparative cost analysis.

Despite of above, it should not forgotten, distance to travel in transport between two points is not the same by sea tan by land, so a study of transport in each case is necessary.

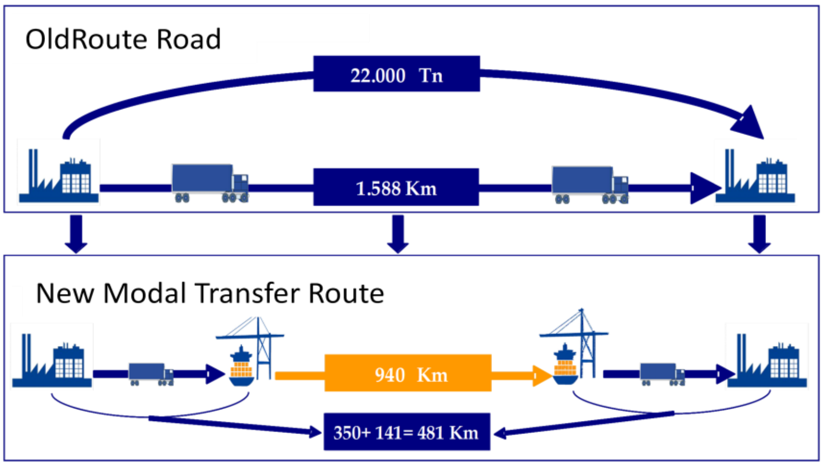


Fig. 2 Comparative Milan-Madrid road route and modal shift. Source: García Menéndez, L and Feo Valero, M (2010).

5 References

Coca Castaño, P and Colomer Ferrández, JV (2010). El transporte terrestre de mercancías. Valencia editorial Fundación Valencia Port.

Comisión Europea (1992). Libro Blanco sobre política de transportes. Curso futuro de la política común de transportes.

Comisión Europea (1995). Libro Verde. Hacia una tarificación equitativa y eficaz del transporte.

Comisión Europea (1998). Libro Blanco. Tarifas justas por el uso de las infraestructuras, una estrategia gradual para un marco común de tarificación de infraestructuras de transporte en la Unión Europea.

Comisión Europea (2002). Libro Blanco. La política europea de transportes de cara al 2010: la hora de la verdad. Luxemburgo. Oficina de Publicaciones Oficiales de las Comunidades Europas.

Comisión Europea (2011). Libro Blanco. La hoja de ruta Transporte 2050. Hacia un espacio único europeo de transportes: por una política de transportes competitiva y sostenible.

Directiva 2001/12/CE del Parlamento Europeo y del Consejo, por la que se modifica la Directiva 91/440/CEE sobre el desarrollo de los ferrocarriles comunitarios. www.boe.es/doue/2001/075/L00001-00025.pdf

Directiva 2001/14/CE del Parlamento Europeo y del Consejo, relativa a la adjudicación de la capacidad de infraestructura ferroviaria, aplicación de cánones por su utilización y certificación de la seguridad. www.boe.es/doue/2001/075/L00029-00046.pdf

García Menéndez, L and Feo Valero, M. (2010). Patrón modal y comercio con Europa: tendencias en el transporte de mercancías. Valencia. Fundación Valenciaport.

Martinez Valiente, S. and Estelles-Miguel, S. (2013) Política de transporte de mercancías entre España y Europa: Iniciativas económicas para el reequilibrio modal. Trabajo Fin de Carrera de la Universitat Politècnica de València.

059 An empirical network based analysis of the characteristic influence distance among urban business interactions

Sánchez RM, Pereda M, Santos JI, Galán JM

Rosa Mª Sánchez Saiz(✉ e-mail:rsanchez@ubu.es)
Área de Organización de Empresas.EPS. UBU. C. Villadiego S/N, 09001 Burgos.

María Pereda García (✉e-mail: mpereda@ubu.es)
Grupo INSISOC. Área de Organización de Empresas.EPS. UBU.Avda.Cantabria S/N, 09006Burgos.

José Ignacio Santos Martín (✉ e-mail:jisantos@ubu.es)
Grupo INSISOC. Área de Organización de Empresas.EPS. UBU. C. Villadiego S/N, 09001 Burgos.

JoséManuel Galán Ordax (✉ e-mail:jmgalan@ubu.es)
Grupo INSISOC. Área de Organización de Empresas.EPS. UBU. C. Villadiego S/N, 09001 Burgos.

Abstract: In this paper we try to assess the influence of modifying the characteristic distance of influence to quantify the empirical spatial externalities among businesses in urban contexts. We test the results assuming a network approach and varying the distance of interaction. Our study shows that the typical distance where the maxima of attraction or repulsion occur is in the range of 50-150m. The network framework also allows identifying the commercial areas of the region at different scales.

Keywords: localization problem, complex networks, spatial externalities, urban analysis, characteristic distance.

1 Introduction

One of the key problems in Industrial Economics and Management Engineering is localization of new business and industries. There is evidence that the location structures that emerge cannot be merely explained by the result of individual independent decisions(Hoover and Giarratani, 1984). Two types of relationships between previous located business and industries affect the location decision of the new ones: dispersive or repulsive forces and cohesive or aggregating forces.

Many of these interactions are explained in terms of positive or negative externalities between different types of businesses, either because they compete for the same demand, they share potential customers, are complementary activities, parts of the same supply chain or any other spill over effects. Recent research (Duranton and Overman, 2005; Marcon and Puech, 2010) is focused on obtaining a formal formulation to quantify these interactions and hence, understanding quantitatively the nature of these phenomena. A novel approach to make these analyses in urban contexts is the use of complex networks framework. To calculate externalities and find optimal locations in previous empirical analyses, the proximity distance which is assumed to influence other stores - characteristic influence distance - is quantified in 150 meters(Gómez et al., 2009; Jensen, 2006; Jensen, 2009; Sánchez et al., 2012). In this work we verify the validity of this assumption by means of a thorough analysis of a case study.

The structure of the paper is as follows: we briefly analyse the foundations of network based approach used in this work. We then study in a particular case the main properties of the underlying network as function of the characteristic distance and its influence in the attraction and repulsion empirical matrix. Finally, conclusions are presented in the last section.

2 Network based model

One of the most important formal models to statistically capture the spatial distribution of industries was proposed by Duranton and Overman (2005) to analyse business distribution in UK (and posteriorly refined by Marcon and Puech (2010)). Their pioneering analysis underlined the effect of considering agglomeration and dispersion phenomena within a quantitative spatial framework. Based on this work, Jensen, Gomez and colleagues (Gómez et al., 2009; Jensen, 2006; Jensen, 2009) proposed an original approach to empirically quantify the intensity of the attraction and repulsion forces between commercial stores in the city of Lyon (France). They combined this analysis with community detection techniques to understand the overall relation among sectors of retail stores in the city, and the same approach has been also applied as decision support tools for the localization problem of stores in different metropolitan areas (Jensen, 2006; Sánchez et al., 2014).

Succinctly, the methodology typically assumes an urban area with N_T stores located at different placessites$T = \{T_i; i = 1, \dots, N_T\}$. The N_A sites occupied by stores of type A is called subset $A = \{A_i; i = 1, \dots, N_A\}$. $N_T(S, r)$and$N_A(S, r)$ are defined as the number of respectively total and A-stores, including S, whose distance from the site S is less than or equal to a given radius r. The intra-attraction coefficient $M_{AA}(r)$ measures the spatial relation among stores of the same type A, and is defined as:

$$M_{AA}(r) = \frac{N_T - 1}{N_A(N_A - 1)} \sum_{i=1}^{N_A} \frac{N_A(A_i, r)}{N_T(A_i, r)} \quad (1.1)$$

This index averages over the N_A A-stores the result of dividing the local aggregation ratio $\frac{N_A(A_i,r)}{N_T(A_i,r)}$ and the total aggregation ratio $\frac{N_T-1}{N_A-1}$. If the local aggregation ratio is greater than the total aggregation ratio, the coefficient $M_{AA}(r)$is higher than 1. This can be interpreted as spatial aggregation of A-stores since they are more concentrated than if they were randomly distributed among the set of sites T. Conversely, if $M_{AA}(r) < 1$ A-stores show spatial dispersion.

In order to quantify the spatial interaction of any pair of different types of stores A and B an inter-attraction coefficient can be defined as:

$$M_{AB}(r) = \frac{N_T - N_A}{N_A N_B} \sum_{i=1}^{N_A} \frac{N_B(A_i, r)}{N_T(A_i, r) - N_A(A_i, r)} \quad (1.2)$$

where$N_T(A_i, r)$, $N_A(A_i, r)$ and $N_B(A_i, r)$ are respectively the number of total, A-stores and B-stores whose distance from the site A_i is less than or equal to a given radius r. An index $M_{AB}(r) > 1$ implies that the local aggregation average of B-stores around A-stores is greater than expected assuming a random distribution of stores. The interpretation is analogous to the previous coefficient, when $M_{AB}(r) < 1$ A-stores are not usually found near B-stores and when $M_{AB}(r) > 1$ A-stores and B-stores are often located spatially together.

In this paper we explore the intra and inter attraction coefficients and some additional features of the commercial map of an urban area by means of an underlying network. We define as node of the network each one of the N_T retail stores. There is a link between two nodes if and only if the spatial distance between the stores associated with each node is smaller than a given radius.

Once the matrix of attraction coefficients has been computed, the obtained values can be transformed logarithmically according to:

$$\alpha_{AB} = \log(M_{AB}) \quad (1.3)$$

This transformation allows interpreting the relationship between sectors easily: a positive value represents an interaction of attraction and a negative one an interaction of repulsion.

3 Analysis and results

3.1 Case study

Our empirical analysis is focused on the area of Turin, a city located in the north of Italy. We have analysed 3866 geo referenced stores grouped in 21 types of business (see Table 1), ranging from 541 in the case of the most numerous category, to 23 in the case of the least.

Table 1 Type of business considered in the empirical analysis

Category	Category	Category	Category
Furniture	Computers	Gym	Architecture
Car company	Travel agency	Hotel	Gardening
Transportation	Cleaning	Household appliance	Restaurant
Electronics	Taxi	Real Estate	Bank
Hair-dressing	Insurance	Construction	Manufacturing
Painting			

3.2 Main properties of the network

According to the definition of network of the previous section, we analyse how the topologic properties evolve when the radius r is modified. We can visually observe some of the changes in connectivity in Fig 1. When r increases the number of stores which are considered neighbours of a given location also increases.

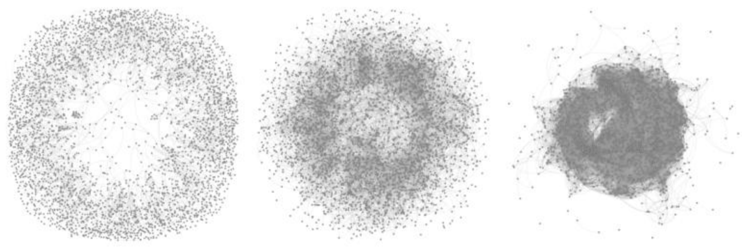


Fig. 1 Influence of the radius in the connectivity of the retail store network of Turin (Italy). The left figure represents a radius of 50m, the network in the middle 150m and the figure on the right illustrates the case of 500m. For visualization purposes the nodes are not geographically represented, a Yifan Hu layout has been applied in the three cases.

We quantitatively represent these changes in Fig 2. We study different metrics of the network. In Fig 2a) it is represented the clustering coefficient of the network as function of the radius; a minimum can be observed at approximately a radius of 650m. Fig 2b) confirms the visual output illustrated in Fig 1, increasing the radius increases the degree (i.e.,the number of links of each node) and consequently the average degree also increases.

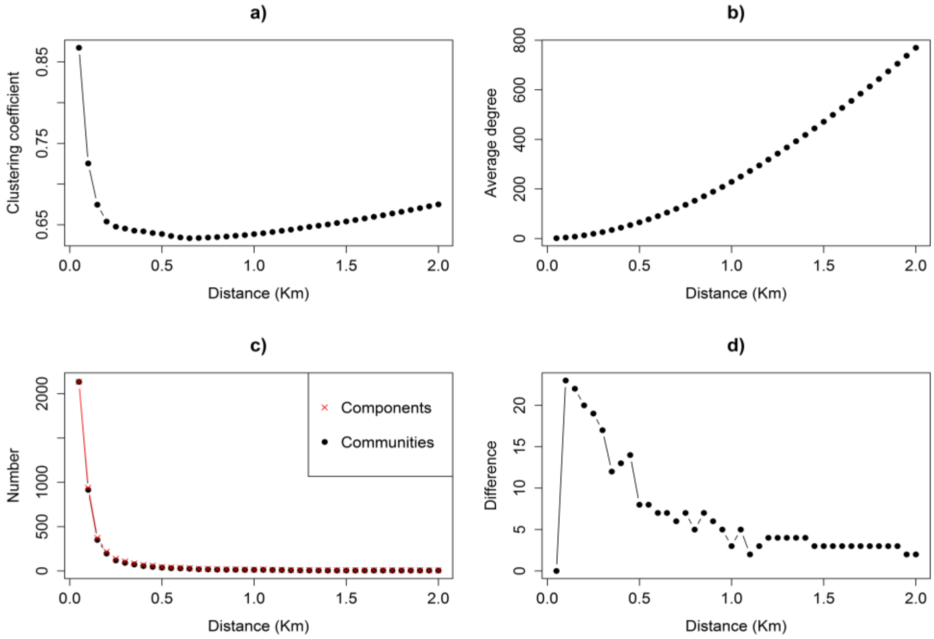


Fig. 2 Evolution of some of the metrics of the network as function of the radius r. Figure a) shows the clustering coefficient of the network, b) represents the average degree. In Figure c) are represented the number of components and detected communities. In Figure d) is shown the difference between the number of communities and components.

We have also analysed the number of disconnected components of the network and the number of communities. A component is a maximal set of nodes that are connected, while a community in network theory can be informally defined a subset of nodes that are relatively densely connected to each other but sparsely connected to other dense groups (Porter et al., 2009). In our context of application identifying these structures is important since they represent the different commercial areas in the city. Finding a more formal definition of a community is not the only problem to detect those structures, identifying communities within a network is computationally a very difficult task. In spite of these drawbacks several methods for community detection have been developed (Danon et al., 2005; Fortunato, 2010). Although our network is not extremely large, since we sweep the radius parameter we have used the fast greedy Clauset-Newman-Moore algorithm (Clauset et al., 2004). That algorithm is based on modularity optimization. In our case study the number of components stabilizes at 5 for more than 1300m radius (see Fig 2c). We also represent in Fig 2d, the difference between the number of communities detected by the fast greedy algorithm and the number of disconnected commercial components.

3.3 Analysis of the influence distances

Given that the network defined by $\alpha_{AB} = \log(M_{AB})$ for radius 150 m is being used as input to quantify spatial externalities and localization problems, we want to verify the degree of confidence of that assumption. In order to do so, we have used the different networks of our case study defined in the previous section, and compute for each case the α_{AB} matrix. These results give some insights about the evolution of the attraction/repulsion forces among categories of business when the radius distance is modified in the range from 50m to 2km.

Our results are summarized in Fig 3. For each pair of categories A-store and B-store we calculate the maximum of attraction and the distance in which that optimum is obtained. Fig 3a shows these characteristic distances, and Fig 3b the maximum of attraction obtained. The distribution of distances seems uniformly distributed (Fig 3a), however these results can be misleading if we do not analyse at the same time Fig 3b. We see that many maxima are obtained for values very close to 0, which can be the case of situations in which the function of attraction/repulsion has a minimum attenuated for long distances. Although the effect is not so extreme, the rationale can also be applied for Fig 3c and Fig 3d. In this case the minimum of attraction/repulsion is calculated, the distance in which has occurred is represented in Fig 3c and the actual minima are represented in Fig 3d. To avoid the effect of attenuation we calculate the absolute value of α_{AB} for all the radius range. In this way we lose information about attraction or repulsion but we characterize better the characteristic distances. These results are shown in Fig 3e and 3f. We can observe in Fig 3e that more than 90% of the optima are found for distances in the range between 50-150m. This result reinforces the research which assumes this condition. Notwithstanding, we should take these results cautiously since they are obtained just for a particular case study and extrapolation for other cases has not been proved and as we can see in Fig 3e, many of the optima occur for relatively low values of attraction or repulsion. Additional research is needed to verify if all the characteristic distances obtained are for statistical significant quantitative spatial externalities or on the contrary can be just explained by randomness.

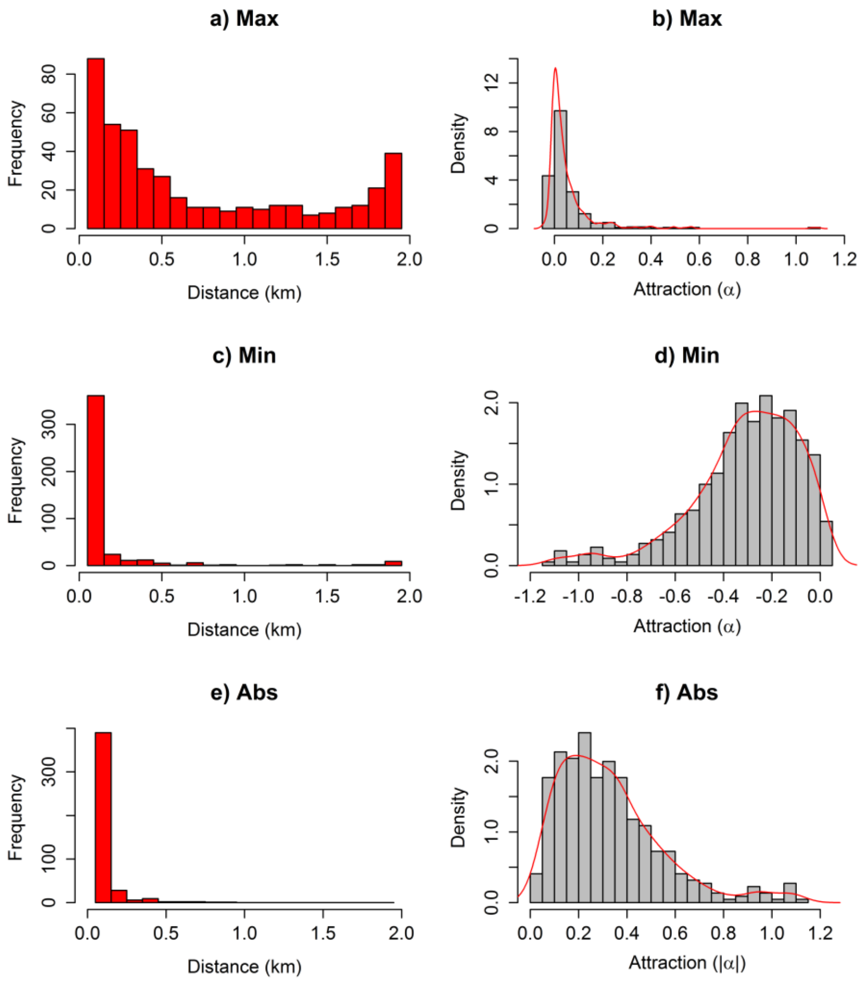


Fig. 3 Empirical distributions of characteristic distances and their corresponding attraction/repulsion values found in the analysed cased study. Fig a) and b) represent the maxima of attraction, Fig c) and d) represent the minima of attraction and Fig e) and d) are the results obtained for absolute values of attraction/repulsion.

4 Conclusions

Recent research literature assumes that a characteristic distance to quantify the spatial externalities among types of business in urban contexts may be 150m. In this work we study the validity of that assumption for the case study of Turin

(Italy). Our results show that most of the maxima of attraction/repulsion are found in range 50-150 meters (especially for 50 m distance). This result endorses previous research for retail stores spatial externalities. However our findings may be refined using just the cases in which those maxima are statistically significant. We have also analysed how the main properties of the underlying network vary when the assumption is modified. The analysis of the components and communities in the network gives hints at different scales of the spatial organization of commercial areas in urban contexts.

5 References

Clauset A, Newman MEJ, Moore C (2004). Finding community structure in very large networks. Physical Review E - Statistical, Nonlinear, and Soft Matter Physics, 70(6): 066111, doi: 10.1103/PhysRevE.70.066111.

Danon L, Díaz-Guilera A, Duch J, Arenas A (2005). Comparing community structure identification. Journal of Statistical Mechanics: Theory and Experiment,(9): 219-228, doi: 10.1088/1742-5468/2005/09/P09008.

Duranton G, Overman HG (2005). Testing for localization using micro-geographic data. Review of Economic Studies, 72(4): 1077-1106, doi: 10.1111/0034-6527.00362.

Fortunato S (2010). Community detection in graphs. Physics Reports, 486(3-5): 75-174, doi: 10.1016/j.physrep.2009.11.002.

Gómez S, Jensen P, Arenas A (2009). Analysis of community structure in networks of correlated data. Physical Review E - Statistical, Nonlinear, and Soft Matter Physics, 80(1), doi: 10.1103/PhysRevE.80.016114.

Hoover EM, Giarratani F (1984) An Introduction to regional economics. McGraw-Hill.

Jensen P (2006). Network-based predictions of retail store commercial categories and optimal locations. Physical Review E - Statistical, Nonlinear, and Soft Matter Physics, 74(3), doi: 10.1103/PhysRevE.74.035101.

Jensen P (2009). Analyzing the Localization of Retail Stores with Complex Systems Tools. Lecture Notes in Computer Science, 5772: 10-20, doi: 10.1007/978-3-642-03915-7_2.

Marcon E, Puech F (2010). Measures of the geographic concentration of industries: improving distance-based methods. Journal of Economic Geography, 10(5): 745-762, doi: 10.1093/jeg/lbp056.

Porter MA, Onnela JP, Mucha PJ (2009). Communities in networks. Notices of the American Mathematical Society, 56(9): 1082-1097, doi: 10.1063/1.3194108.

Sánchez RM, Galan JM, Santos JI (2014). Localization based on business interactions through a simulated annealing algorithm. Lecture Notes in Management and Industrial Engineering, 2

Sánchez, R.M.; Galan, J.M.; Santos, J.I.; Izquierdo, L.R., (2012). Localización basada en interacciones entre negocios mediante un algoritmo genético simple, Industrial Engineering: Overcoming the Crisis. Book of Full Papers of the 6th International Conference on Industrial Engineering and Industrial Management - XVI Congreso de Ingeniería de Organización: Vigo, pp. 911-918.

060 Tools and Technology Requirements to deal with the establishment of Collaborative Processes

Andres B, Poler R

Beatriz Andres (✉ e-mail: beaanna@cigip.upv.es)
Raul Poler (✉ e-mail: rpoler@cigip.upv.es)
Research Centre on Production Management and Engineering (CIGIP), UniversitatPolitècnica de València (UPV) Plaza Ferrándiz y Carbonell 2, 03801 Alcoy, Spain.

Abstract: In the establishment of collaboration, enterprises must deal with the appearing barriers, especially small and medium ones (SMEs). Technologic tools, applications, services and software are provided in the literature as well founded solutions to overcome the problems enterprises have to face when collaborate. Thus, this paper is focused on identifying the technological requirements needed when designing the tools for supporting the different processes that can be collaboratively carried out within a network. Furthermore, a set of tools dealing with decentralised and collaborative processes are provided in order to give researchers an insight of the collaboration tools used to cope with the aforementioned barriers.

Keywords: Collaborative processes, technology requirements, tools, SMEs.

1 Introduction

Current industrial manufacturing environments are characterised by the establishment of collaborative process. Collaborative enterprises require not only an intense exchange of information but also a strong support of information technology (IT) (Ortiz et al., 2003). Allowing to establish common goals and achieve integrated solutions that provide visibility, agility and interoperability in network enterprises to coordinate their joint activities (Ortiz and Hawa, 2002). In order to do that, collaborative partners must be able to work in an integrate way while individually must maintain their independence and autonomy (Andrés and Poler, 2013b).For supporting collaboration Andrés and Poler (2013a) provide a roadmap that gives the guidelines for establishing collaborative relationships. The roadmap includes the proper implementation of technologies and information systems to encourage communication and information exchange between nodes in an interoperable and secure way, so that only public information is exchanged.

The information exchange will improve the network efficiency and reduce costs by increasing the value of the activity carried out within the enterprises (Corbett et al., 1999). The information management is characterised by the wide variety of types of information shared, the type of information access, the visibility levels, the distributed information and the support for monitoring and coordinating the activities of the network.

In order to deal with the information exchange, network enteprises have to implement coordination mechanisms to support the network processes. There are different approaches in the literature, defining guidelines for the exchange of information within the network (Rezgui et al., 2000; Egri et al., 2007). Especifically, technological tools are considered meaningful solutions to support the exchange of information (Camarinha-Matos and Afsarmanesh, 2005). The advances experienced by enterprises in software and ICT, and the increasing use of the strategic partnership, have increased the number of information system (IS) alternatives to support the exchange of information in the network (Camarinha-Matos, 2007).This paper deals with the information exchange process among collaborative network partners. In the light of this, (i) common tools for establishing collaborative processes from a decentralised decision-making perspective and (ii) the technological requirements, characteristics of the tools that are necessary to support collaboration between partners the network, have been identified.

2 Background

SMEs that decide to establish collaborative relationships must address the cultural changes associated. Since previously the decisions were made by the dominant firm, the new collaborative scenario leads the network companies to jointly take these decisions. For this reason, SMEs need to vary their perspective and start making collaborative and decentralised decisions.

The use of a roadmap support SMEs in the migration process towards decentralised collaboration (Andrés and Poler, 2013a). Software tools have an important role in supporting and implementing the roadmap within companies willing to collaborate. However, these tools alone cannot provide good work plans, and must be integrated with the human aspects. A key benefit derived from the roadmap is sharing knowledge and developing a common vision on where the enterprises headed. The proposed roadmap developed by Andres and Poler (2013a) gives special attention to knowledge and information sharing and the establishment of connections between the information technology and systems (IT/IS) in order to build a stable collaborative network. In the light of this, the provided roadmap focuses on the review of existing technologies in organisations and capabilities that firms possess as regards the acquisition of suitable tools to deal with collaboration (*phase 2 Asses the current SMEs status* and *phase 4 SMEs needs identification*, Andrés and Poler, 2013a). Both phases enable the assessment of the current resources and capabilities of the SMEs willing to collaborate and the identification of how SMEs features fit into the requirements established to participate in decentralised and collaborative networks.

3 Tools and technology requirements

In collaborative networks, rapid responses and full integration between enterprise systems is crucial. Therefore decisions, as regards the collaborative processes performed, among enterprises should be automate through IS and IT. In addition, the management and execution of processes from the distributed perspective is a key point in business collaboration. Collaborative processes connection, in highly dynamic contexts, requires new levels of agility and interoperability among different technologies of information and knowledge sharing.

A set of key processes have been identified in the literature to address collaboration (Andrés and Poler, 2013c). Derived from the importance to collaboratively establish these processes, among the members of a network; this paper lists the requirements that tools must filling order to be applied in each collaborative process for giving the necessary technological support to establish them from the decentralised perspective (Table 1). Furthermore, Table 1 shows in the last column the most used tools for supporting collaboration in each of the defined processes, always considering the decentralised perspective of decision making within a collaborative network. Both, the technological requirements and the set of tools, defined in each processes, have resulted from the literature reviewed in the context under study.

Globally speaking, enterprises have two options: (i) have its own IS/IT adapted to support collaboration or otherwise, (ii) hire a system server via a subscription to a service provider. So that software vendors install inter operable software for collaboration in SMEs, or activate a contracted service to the technology provider.

A summary of the tools that allow exchanges of data and information management to support interoperability is provided. Mainly, tools for supporting collaborative processes are based on *service oriented architectures* (SOA), *enterpriseservice bus* (ESB), *web services* (WS), *standards*, J2*E*E, *.net*, agents, *P2P* technologies, *computation independent model* (CIM), *platform independent model* (PIM), *platform specific model* (PSM) , *reference ontologies* , *UEML* and *process specification language* (PSL) (Elvesæter et al., 2006;Bénaben et al., 2010).

Specifically, SOA is proposed as a tool that facilitates the access to interoperable systems and enhances interoperability in processes, services and data, as well as offers standardisation, flexibility and scalability for establishing collaborative relationships within a network (Franco et al., 2009). In SOA implementation it is very important the orchestration of business processes through the implementation of mediation systems based on *enterprise service bus* (ESB), (Lemrabet et al., 2010). For the application of each tool the characteristics of information and knowledge for all members of the collaborative network should be taken into account. For processes in which the tools to support collaboration are different for each enterprise, common alternatives must be sought for all the partners to deal with the collaborative barriers.

Table 1. Tools and technology requirements for collaborative processes

Collaborative Processes	Technology Requirements	Tools
Decision System Design	Represent the behaviour of human decision-makers; Model a system from the decentralized decision making perspective; Exchange strategic and tactical information among the decision makers; Consider different criterion and agents in the decision making process; Work with multi-agent systems (MAS)	Multi-agent systems (MAS) decision making platforms DGRAI (Poler, et al, 2002)
Strategy Alignment	Consider all the strategies of the partners of the NHN; Identify the value propositions of the partners; Record data from each company on the same indicator; Identify strategy common parts via common indicators to all companies; Analyse the degree of alignment between the partners (through KPIs); Identify strategy and objectives imbalances; Define a common and mutually beneficial strategy for all partners collaborative partners	Strategies identification (Andrés and Poler, 2014)
Partners Selection	Identify partners features; Select the remarkable characteristics of the collaborative partners; Select appropriate services and partners on the basis of their skills and relationships with other services/partners; Analyse capable partners and those willing to be part of a collaborative network; Make possible online communication among partners; Registration service tool to allow each partner to manage their own information to be eligible	Enterprise service bus (ESB), service oriented architectures (SOA) (Biennier et al., 2010), communication tools ICT platforms, service registries
Partners Coordination	Interoperability; BPMN languages to deal with business integration; Communication protocols, platforms and solutions based on web services, or hub channels; Automation of business processes and orchestration to integrate services and IT companies; e-collaboration	e-collaboration MAS SOA, e-HUBS, web portals, orquestation (Vernadat, 2007) e-procurement communication tools
Product Design	Exchange information between expert partners; Manage partners' knowledge; Provide a platform for joint design; Share documents of product features	Platform for co-designing (Germani et al. 2010), web 2.0, CAD
PMS Design / Management	Information exchange; Integration: cover from the strategic to the operational decision making levels and from the supplier to the client nodes of the collaborative network; Base on multi-criteria decision making; Gather, process and analyse the information used in the management and performance measurement	Information exchange BUS (Alfaro et al. 2010), platforms, integrated performance management systems
Coordination Mechanisms Design / Management	Offer a decentralized coordination system and maintain the autonomy in partners' decision-making; Limit the access to private information; Identification of all collaborative partners (multiple buyers and multiple vendors related to multiple clients); Combine data from different sources to create valuable information	e-collaboration, MAS, Grid Computing, web 2.0, Autonomous Agents (Shen et al. 2006)
Collaborative Forecast	Forecast sales at client level or POS level for all the collaborative network partners; Forecast sales at SKU level; Exchange the values of sales forecast among networked partners; Integration of special events (promotions, holidays, etc.); Send sales forecast data to other systems; Interoperability; Forecast sales in the short, medium and long term; Work with dependent demand.	MAS, e-collaboration (Rodriguez et al. 2008)Forecast Management platforms (Poler et al. 2007)
Operations Planning	Change planning orders values; Define different lead times to customers; Generate the master plan for program production needs with limited capacity; Integrate with replenishment tools; Implement forecast tools; Integrate and implement production planning tools with other collaborative partners; Planning at short, medium and long term; Send orders to the operations planning tool after checking the SMEs capacities; Option to divide the production plan in the different levels of partners; Integrate orders from customers; Integrate planning tools; Integrate collaboration tools; Interoperability	applications to support temporal and spatial distributed decision-making process (Camarinha-Matos et al., 2008), DGRAI, MAS
Scheduling	Record all negotiations and/or changes in the replenishment plan; Generate replenishment plan requirements in the different levels of network partners; Visibility of production scheduling across network partners; Communicate changes in any of the scheduling requirements; Analyse the effectiveness of scheduling and recommend scheduling programs	Platforms, MAS (Gómez et al. 2009)

Table 1(continued). Tools and technology requirements for collaborative processes

Collaborative Processes	Technology Requirements	Tools
Inventory Management	Negotiation process to determine the optimal batch quantity; Repeat negotiations where the inventory information is offered; Compute balanced an optimal inventory and orders quantities; Integrate tools from different individual interfaces to one platform with a standardized data model; Coordinate the stock capability levels and review periods; Reduce the cost of generating orders and compute the order quantities; Integrate inventory models to properly combine and estimate the demand variability during lead time considering all the cost elements; Calculate what to buy/manufacture, how much to buy/manufacture, when required, when to buy/manufacture and how and where to store it; Balance inventory and stock-outs and solve conflicting objectives; Generate mutually beneficial optimal solutions for network partners through balance and integrate the inventory, minimizing annual costs; Include simulation techniques; Promote the exchange of dynamic information and collaborative decision making so that the stocks are exchanged for information	Networked Inventory Management Information Systems (Giannoccaro and Pontrandolfo 2002)
OPP	Support the negotiation processes as regards the time of arrival and the price of the materials; Orders management to achieve satisfaction in customers; Manage due dates and delivery locations; Communicate any changes in the orders requirements; Offer visibility of production scheduling across collaborative partners; Integrate individual interfaces to one platform to a standardized data model	MAS, platform (Gómez et al. 2009), SOA (Schuh et al. 2008)
Uncertainty & Knowledge & Information Management	Combine business models with knowledge creation models; Place knowledge and information management on each transition of the network; Exchange and transform knowledge that incorporates a common part and a specific part; Knowledge sharing; Support collaboration between the knowledge management at individual level of firms and at network level, revealing business opportunities, problematic areas and elements of learning; Consider explicit knowledge and expertise; Access to distributed information platforms of various organizations; Dealing with uncertainty; e- commerce solutions; Federated information management; Visibility and access rights, Standard languages; Security protocols and frameworks; Limit visibility; Exchange information in a flexible, scalable, interoperable and integrated way; Distributed, open and integrated technological infrastructures; Allow the management by other operators; Publish and find information; Access to information of a company and its technical interfaces; Generate updates when other partners make changes	e-procurement, hub portals, e-marketplace, VPN, GRID security, ICT Platform, Web 2.0, SOA, UDDI, Saas, platform for business–IT alignment of an enterprise, EDIFACT, XML, plug-and-play tools, WS, Grid-based distributed (Camarinha-Matos et al. 2005), (Rabelo 2008), (Astorga et al. 2010)
Negotiation Contracts	Establish protocols for negotiation and modelling contracts; Electronic procurement (e-contracts) - model contracts, automatic transactions between the partners, digital signature; Standard e-contract language; Security-Secure Electronic Contracts (SeCo); Negotiate multiple contracts supporting the negotiation of the different partners; Extend the traditional negotiation of a single contract towards a group of negotiation in which different partners take part; Obtain a synthesis of all the commitments that partners have reached during the negotiation phase	platform , e-contracts , MAS multiple contract negotiations Agent-based simultaneous negotiation methods for bilateral contracts in a multi agent market (Oliveira and Camarinha-Matos 2008)
Share Costs & Profits	Compute a fair division of benefits among network members; Exchange and record information about costs, investments, generated assets and used resources; Generate revenue sharing agreements of all the partners; Send data to other systems of the network partners	
Processes Connection	Work with process modelling languages; Standardised initiatives; Connection to distributed platforms, where computers are connected through heterogeneous networks and systems; Work with standardized languages for data exchange	BPEL, CIM, PIM, .net, MAS, P2P, UEML, BPML, XML, SOA, WS, distributed platforms (Osório and Camarinha-Matos 2008), (Lemrabet et al. 2010), (Bénaben et al. 2010)

4 Conclusions

This paper has its background on the developed work in the collaborative processes identified (Andrés and Poler, 2013c) and the roadmap (Andrés and Poler, 2013a), bringing together the work previously done. The identification of the technology requirements and tools needed to support the establishment of collaborative processes, from the decentralised decision making perspective, is the main contribution of the paper.

Future research lines are led to design tools considering the technological requirements identified in those processes that present a lack on their tools, considering the preliminary conditions provided. The *inventory management* process and the *share costs and profits* process are two examples. In both cases, the tools provided in the literature do not fit the requirements demanded in order to be applied in collaborative and decentralised relations. Therefore, further work should be led to design a tool to bridge the gap found in the review work; taking into account the technological requirements as guidelines to develop new devices dealing with collaboration and decentralised decision making within network partners.

5 References

Alfaro JJ, Rodríguez R, Ortiz A, Verdecho MH (2010) An Information Architecture for a Performance Management Framework by Collaborating SMEs. Computers in Industry 61 (7): 676-685. doi: 10.1016/j.compind.2010.03.012.

Andres B, Poler R (2013a) A Roadmap to Establish Collaboration among SMEs belonging to Non-Hierarchical networks. Book of Proceedings of the 7th International Conference on Industrial Engineering and Industrial Management. Managing complexity: Challenges for Industrial and Operations Management 508-516.

Andres B, Poler R (2013b) Method to Quantify the Power Distribution in Collaborative Non-hierarchical Networks. In: Camarinha-Matos LM, Scherer RJ (eds.) Collaborative Systems for Reindustrialisation 408: 660-669. Springer Heidelberg NewYork.doi: 10.1007/978-3-642-40543-3

Andres B, Poler R (2013c) Relevant problems in collaborative processes of non-hierarchical manufacturing networks. Journal of Industrial Engineering and Management 6(3):723-73. doi: http://dx.doi.org/10.3926/jiem.552

Andrés B, Poler R (2014) Computing the strategies alignment in Collaborative Networks. In: Mertins K, Bénaben F, Poler R, Bourrières JP (eds.) Enterprise Interoperability IV 7:29-40, doi: 10.1007/978-3-319-04948-9_3

Astorga J, Saiz P, Jacob E, Matias J (2010) A Privacy Enhancing Architecture for Collaborative Working Environments In Camarinha-Matos LM, Boucher X., Afsarmanesh H. Collaborative Networks for a Sustainable World 569-576. Springer Berlin Heidelberg.doi: 10.1007/978-3-642-15961-9_68

Bénaben F, Boissel-Dallier N, Lorré JP, Pingaud H (2010).Semantic Reconciliation in Interoperability Management through Model-Driven Approach. In Camarinha-Matos LM, Boucher X, Afsarmanesh H (eds.) Collaborative Networks for a Sustainable World 705-712. Springer Berlin Heidelberg.doi: 10.1007/978-3-642-15961-9_83

Biennier F, Aubry R, Maranzana M (2010) Integration of Business and Industrial Knowledge on Services to Set Trusted Business Communities of Organisations. In Camarinha-Matos LM, Boucher X, Afsarmanesh H (eds.) Collaborative Networks for a Sustainable World 420-426. Springer Berlin Heidelberg.doi: 10.1007/978-3-642-15961-9_50.

Camarinha-Matos LM (2007). Collaborative networks in industry- Trends and Foundations. In: Digital Enterprise Technology (pp. 45 - 56). Springer US.

Camarinha-Matos LM, Afsarmanesh H (2005). Collaborative Networks: A New Scientific Discipline. Journal of Intelligent Manufacturing 16 (4):439-452. doi: 10.1007/s10845-005-1656-3

Camarinha-Matos LM, Afsarmanesh H, Ollus M (2008) ECOLEAD and CNO based concepts. In Camarinha-Matos LM, Afsarmanesh H, Ollus M (eds.) Methods and Tools for Collaborative Networked Organizations, 3-36. Springer US.doi: 10.1007/978-0-387-79424-2_1

Camarinha-Matos LM, Silveri I, Afsarmanesh H, Oliveira A (2005).Towards a Framework for Creation of Dynamic Virtual Organizations. In Camarinha-Matos LM, Afsarmanesh H, Ollus M (eds.) Methods and Tools for Collaborative Networked Organizations, 69-80. Springer US.doi: http://dx.doi.org/10.1016/j.arcontrol.2007.03.006

Corbett CJ, Zhou D, Tang C (1999) Designing Supply Contracts: Contract Type and Information Asymmetry. Quantitative Models for Supply Chain Management 17, 269-297. doi: 10.1007/978-1-4615-4949-9_9

Egri P, Karnok D, Vancza J (2007) Information Sharing in Cooperative Production Networks. Proc. of IFAC Workshop on Manufacturing Modelling. Management and Control 115-120

Elvesæter B, Hahn A, Berre TN (2006) Towards an Interoperability Framework for Model-Driven Development of Software Systems. In Konstantas D, Bourrières JP, Léonard M, and Boudjlida N (eds.) Interoperability of Enterprise Software and Applications, 409-420. Springer, London.doi: 10.1007/1-84628-152-0_36

Franco, R.D., Ortiz,A., and Lario,F., 2009. Modeling Extended Manufacturing Processes with Service-Oriented Entities. Service Business, 3 (1), 31-50. doi: 10.1007/s11628-008-0056-0

Germani M, Mandolini M, Mengoni M, Peruzzini M (2010) Collaborative Design System for Supporting Dynamic Virtual Enterprises". In Camarinha-Matos LM, Boucher X, Afsarmanesh H (eds.) Collaborative Networks for a Sustainable World. 11th IFIP WG 5.5 Working Conference on Virtual Enterprises, 577-584. Springer Berlin Heidelberg.doi: 10.1007/978-3-642-15961-9_69

Giannoccaro I, Pontrandolfo P (2002) Inventory Management in Supply Chains: A Reinforcement Learning Approach. International Journal of Production Economics 78 (2):153-161. doi: http://dx.doi.org/10.1016/S0925-5273(00)00156-0

Gómez P, Franco RD, Rodríguez R, Ortiz A (2009) A Scheduler for Extended Supply Chains Based on Combinatorial Auctions. Journal of Operations and Logistics 2 (1): 1-12.

Lemrabet Y, Clin D, Bigand M, Bourey J (2010). From BPMN 2.0 to the Setting-Up on an ESB –Application to an Interoperability Problem. In Camarinha-Matos LM, Boucher X, Afsarmanesh H (eds.) Collaborative Networks for a Sustainable World. 11th IFIP WG 5.5 Working Conference on Virtual Enterprises 722-729. Springer Heidelberg Berlin.doi: 10.1007/978-3-642-15961-9_85

Oliveira AI, Camarinha-Matos LM (2008) Agreement Negociation Wizard. In Camarinha-Matos LM, Afsarmanesh H, Ollus M (eds.) Methods and Tools for Collaborative Networked Organizations 191-218. Springer US.doi: 10.1007/978-0-387-79424-2_7

Ortiz A, Franco R, Alba M (2003) V-CHAIN: Migrating from Extended to Virtual Enterprise within an Automotive Supply Chain. In: Camarinha-Matos LM, Afsarmanesh H (eds.) Processes and Foundations for Virtual Organizations, Kluwer Academic Publishers, 145-152. doi: 10.1007/978-0-387-35704-1_15

Ortiz A, Hawa M (2002) Extended enterprise for supply chain management. Why, when and how to apply it. A reference model for collaborative planning in the automotive sector.

Osório A, Camarinha-Matos LM (2008) Distributed Process Execution in Collaborative Networks. Robotics and Computer-Integrated Manufacturing 24 (5): 647-655. doi: http://dx.doi.org/10.1016/j.rcim.2007.09.013

Poler R, Lario FC, Doumeingts G (2002) Dynamic modelling of decision systems (DMDS). Computers in Industry 49(2):175-193. doi: http://dx.doi.org/10.1016/S0166-3615(02)00083-0

Poler R, Ortiz A, Lario FC, Alba M (2007) An interoperable platform to implement collaborative forecasting in OEM supply chains. In Doumeingts G, Müller J, Morel G, and Vallespir B (eds.) Enterprise Interoperability – New Challenges and Approaches179-188. London: Springer. doi: 10.1007/978-1-84628-714-5_17

Rabelo RJ (2008) Advanced Collaborative Business ITC infrastructures. In Camarinha-Matos LM, Afsarmanesh H, Ollus M (eds.) Methods and Tools for Collaborative Networked Organizations 337-370. Springer US.doi: 10.1007/978-0-387-79424-2_14

Rezgui Y, Zarli A, Bourdeau M. Cooper G (2000) Inter-Enterprise Information Management in Cynamic Virtual Environments: The OSMOS Approach. Construction Informatics Digital Library 78:1-11

Rodriguez R, Poler R, Mula J, Ortiz A (2008). Collaborative Forecasting Management: Fostering Creativity within the Meta Value Chain Context. Supply Chain Management: An International Journal 13(5):366-374. doi: 10.1108/13598540810894951

Schuh G, Kampker A, Narr C, Potente T, Attig P (2008).MyOpenFactory. International Journal of Computer Integrated Manufacturing 21 (2):215-221. doi: 10.1080/09511920701607766

Shen W, Hao Q, Yoon HJ, Norrie DH (2006). Applications of Agent-Based Systems in Intelligent Manufacturing: An Updated Review. Advanced Engineering Informatics 20(4):415-431.doi: http://dx.doi.org/10.1016/j.aei.2006.05.004

Vernadat FB (2007) Interoperable Enterprise Systems: Principles, Concepts, and Methods. Annual Reviews in Control 31(1):137-145. doi: http://dx.doi.org/10.1016/j.arcontrol.2007.03.004

061 Una Aplicación de la planificación Docente basada en Competencias en la Dirección de Operaciones

An Application of the Learning Plan based on Competencies to Operations Management

Cardós M, Guijarro E, Babiloni E, Vicens E

Manuel Cardós Carboneras (✉ e-mail:mcardos@doe.upv.es). Dpto. de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia.

Ester Guijarro Tarradellas (✉ e-mail: esguitar@upvnet.upv.es). Dpto. de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia.

Eugenia Babiloni Griñón (✉e-mail: mabagri@doe.upv.es). Dpto. de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia.

Eduardo Vicens Salort (✉ e-mail: evicens@omp.upv.es). Dpto. de Organización de Empresas. Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia.

Abstract: The European Higher Education Area has introduced a new philosophy of university education focused on competency-based learning. It differs from other approaches in that students not only should know (knowledge) but also should develop the know-how (skills) and know how to be (attitude). To do this, lecturers need to plan their courses from the skills perspective, selecting the contents and learning methodologies to ensure the development of these competencies. This paper discusses the curriculum of Design of Production and Logistics Systems in the Industrial Engineering degree and shows how it focuses on the competency-based learning.

Resumen El Espacio Europeo de Educación Superior supone un cambio en el modo de entender la docencia universitaria, ya que se centra en la formación en competencias y no en contenidos. Eso implica que el alumnado no sólo ha de saber (conocimientos) sino que también ha de saber hacer (habilidades) y saber estar (actitudes). Para ello, es necesario planificar las asignaturas desde la óptica de las competencias, seleccionando los contenidos y las metodologías de aprendizaje que garanticen el desarrollo de dichas competencias. En este trabajo se analiza cómo la propuesta curricular de la asignatura Diseño de Sistemas Productivos y Logísticos del Grado en Ingeniería de Organización Industrial gira en torno a la adquisición de las competencias del título.

Keywords: learning plan, competency-based learning, coordination, curriculum
Palabras clave: planificación docente, aprendizaje basado en competencias, coordinación, propuesta curricular

1 Introducción

La adaptación de las titulaciones universitarias al Espacio Europeo de Educación Superior (EEES) supone un profundo cambio curricular de los planes de estudio, que deben adaptarse a las exigencias del mercado laboral, desarrollando para ello el aprendizaje basado en competencias profesionales. Para ello es necesario planificar y diseñar las asignaturas de un modo diferente al tradicional ya que éstas deben ayudar al desarrollo y alcance de una serie de competencias, así como facilitar su posterior evaluación (Guijarro et al. (2013). Existe una amplia literatura sobre cómo planificar la docencia de las asignaturas en el contexto del EEES (pueden consultarse (Yániz & Villardón 2008), (Bolívar 2008), (Patier 2009), (Florido 2012) entre otras). Básicamente consiste en responder cuatro grandes preguntas (véase la Figura 1): (i) qué enseñar, (ii) cómo enseñar, (iii) cuándo enseñar, y (iv) qué, cómo y cuándo evaluar.

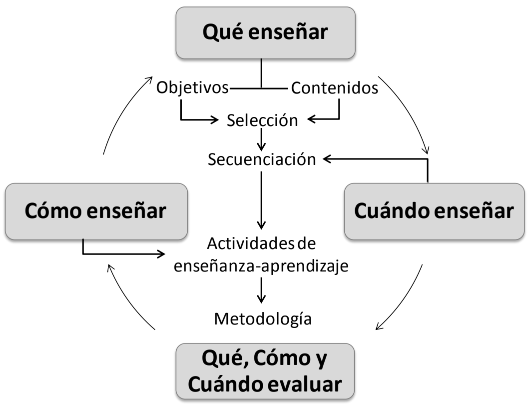


Fig. 1 Etapas de la planificación del proceso enseñanza-aprendizaje

Sin embargo su puesta en marcha puede resultar compleja debido a la existencia de limitaciones o dificultades. Entre otras, puede ocurrir que el diseño y planificación del propio plan de estudios en su conjunto dificulte el desarrollo curricular por no estar bien secuenciado u organizado. En otras ocasiones, el problema principal puede ser los recursos disponibles o bien las condiciones de partida para la puesta en marcha del plan docente ya que el número de alumnos es muy elevado o difiere del planificado, los estudiantes no tienen suficiente formación previa, etc.

El reto consiste, precisamente, en superar esos obstáculos y lograr una propuesta curricular que logre el objetivo del aprendizaje en competencias para el ejercicio profesional. En este trabajo se presenta una propuesta de planificación de la asignatura Diseño de Sistemas Productivos y Logísticos (DSPL), caracterizada como obligatoria de segundo curso en el título de Grado en Ingeniería de Organización Industrial de la Universitat Politécnica de Valencia (UPV). Esta propuesta se realiza desde la óptica del desarrollo de competencias, superando las limitaciones y dificultades observadas en los últimos cursos desde la puesta en marcha del grado.

Este artículo se organiza como sigue: tras la sección de Introducción, se contextualiza la asignatura DSPL analizando cuál han sido los problemas y deficiencias detectadas en los últimos cursos. A continuación, se presenta la propuesta curricular, objeto de este trabajo, siguiendo el esquema resumido en la Figura 1, siempre desde el prisma del aprendizaje en competencias. Por último, se resaltan las conclusiones principales de este trabajo así como las futuras líneas de investigación.

2 Contextualización de la Asignatura en su Plan de Estudios

Para el diseño de cualquier asignatura es necesario tener en cuenta el contexto de la misma en su plan de estudios y, especialmente, en la materia en la que se encuentra ya que es dicha materia la que debe garantizar el alcance de una serie de conocimientos y competencias. Ello requiere una planificación a un nivel superior y con un mayor grado de personas involucradas, con la dificultad añadida que puede suponer (Fernández 2006).

La asignatura DSPL forma parte de la materia Organización de la producción, junto con tres asignaturas más Estudio del Trabajo (segundo curso, semestre A), Planificación de Producción e Inventario (tercer curso, semestre A) y Programación y Control de Producción y Operaciones (tercer curso, semestre B).

Desde la puesta en marcha en el grado se han detectado deficiencias en la planificación de la materia tales como algunos solapamientos de contenidos y al mismo tiempo conceptos tratados sin la profundidad necesaria al suponerse estudiadas en el resto de asignaturas. En cuanto a las competencias, tampoco existía una planificación ordenada en relación a su desarrollo ni al nivel de alcance requerido en cada asignatura, cuando la adquisición de las competencias debe ser gradual a medida que se avance curricularmente.

Para mejorar estas deficiencias, se propone realizar reuniones de coordinación entre los profesores que imparten las cuatro asignaturas. Con estas reuniones se busca un doble objetivo: (i) coordinar y secuenciar los contenidos de las cuatro asignaturas, evitando de este modo solapes y posibles huecos, y (ii) definir en cada asignatura qué competencias se trabajan, cómo se desarrollan y, sobre todo, qué nivel de alcance se espera obtener tras cursarla. Con ello, se pretende que los alumnos, al estudiar la materia en su conjunto, hayan aprendido una serie de conocimientos específicos de la misma pero además hayan desarrollado las competencias profesionales relacionadas con la misma, a diferentes niveles.

El resultado de estas reuniones permite establecer la base sobre la que desarrollar toda la propuesta curricular para DSPL. De este modo, se responde a las preguntas de "qué enseñar" y "cuándo enseñar" desde el punto de vista de materia, lo que permite definir el "cómo enseñar" ya a un nivel particular de cada asignatura.

3 Propuesta Curricular basada en Competencias

La propuesta curricular de este trabajo no se centra en los contenidos que los alumnos deben adquirir, sino en las competencias que han de desarrollar. El primer paso es, pues, identificar cuáles deben ser dichas competencias, distinguiendo entre genéricas (G) y específicas (E) (Tabla 1).

Tabla 1 Competencias genéricas (G) y específicas (E) de la asignatura DSPL

ID	Descripción
15(E)	Diseñar, proyectar y planificar procesos, sistemas de producción y operaciones, plantas industriales y dispositivos con finalidades prácticas, económicas y financieras.
16(E)	Gestionar los recursos físicos de las empresas industriales o prever sus necesidades, planificar su disposición y programar, dirigir y controlar su utilización.
17(E)	Asesorar, organizar y gestionar empresas industriales y de servicios, así como otras instituciones, centros tecnológicos, instalaciones o proyectos, tanto individualizadamente como formando redes, y en todas sus áreas funcionales y dimensiones (técnica, organizativa, financiera y humana), con una fuerte orientación emprendedora y de innovación.
21(E)	Hacer funcionar, mantener y mejorar las organizaciones, los sistemas de producción, los servicios y los procesos, de modo que se mejore la competitividad del entorno actual y para aplicar los principios y métodos de la calidad.
23(E)	Realizar mediciones, cálculos, valoraciones, estudios, informes, planes de labores y otros trabajos análogos relacionados con la Ingeniería de Organización Industrial.
25(G)	Estar capacitado para trabajar en equipo en un entorno multilingüe y multidisciplinar.
26(G)	Comunicarse efectivamente con otras personas.
27(G)	Resolver problemas con iniciativa propia y con espíritu emprendedor, toma de decisiones, creatividad, razonamiento crítico y comunicar y transmitir conocimientos, habilidades y destrezas en su campo.
29(G)	Usar las técnicas, habilidades y herramientas modernas de la ingeniería, necesarias para la práctica profesional.
31(G)	Disponer de las bases necesarias y de la motivación para el aprendizaje autónomo con el

convencimiento de que el aprendizaje es continuo a lo largo de la vida.

Dada la importancia que tienen las competencias es importante destacar la primera dificultad encontrada y que está relacionada con su propia definición. Las competencias se definieron en la fase de diseño del título de grado, en un estadio previo a la implantación y sin experiencia previa de las universidades en este campo. Esto ha supuesto que en algunos casos las competencias estén vagamente definidas o bien que engloben conceptos y habilidades distintas en una misma definición, dificultando definir en qué grado una asignatura participa en la adquisición de la misma. Además, para poder evaluar competencias es necesario definir previamente los niveles de consecución de cada una de ellas, cosa que actualmente no existe en los planes de estudio. Una recomendación a futuro sería la revisión y actualización de las definiciones de las competencias.

La propuesta curricular de este trabajo se desarrolla a partir de las competencias que actualmente están definidas en el plan de estudios y guía docentes de la asignatura. En las siguientes sub-secciones se presenta el contenido de esta propuesta curricular, pero a diferencia de otros proyectos docentes, no se presenta el detalle de los contenidos, objetivos docentes o técnicas de evaluación propuestos para DSPL, sino que en realidad se muestra cómo los distintos contenidos de la propuesta curricular están pensados desde una óptica de competencias, mostrando cómo los contenidos y metodologías de enseñanza-aprendizaje se seleccionan para desarrollar las competencias de la asignatura.

2.1 Relación entre los contenidos y las competencias

Como muestra la Figura 1, la primera pregunta que debe responderse cuando se diseña una asignatura es "qué enseñar" y su respuesta implica definir los objetivos, los contenidos y su secuenciación. Puede suceder que la respuesta a esta pregunta se haga se forma aislada para cada uno de estos elementos y sin tener en consideración una visión global de las competencias de las asignaturas, lo que obviamente contradice la filosofía del aprendizaje en competencias.

El contenido docente de la asignatura DSPL se divide en un total de doce unidades didácticas (UD). Tal y como muestra la Tabla 2, la selección de estos contenidos se ha realizado procurando que en todas las UD se trabajen las distintas competencias de la asignatura. Obviamente, todas las unidades didácticas contribuyen a la consecución de las competencias específicas, mientras que en el caso de las genéricas se distingue entre dos tipos: las que tienen que ver con las habilidades relacionadas con el trabajo en equipo (25, 26, 27 y 31) que se trabajan en algunas UD, y la competencia 29, relacionada con la aplicación práctica, que también se desarrolla en todas las UD. Es importante clarificar en este punto que, como se verá en el siguiente apartado, las competencias relacionadas con las habilidades del trabajo en equipo (25, 26, 27 y 31) se trabajan en aquellas UD en las que se emplean metodologías de enseñanza-aprendizaje basadas en el trabajo en grupo y colaborativo.

Tabla 2 Relación entre las UD y las competencias de la asignatura DSPL

Competencias	15	16	17	21	23	25	26	27	29	31
UD 1	✓	✓	✓	✓	✓				✓	
UD 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
UD 3	✓	✓	✓	✓	✓				✓	
UD 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
UD 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
UD 6	✓	✓	✓	✓	✓				✓	
UD 7	✓	✓	✓	✓	✓				✓	
UD 8	✓	✓	✓	✓	✓				✓	
UD 9	✓	✓	✓	✓	✓				✓	
UD 10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
UD 11	✓	✓	✓	✓	✓				✓	
UD 12	✓	✓	✓	✓	✓				✓	

2.2 Relación entre las metodologías de aprendizaje y las competencias

Las competencias desarrolladas en cada UD están estrechamente vinculadas con las metodologías de enseñanza-aprendizaje empleadas. En la asignatura DSPL se utilizan cinco metodologías distintas, que combinan técnicas con una mayor participación del profesor, en este caso la lección magistral participativa, con otras metodologías donde se fomenta más el trabajo autónomo de los alumnos, concretamente se utiliza el trabajo académico, individual o grupal, y la resolución de casos. En la Tabla 3 se resume cuál de estas metodologías se emplea en cada UD. Como puede observarse, no hay ninguna UD en la que se emplee una única, pues se requiere de la combinación de varias metodologías de enseñanza-aprendizaje para lograr un aprendizaje significativo de los estudiantes. Además, si se analizan las competencias específicas de la signatura DSPL, la mayoría de ellas están definidas desde una perspectiva práctica, lo que justifica la necesidad de que los contenidos y las metodologías estén diseñadas no sólo para que el profesor exponga contenido (lección magistral) y el alumno lo reciba de forma pasiva, sino para que los estudiantes apliquen de forma práctica los contenidos (resolución de problemas o casos).

Tabla 3 Relación entre los contenidos y las metodologías de enseñanza-aprendizaje

Metodología	Lección magistral participativa	Método del caso	Resolución de problemas	Trabajo académico	Trabajo en grupo
UD 1	✓		✓		
UD 2	✓		✓		✓
UD 3	✓		✓		
UD 4	✓	✓	✓		✓
UD 5	✓	✓	✓	✓	✓
UD 6	✓	✓	✓	✓	
UD 7	✓	✓	✓	✓	
UD 8	✓	✓	✓		
UD 9	✓	✓	✓		
UD 10	✓	✓	✓		✓
UD 11	✓	✓	✓		
UD 12	✓	✓	✓	✓	

El hecho de combinar varias metodologías facilita, además, el desarrollo de las diferentes competencias de la asignatura. Además, la selección de cuál de todas ellas utilizar en cada momento está fundamentada en lo que se pretende alcanzar, tanto en términos de conocimientos, que coincide con la visión docente más tradicional, como en términos de competencias, lo que responde a la demanda de la nueva filosofía docente de Bolonia.

Tabla 4 Relación entre las metodologías de enseñanza-aprendizaje y las competencias

Competencias	15	16	17	21	23	25	26	27	29	31
Lección magistral participativa		✓	✓	✓	✓					
Método del caso	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Resolución de problemas	✓	✓	✓	✓	✓					
Trabajo académico	✓	✓	✓	✓	✓			✓	✓	✓
Trabajo en grupo	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

En la Tabla 4 se muestra cómo en la asignatura DSPL cada metodología se utiliza para que los estudiantes desarrollen diferentes competencias. Tal y como ya se ha adelantado previamente, las competencias referidas al trabajo en grupo se trabajan con el método del caso (que se resuelve en pequeños grupos de estudiantes) y con la realización de un trabajo académico grupal. Por su parte, las competencias específicas, referidas a la resolución de problemas profesionales dentro del área de la organización de la producción, se trabajan combinando la lección magistral participativa, con la que se busca una transmisión de conocimientos, con la resolución de problemas, trabajos académicos y casos, con las que se busca precisamente que el alumno sea capaz de poner en práctica esos conocimientos.

4 Conclusiones

El EEES plantea un modo de entender la enseñanza ya que ha pasado de ser un acto en el que el profesor transfería conocimientos y los evaluaba a integrarse en un proceso activo en el que el protagonista es el alumno y donde el profesor actúa como guía de su aprendizaje. Este cambio educativo supone adaptar los programas antiguos por objetivos a programas por competencias y la subordinación de los contenidos disciplinares a dichas competencias. Esta adaptación implica un modo absolutamente distinto de organización curricular, al mismo tiempo que un cambio sustancial en los métodos de enseñanza y aprendizaje que pasan de estar centrados en el profesor a focalizarse en los estudiantes.

Con esta filosofía se presenta una propuesta curricular de la asignatura DSPL del Grado en Ingeniería de Organización Industrial de la UPV. En este trabajo no se pretende entrar en el detalle de los contenidos u objetivos docentes definidos, sino que se busca mostrar cómo la planificación docente realizada se ha centrado en las competencias de la asignatura.

Como paso previo, se han analizado las dificultades encontradas en los últimos cursos y que se basaban, en primer lugar, en no haber considerado la materia en su conjunto. Para resolver esta dificultad, se realizan unas reuniones de coordinación docente con el profesorado de las asignaturas de la materia, lo que permite evitar solapes o huecos, no sólo en los contenidos de la materia, sino también en las competencias que deben trabajarse y en el nivel de desarrollo requerido.

Por último, se presentan unas tablas (Tabla 2, 3 y 4) que reflejan cómo toda la propuesta curricular de DSPL está centrada en el desarrollo de competencias, de modo que tanto los contenidos didácticos como las metodologías de enseñanza-aprendizaje han sido seleccionados para propiciar su desarrollo.

5 Referencias

Bolívar, A. 2008. La planificación por competencias en la reforma de Bolonia de la educación superior: un análisis crítico. A planificação por competências a reforma de Bolonha da educação superior: uma análise crítica. *ETD-Educação Temática Digital* 9(esp), pp. 68-94.

Fernández, A. 2006. Metodologías activas para la formación de competencias. *Educatio siglo XXI* 24, pp. 35-56.

Florido, C., Jiménez, J. L., & Perdiguero, J. 2012. Cómo (no) adaptar una asignatura al EEES: Lecciones desde la experiencia comparada en España. *Revista electrónica sobre la enseñanza de la Economía Pública* 10, pp. 24-48.

Guijarro, E. et al. 2013. Diseño de una asignatura de grado en una carrera nueva. *I Workshop de Intercambio de Experiencias Docentes Innovadoras en Organización de Empresas*

Patier, C.C., Castillo, B.B. 2009. La importancia de la planificación docente en el EEES: El caso de la asignatura Sistema Fiscal Español y Comparado en la USP-CEU. *E-pública: revista electrónica sobre la enseñanza de la economía pública* 5, pp. 29-57.

Yániz, C. and Villardón, L. 2008. *Planificar desde competencias para promover el aprendizaje* Publicaciones de la Universidad de Deusto.

070 Coordination mechanisms and software in industrial networks – a literature review

Mittermayer H, Rodríguez Monroy C,Peláez García M A

Herwig Mittermayer

Carlos Rodríguez Monroy (✉ e-mail: crmonroy@etsii.upm.es)
Departamento de Ingeniería de Organización, Administración de Empresas y Estadística. Escuela Técnica Superior de Ingenieros Industriales. Universidad Politécnica de Madrid. Calle José Gutiérrez Abascal 2, 28006 Madrid.

Miguel Ángel Peláez García (✉e-mail: miguelangel.pelaez@upm.es)

Abstract: This paper group's recent supply chain management research focused on organizational design and its software support. The classification encompasses criteria related to research methodology and content. Empirical studies from management science focus on network types and organizational fit. Novel planning algorithms and innovative coordination schemes are developed mostly in the field of operations research in order to propose new software features. Operations and production management realize cost-benefit analysis of IT software implementations. The success of software solutions for network coordination depends strongly on the fit of three dimensions: network configuration, coordination scheme and software functionality. This paper concludes with proposals for future research on unaddressed issues within and among the identified research streams.

Keywords: Supply chain management, literature review, network type, organizational design, and coordination mechanism.

1 Introduction

Research in the field of supply chain management touches multiple academic disciplines in light of ambiguous definitions. In this literature review organizational proposals and their IT system support is focused. Relevant articles are classified in three major groups.

First, management or organization science analyses the influence of network characteristics and organizational parameters on the supply chain performance. This kind of research seeks for empirical evidence about the diffusion of Supply

Chain Management (SCM) technologies or best practices and observable success factors or enablers.

Second, a large number of papers predominantly from operations research deal with the development of novel planning algorithms and business process models. New methods shall improve commercial supply chain software functionalities or increase implementation efficiency. Regarding novel planning algorithms, either the classic centralized approach is extended in order to better reflect real word conditions or decentralized coordination schemes are proposed.

Third, researchers from production and operations management develop methods for the evaluation of software investments. Particularly interesting are contributions that deliver information about organizational cost and benefits.

The contributions are sorted by research approach, validation method applied, the organizational concept regarded and the objective of software use under study. The classification based on these criteria characterizes briefly each paper within one of three major groups. In the next section these research streams are presented before in chapter 3 findings are summarized and conclusions are drawn.

2 Identification of research streams

All papers are grouped in one out of three major research streams.

Within the considered research papers network and organizational characteristics are discussed (section 2.1) which influence the utility of SCM software. Mainly empirical data from surveys is used to study the performance increase due to the use of SCM software within hierarchical organizations. For decentralized, collaborative concepts often contracts are discussed instead of software functionality. Other authors address coordination schemes (section 2.2) mainly based on analytical deductive research. A wide range of methods such as simulation and stochastic optimization have been developed which can enhance SCM software functionality in the future. Some researchers propose economic evaluation models (section 2.3) concerning the use of SCM software following a theoretical descriptive approach. In all research streams hierarchical as well as collaborative concepts are of interest.

Table 1 provides an overview of all reviewed articles. In the sequel listed papers are briefly discussed.

Table 1 Characterization of relevant literature

Ch.	Source	Approach	Method	Organization	Purpose
2.1	Bichescu and F. (2009)	Analytical deductive	Numerical analysis	Hierarchical & Collaborative	SCM software benefit
2.1	Chan and C. (2010)	Analytical deductive	Simulation	Collaborative	SCM software benefit
2.1	Dale and M.(2009)	Empirical inductive	Survey	Hierarchical & Collaborative	SCM software benefit
2.1	Kim et al. (2011)	Empirical inductive	Case study	Collaborative	Operational performance
2.1	Teller et al. (2012)	Empirical inductive	Survey	Collaborative	Operational performance
2.1	Wong et al. (2011)	Empirical inductive	Survey	Collaborative	Operational performance
2.2	Almeder et al. (2009)	Analytical deductive	Hybrid models	Hierarchical	SCM software functionality
2.2	Gupta and G.(2011)	Analytical deductive	Stochastic optimization	Hierarchical	SCM software functionality
2.2	Sodhi and T. (2009)	Analytical deductive	Stochastic optimization	Hierarchical	SCM software functionality
2.2	Albrecht (2009)	Analytical deductive	Deterministic Optimization	Hierarchical & Collaborative	SCM software functionality
2.2	Jung et al. (2008)	Analytical deductive	Deterministic Optimization	Hierarchical & Collaborative	Operational performance
2.2	Zhao and S. (2011)	Analytical deductive	Simulation	Collaborative	SCM software functionality
2.3	Arshinder and D. (2008)	Theoretical descriptive	Literature review	Hierarchical	SCM software benefit
2.3	Blankley et al. (2008)	Theoretical descriptive	Survey	Hierarchical	SCM software benefit
2.3	Hvolby and S. (2010)	Theoretical descriptive	Case study	Hierarchical	SCM software functionality
2.3	Kaipia (2009)	Theoretical descriptive	Survey	Collaborative	Coordination cost
2.3	Mittermayer and R. (2013)	Analytical deductive	Simulation	Hierarchical & Collaborative	Coordination cost & benefit

2.1 Network types and organizational fit

Real world network configurations and organization characteristics are frequently subject of empirical research. Within this group predominantly surveys and case studies are conducted in order to quantify organizational performance and software benefits.

For the characterization of networks so called contextual factors are crucial. The organizational proposals typically imply the organization structure, coordination mechanisms to interact among the units and an IT system to support the processes.

Contextual factors have been studied by Bichescu and Fry (2009). They confirm that the distribution of decision rights among supply chain partners influences strongly the SCM performance. Particular settings of cost parameters, such as penalty and holding cost, also have considerable impact.

Based on a survey among senior managers Importance-Performance Analysis (IPA) has been performed by Teller et al. (2012) in order to identify major improvement opportunities for the execution of SCM. The study revealed that favorable internal SCM conditions have the strongest positive impact on SCM execution but these conditions rarely are found in industrial practice.

The statistical analysis of a survey among managers of automotive manufacturing plants revealed that high environmental uncertainty affects dimensions of SC integration and operational performance distinctively (Wong et al. 2011).

SC integration efforts in a high uncertainty environment do not always lead to desirable operational performance outcomes. The paper demonstrates the need of conceptualizing SC integration and operational performance as multidimensional constructs.

These findings are confirmed by Chan and Chan (2010) who compare the performance of different decentralized coordination mechanisms regarding cost and order fulfillment objectives. The authors find out that high capacity utilization generally calls for ‘adaptive’ coordination while the ‘flexible’ approach is particularly recommendable in case of low demand uncertainty and low capacity utilization.

The relationship between IT capabilities and firm performance has been discussed controversy. Dale and Muhanna (2009) argue that aggregate data lead to mixed results and therefore propose to separate internal from external IT capabilities and to examine the influence of industry-specific environmental conditions (dynamism, munificence and complexity). They identify a strong influence of contingency factors (and even of combination of them) on the financial performance regarding different IT capability types.

Social network analysis has been recently applied to study three automotive supply networks (Kim et al. 2011). Several centrality and complexity metrics at the node- and firm-level help to determine specific roles in a supply network. Although no concrete recommendations are presented, requirements for system integration or supply risk management can be derived from the network metrics.

2.2 Novel planning algorithms and coordination schemes

Today SCM software still employs deterministic optimization models based on a strictly centralized, hierarchical organization concept.

Within the last years practitioners as well as scientists have been recognized that deterministic optimization models do not represent adequately real world complexity. Important extensions to the basic model consider uncertainties either using stochastic programming or a combination of analytical and simulation modeling techniques, so-called "hybrid models" (Almeder et al. 2009). Probably the most important critics on SCM software address the difficulty to establish a central decision unit that will be accepted by all actors. Therefore partially centralized or decentralized organization forms have been developed as alternatives to hierarchical planning.

Stochastic programming is applied to increase planning quality by incorporating uncertain demand and obtain improved expected values for service level and cost. Basically, some of the parameters defining a problem instance are random (e.g. demand or yield). After decision making now (stage 1) corrective action can be taken in the future, after revelation of the uncertainty on further stages (Gupta and Grossmann, 2011). Recently, Georgiadis et al. (2011) consider time varying demand uncertainty in the stochastic program for the optimal design of supply chain networks. Other model extensions incorporate financial supply chains: Sodhi and Tang (2009) include cash-flow optimization taking into account borrowing limits in their SC model. Additionally, adapting the Value-at-Risk (VaR) measures from financial risk management, they introduce demand-at-risk, inventory-at-risk and borrowing-at-risk measures that quantify the probability of violation of financial constraints.

To reduce the calculation time and complexity, solution strategies recently are developed (Gupta and Grossmann, 2011). The primary reason why stochastic programming is not widely applied in industrial applications is the complexity of the method and its low comprehensibility. "Selling the superiority of optimization-based risk-management approaches to managers is a challenge facing researchers." (Sodhi and Tang 2009, p. 737).

One of the mayor problems with decentralized planning approaches is that involved parties are not willing to share local information. Private data may be sensitive (especially capacity data) and constitute a strategic advantage for bargaining, which is lost after revelation.

Albrecht (2009) develops several coordination schemes that define the type and sequence for the exchange of private information. Different mechanisms for surplus sharing of the system-wide benefits are proposed that encourage truthful information exchange among the actors. In a similar manner,

Jung et al. (2008) show that with decentralized coordination acceptable performance levels are achievable compared to the fully centralized form if quantity information is shared.

Recently the competition among supply chains moved in the focus of research interest. For example, Zhao and Shi (2011) examine several influence factors such as market competition (i.e. the degree of product substitution between supply chains), the number of suppliers, the contract type and the decentralization grade.

2.3 Cost-benefit analysis

SCM system´s complexity is considered the major reason for the slow propagation and its limited use. At the same time benefits of these systems increase with the planning complexity to deal with (Hvolby and Steger-Jensen 2010).

The operational and financial impact of SCM software implementations have been studied by Blankley et al. (2008). Apart from first-order operational effects also second-order, financial impact can be observed – but after a significant time lag. Those benefits, such as sales growth, reduction in administration cost or the increase of firm value are more difficult to capture.

SCM research focuses in a large number of cases only on the benefits of software implementations. Kaipa (2009) remarks that information gathering and analysis results in important organizational cost. Therefore the optimal level of (costly) information sharing shall be determined according to the capability to react to changes on the material flow level.

Several organizational forms and IT support levels have been evaluated in different network types by means of simulation (Mittermayer and Rodríguez, 2013). For each network configuration specific business process architectures have been proposed.

3 Summary and future research opportunities

The first group of researchers carried out empirical studies on the experience with SCM and supporting IT systems.

There is no doubt that contextual factors such as firm size, production system properties, demand uncertainty or power balance among partners have strong influence on the appropriateness of different organizational designs. However, very few papers have discussed coordination mechanisms and their proper implementation. Arshinder and Deshmukh (2008) highlight the lack of empirical studies on the "conditions under which sub-type of coordination mechanism" shall be employed. They also remark that "there can be situations where two mechanisms are required to reduce the SC cost" and that "models are required to evaluate the degree of coordination" (Arshinder and Deshmukh 2008, p. 325). Social network analysis used by Kim et al. (2011) provides centrality and complexity metrics but the study is realized on a high aggregation level. Within this research stream, we propose to detail contextual factors, organizational designs and software functionalities and study the fit among the three elements. Higher resolution of the research scope will allow more concrete recommendations for industrial practice.

The second research group can be split in those authors who further improve centralized optimization algorithms considering uncertainty either by means of stochastic programming or ‘hybrid’ models and others who focus on decentralized coordination procedures. Within the latter community, relatively simple coordination schemes have been presented which achieve near-optimal results if at least some uncritical information is made available to the SC Partners. Future research within this stream shall focus on the identification of coordination mechanisms required for the beneficial use of collaboration-focused SCM modules. This is important because the success of decentralized concepts depends strongly on the willingness of SC partners and the dynamic interaction of organization units. Therefore prerequisites – i.e. favorable conditions for the implementation of particular coordination schemes shall be described.

The third group of Scientifics focuses on benefits and costs of SCM software implementations. The list of benefit and cost categories is much longer than might be expected at first sight. Apart from positive direct operational effects, the use of SCM software might suppose indirect, long term benefits such as sales growth or an increase in firm value. The evaluation of SCM software success depends on uncontrollable contextual factors, but also on controllable organizational design parameters. In general, few methods have been developed for the a-priori evaluation of SCM software benefits. Organizational costs are not considered with sufficient concern and available methods in many cases do not allow the comparison of different organizational designs and IT solutions. For example, decentralized planning approaches might offer acceptable results using relatively simple, low-cost software solutions.

Apart from the above mentioned proposals, results from one research segment shall be exploited in other fields. For instance, observations from empirical studies about organizational fit and network characteristics can be used as basis for decision support tools regarding SCM software investments. Furthermore, real world conditions should be taken into account when evaluating the efficiency of SCM software because success probabilities depend largely on the representation of complexity. Available off-the-shelf SCM software packages do not incorporate stochastic methods as described in section 2.2. However, these sophisticated prototype algorithms can be applied in experimental scenarios for the identification of (un)favorable contextual factors, leading to improved software investment decisions.

4 References

Albrecht M (2009) Supply Chain Coordination Mechanisms: New Approaches for Collaborative Planning.Springer, Heidelberg

Almeder C, Preusser M, Hartl R (2009) Simulation and optimization of supply chains: alternative or complementary approaches? OR Spectrum 31(1):95

Arshinder A, Deshmukh S, (2008) Supply chain coordination: Perspectives, empirical studies and research directions. International journal of production economics 115(2):316

Bichescu BC, Fry MJ (2009) A numerical analysis of supply chain performance under split decision rights. Omega 37(2):358–379

Blankley A, Khouja M, Wiggins C (2008) An Investigation into the Effect of Full-Scale Supply Chain Management Software Adoptions on Inventory Balances and Turns. Journal of Business Logistics 29(1):201

Chan HK, Chan FTS (2010) Comparative study of adaptability and flexibility in distributed manufacturing supply chains. Decision Support Systems 48(2):331–341

Dale Stoel M, Muhanna WA (2009) IT capabilities and firm performance: A contingency analysis of the role of industry and IT capability type. Information & Management 46(3):181–189

Georgiadis MC, Tsiakis P, Longinidis P, Sofioglou MK (2011) Optimal design of supply chain networks under uncertain transient demand variations. Omega 39(3):254–272

Gupta V, Grossmann IE (2011) Solution strategies for multistage stochastic programming with endogenous uncertainties. Computers & Chemical Engineering 35(11):2235–2247

Hvolby H., Steger-Jensen K (2010) Technical and industrial issues of Advanced Planning and Scheduling (APS) systems. Computers in Industry 61(9):845

Jung H, Frank Chen F, Jeong B (2008,) Decentralized supply chain planning framework for third party logistics partnership. Computers & Industrial Engineering 55(2):348–364

Kaipia R (2009) Coordinating material and information flows with supply chain planning. International Journal of Logistics Management 20(1):144

Kim Y, Choi TY, Yan T, Dooley K (2011) Structural investigation of supply networks: A social network analysis approach. Journal of Operations Management 29(3):194–211

Mittermayer H, Rodríguez Monroy C (2013) Evaluating alternative industrial network organizations and information systems. Industrial Management & Data Systems 113(1):77–95

Sodhi MS, Tang CS (2009) Modeling supply-chain planning under demand uncertainty using stochastic programming: A survey motivated by asset–liability management. International Journal of Production Economics, 121(2):728–738

Teller C, Kotzab H, Grant, DB (2012) Improving the execution of supply chain management in organizations. International Journal of Production Economics 140(2):713–720

Wong CY, Boon-Itt, S, Wong, CWY (2011) The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance. Journal of Operations Management 29(6):604–615

Zhao X, Shi, C (2011) Structuring and contracting in competing supply chains. International Journal of Production Economics 134(2):434–446

071 Creative Economy transforming the Market

Franzoni M L, Kanashiro Makiya I

Michelle Louise Franzoni (✉ e-mail: michellefranzoni2@hotmail.com)
Production Engineering. School of Applied Sciences. State University of Campinas. Unicamp.
Rua Pedro Zaccaria, 1300, Limeira – SP. Brazil.

Ieda Kanashiro Makiya (✉ e-mail: iedakm@gmail.com)
Business Management. School of Applied Sciences.State University of Campinas. UNICAMP.
Rua Pedro Zaccaria, 1300, Limeira – SP. Brazil.

Abstract: Creativity has been used in business with the intention to transform and renew industries, making them reach a wider consumer market. Therewith, this paper explores the impact of the creative economy mainly in the audiovisual segment and its market expansion. Also, there is a discussion about the importance of the design and the multidisciplinary issues in product development, due the changes and challenges in the consumer behavior.

Keywords: creative economy, market, technology, consumer behavior.

1 Creative Economy Overview

"Creation is a human activity whose origins remain mysterious and creativity is a virtuality that is universal but little understood" (Tremblay, 2011). Nobody can say when the humanity started to think creatively, but it was always essential for human life: it was necessary to create and renovate materials, techniques and survival.

Actually, creativity is the new way to solve problems in the world, in the industry (Adler, 2011) and in the cities (Comunian, 2010). In the business context creativity works as an important productivity factor, given that the current market environment is based in innovation. Quality assurance of products/services has become a major trend obligation and is creating a fit to innovate organizational culture (Rodrigues, 2009).

Stimulation on creativity in organizations means finding solutions to problems, always aiming at the optimization of profits, improved productivity and quality (Velloso Filho, 1999). Despite its importance, innovation has just been valued in the past decade, and since then has grown amazingly (Rodrigues, 2009)

Organizations that do not seek for innovation usually have great concern about the control and supervision, keeping multiple levels of hierarchy and thereby giving only to the staff of the highest management autonomy to innovate. Furthermore, the use of inflexible schedules and manual labor was a great enemy in encouraging creativity. As for the creativity promoting companies (Velloso Filho, 1999) - which have "flat" hierarchical pyramid treatment, plans must be different: the employee must have certain freedom at work, autonomy to make decisions, flexible schedules and fees. Therefore, so long was difficult for companies to ensure a propitious environment for the generation of new ideas.

The topics explained previously display the emergence of the new sector of creative industries which some authors (Tremblay, 2011) have moved to declare the birth of a new economy, the creative economy, in which creative activities and products play the main role. The term ‘Creative Economy’ (UNCTAD, 2008) can be defined as the cycle of creation, production and distribution of a tangible product with creative content, economic and cultural value and a market objective.

2 Countries and audiovisual market

In the UK, creative economy’s sector has an important view. Actually, UK design industry, which as a creative business service constitutes an important sector of the creative industries, moves the market of creativity. While it tends to be mainly associated with arts, in other countries (especially USA) it is commonly used to refer to individual and organizational performance (Vorley et al, 2008).

According to Tremblay’s data collection (2011), the software and design sectors represent a larger portion of the GDP (Gross Domestic Product) than the combined publishing, television, music, film and performing arts sectors. Those activities not traditionally associated with creative and cultural industries count indeed with 65 percent of total revenues for creative industries.

The following figure (fig.1) shows the sectors that have been more impacted by creativity. Software and design industry are in the top of the list followed by publishing, television & radio, music, film & video, whose are normally associated with creativity.

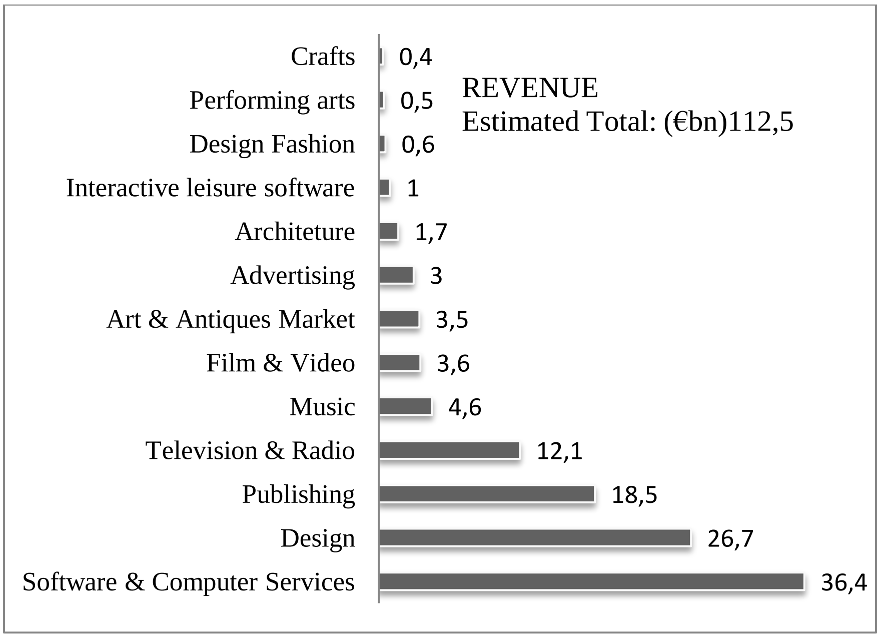


Fig. 1 The creative industries, ranked by revenue. (in €bn) Source: Tremblay, 2011

The fashion business also is changed by innovation: Fashion industry depends on the development of new techniques and requires sophisticated management to get success (Unay, 2012).

In 2008, the United Nations Conference on Trade and Development (UNCTAD) analyzed the countries that were most involved with creative economy in 2005. The countries that export more creative products were: China, Italy, USA, Germany, UK, France, Canada, Belgium and Spain.

Except for China, all countries in the list are developed and have an amazing staff and technological capacity. In the other hand, China is the largest exporter of goods in the world. In table 1 are listed the top nine exporting countries in 2005 according to UNCTAD and the sum of all creative industries value (in millions of dollars).

Table 1 Export of creative products: top nine exporting countries in the world in 2005
Source: UNCTAD (2008)

Exporting country	All creative industries value in millions of US$
China	61,360
Italy	28,008
United States ofAmerica	25,544

Germany	24,763
United Kingdom	19,030
France	17,706
Canada	11,377
Belgium	9,343
Spain	9,138

With respect to audiovisual market, it is important to remember that we are dealing with a sector that renews every single year. Because of this, creative is essential for product development and it will make loyal consumers every purchase. It means that managers have to lead with innovation the central tenet of theories on the information society (Tremblay, 2011).

Also, audiovisual market, as the capitalism in general, is characterized by flexible production, fierce competition and open trade: ingredients that made creativity an obligation for industry survival (Vanolo, 2013). This scenario requires constant change in business structure, which Schumpeter (1985) called 'creative destruction'. In the other side, some corporations prefer incremental improvements: the change needs to be continuous and follow the market need. In both cases, success depends on rethinking strategy, technology and market (Hart et. al; 1999).

UNCTAD (2008) brought a surprising result in the evaluation of the creative economy, which is the export of audiovisual products. There we would expect to find the following exporting countries: India, the United States, Brazil, and Mexico. Instead, it is Canada that comes first in the global export of audiovisual goods (Tremblay, 2011), as shown in table 2.

Table 2 Export of audiovisual goods: top ten exporters in the world in 2005
Source: UNCTAD (2008: Table 1.4.1A)

Exporting countries	Audiovisual goods value in millions of US$
Canada	318
Italy	160
United Kingdom	29
United States	28
France	21
India	16
Mexico	11
Korea	10
Australia	10
Romania	9

One of the most important changes need, especially in audiovisual case, is focus on reducing the life cycle impacts of products (Cunningham, 2007) through technological innovation. Considering the consumer economy, no business will work without this topic.

3 Design and Multidisciplinary

Design products have an embedded value, and the cost of the art is lower than the earned value. But to permit this profit, managers have to be prepared and make changes to transform the business in a creative business. Maybe the actual business has been thinking differently regarding this matter: some authors (Adler, 2011) say that the gap between what people can imagine and what they can accomplish has never been so smaller.

Phones with multi functions, watches that also work as thermometers, and a lot of others products and sectors that have been created recently show that encounters of different art forms, technologies, cultures, disciplines or whatever are a powerful element (Crossick, 2006) in creating new opportunities and new knowledge in the creative sectors.

Otherwise with the Creative Economy growth, some rules needs to be imposed (Coy, 2001): governments will have to strike a delicate balance: enforce patents, copyrights, trademarks and non-compete clauses to preserve incentives to create, but not so much that it will suppresses competition.

4 The new language of consumption

The consumption of market-made commodities and desire-inducing marketing symbols is central to consumer culture, and yet the perpetuation and reproduction of this system is largely dependent upon the exercise of free personal choice (Holt 2002) in the private sphere of everyday life

As consequence, Consumer Culture Theory (Arnould & Thompson, 2005) has advanced consumer behavior knowledge by illuminating sociocultural processes and structures related to (1) consumer identity projects, (2) marketplace cultures, (3) the socio-historic patterning of consumption, and (4) mass-media marketplace ideologies and consumers' interpretive strategies.

Consumer Culture Theory research demonstrates that many consumers' lives are constructed around multiple realities and that they use consumption to experience realities (linked to fantasies, invocative desires, esthetics, and identity play) that differ dramatically from the quotidian Over the last fifty years the economic base has shifted from production to consumption, from the sphere of rationality to the realm of desire: from the objective to the subjective, to the realm of psychology (Gobe, 2001). Pleasure and emotional satisfaction became regarded as located and activated *inside the mind* and hence no longer dependent on the physical experience of using (and owning) an object (Denegri-Knott & Molesworth, 2010).

In this manner, more recently, firms interested in exploiting user-led innovation are experimenting with the "tool-kit" approach (Oyama & Izushi, 2008), which provides a framework for product development that can be driven primarily by the user. It reduces the cost of gathering "sticky" information on consumer preferences; particularly this meets the need of manufacturers to standardize the production process on their part and achieve scale economies while allowing consumers to flexibly adapt products to their specific needs.

A new approach (Loorbach & Rotmans, 2010) for dealing with complex social problems and governance in this context is through co-production of a common language and future orientation as the heart of transitional management structured in coproduction process, new insights emerging, implemented and reflected upon a continuing way.

5 Internal and external view of video-games industry

As stated previously, the software development industry is the most prominent in the creative economy sector. Here, internal and external views of this sector will be used.

As an internal view of the game industry (Vallance, 2014), will be used as an example the learning process that the UK is experiencing: how to develop video games studios.

Unlike most functional forms of software, this sector cannot be developed by a specification or a pre-defined project: many tests periodically during the project can mean a drastic change of the team direction, which requires ability to change and rise again at any moment.

The video games development in the UK follows an adversarial model of the creative economy, where a lot of compliments of conventional character and which should be reviewed by these companies: (1) centralized geographic pattern, (2) the long term projects and consequently the teams and (3) the degree to which essential functions are maintained in-house. These latter characteristics explain why the UK, despite being the country with the highest number of studios to create games, is not the country with the greatest success in the industry.

In the next paragraphs, the focus is the external view of the video-games industry: how games like "Second Life" (Beck, 2010) can radicalize the lives of its users and the economy. The innovation within companies and in people's lives can have various origins, including games such as "Second Life". A study by Chandra and Leenders (2012) analyzes some users who used the "Second Life" platform for innovation: these often were not in their nature entrepreneurs in real life, but the game allowed numerous opportunities that were essential to the development of new skills.

According to these authors, the anonymity of "Second Life" allows users to help and share information, knowledge without any invasion of privacy. The bonds created show that creative innovation is necessarily a collection of knowledge between different people from different areas. Vallence (2014) also states that the exchange of tacit knowledge (informal knowledge) is essential for flexible business practices and work for the creative industries.

The connections between the knowledge of Real Life (RL) and Second Life (SL) are as many as possible, but in most cases entrepreneurs use the SL to RL inert knowledge, i.e., the new way of life allow risk and venture without financial risk and without exposing his true identity. That is the key to success in the creative economy.

Innovation that arises in such situations is not like "destructive economy" (Schumpeter, 1985), but causes a great impact on the way of seeing the new realm of creativity: many users believe that this way of innovating transform and expand the horizons of creative economy.

6 Conclusions

Business concern on quality maintenance and consistency of their products is currently not enough. Companies must now restructure and train staff to enable them to think creatively and to revolutionize their markets.

In many cases, the flexibility and different work environment allow large creations. Some industries have traditionally worked with creativity, as publishing, arts and television. But the survey, displayed by UNCTAD, conveys that the software industry & computer services creative leads in the market, followed by the design industry. In this context we highlight the audiovisual market, which must be renewed every year due to the capitalist dynamics occurred in this sector. Audiovisual products are developed to feed a short life cycle, requiring agile, rapid and effective success on skills development, sometimes based on co-creation process.

While the world worries about specialization, the creative economy requires multidisciplinary aspects based on knowledge and technologies for generating a large mix of products, areas and cultures, many aspects really important.

In addition, 'design' is the second fastest growing sector of the creative economy in income aspects. New demands for innovative products act as a competitive advantage for industries that expand their markets in the current economy on capturing the intangible values valorized by the new consumers.

The virtual environment and social media are accelerating the processes of new personal experiences and stimulating new demands on consumer behavior, shared in real time, changing added and perceived values, with impact on whole system of production for attending the most attractive intangible needs.

7 References

Adler, Nancy J. (2011) Leading Beautifully: The Creative Economy and Beyond. *Journal of Management Inquiry* 20(3) 208–221

Arnould, E.J., Thompson, G.J. (2005) Consumer Culture Theory (CCT): twenty years of research. Journal of Consumer Research, Vol. 31, No. 4 (March 2005), pp. 868-882.

Beck, U. (2010) 'Sobre a lógica da distribuição de riquezas e da distribuição dos riscos' (Cap. 1). in: Sociedade de Risco: Rumo a uma outra modernidade, Editora 34

Chandra, Yanto; Leenders, MarkA.A.M. (2012) 'User innovation and entrepreneurship in the virtual world: A study of Second Life residents' Technovation 32: 464–476

Comunian, Roberta. (2010) Rethinking the Creative City: The Role of Complexity, Networks and Interactions in the Urban Creative Economy. Urban Studies 48(6) 1157–1179,

Coy, Peter. (2001): 'The creative economy'. The Australian Financial Review: 1-2.

Crossick, Geoffrey. (2006): 'Knowledge transfer without widgets: the challenge of creative economy'. Goldmiths – University of London (1-21)

Cunningham, Stuart D. (2007): ' The Creative Economy: Patterning the Future'. Dialogue: Academy of the Social Sciences in Australia 26(1):pp. 15-23.

Denegri-Knott, Janice; Molesworth, Mike. (2010) Love it. Buy it. Sell it': Consumer desire and the social drama of eBay. Journal of Consumer Culture 2010 10: 56. DOI: 10.1177/1469540509355025

Hart, Stuart L.; Milstein, Mark B. (1999): 'Global sustainability and the creative destruction of industries'. Sloan Management Review – ABI /INFORRM Global: 23-32

Holt, Douglas (2002), Why Do Brands Cause Trouble? A Dialectical Theory of Consumer Culture and Branding, Journal of Consumer Research, 29 (June), 70–90.

Gobe, Marc (2001). Emotional branding. New York Allworth Press.

Loorbach, Derk; Rotmans, Jan (2010). The practice of transition management: examples and lessos from four distinct cases. Futures 42, pp. 237-246. doi:10.1016/j.futures.2009.11.009

Oyama, Yuko, Izushi, Hiro (2008). User-led innovation and video game industry. In: Intellectual Property Conference Birkbeck College, Bloomsbury, London, UK

Rodrigues, Jaqueline Fonseca. (2009): 'Influence of creativity techniques in the results of innovation in a company in the metallurgical industry in Ponta Grossa – PR'. Master's degree in Production Engineering from the Federal Technological University of Paraná, Campus Ponta Grossa, Brazil.

Schumpeter, J. (1985): 'Capitalismo, socialismo e democracia'. São Paulo: Abril Cultural. Chapter. 7-8.

Tremblay, Gaëtan. (2011): 'Creative statistics to support creative economy politics', Media Culture & Society 33 (2): 289-298

Unay, Fatma Genç; Zehir, Cemal. (2012) 'Innovation intelligence and entrepreneurship in the Fashion Industry'. Procedia - Social and Behavioral Sciences 41 315 – 321

UNCTDA - United Nations Conference on Trade And Development (2008) Creative Economy Report. The Challenge of Assessing the Creative Economy: Towards Informed Policy Making, URL (consulted October 2010): www.unctad.org/en/docs/ditc20082cer_en.pdf

Vallence, Paul (2014) 'Creative knowing, organizational learning, and socio-spatial expansion in UK videogame development studios' Geoforum 51: 15–26

Vanolo, Alberto. (2013): 'Alternative Capitalism and Creative Economy: the Case of Christiania'. International Journal of Urban and Regional Research, Volume 37.5, 1785–98.

Velloso Filho, Fernando. (1999): 'Considerations for creativity in organizations'. Journal of Public Administration, Vol 33, No 2.

Vorley, T.R., Mould, O.M. and Lawton Smith, H. (2008): 'Introduction to Geographical economies of creativity, enterprise and the creative industries', Geografiska Annaler: SeriesB, Human Geography 90 (2): 101–106.

085 An analysis of the work capacity in the textile sector: a study of the embroiderers section of outfits in the Ibitinga town, Brazil

Castro C, Hermosilla J, Achcar J, Silva E, Costa V M

Caroline Castro (✉ e-mail: ca-1989@hotmail.com)
José Luís Garcia Hermosilla (✉e-mail: jlghermosilla@hotmail.com)
Jorge Achcar (✉ e-mail : achcar@fmrp.usp.br)
Ethel Chiari da Silva (✉ e-mail: e-chiari@uol.com.br)
Vera Mariza Costao (✉e-mail: vmhmcosta@uniara.com.br)

University Center of Araraquara. Rua Carlos Gomes, 1338 – Centro. 14801-340 Araraquara – SP, Brasil.

Abstract: This study is aimed to assess the ability to work of workers in the textile segment of embroiderers section of outfits of the textile sector located in a small town in southeast of Brazil. The study was related to 140 volunteer workers who responded to a WAI (Work Ability Index) questionnaire, of which 86 were validated. The statistical analysis of the data was based on a descriptive preliminary data analysis, an ANOVA (analysis of variance) model and a linear multiple regression model and was performed using the MINITAB software. From this study, it was detected the influence of some important factors as the amount of different activities performed by each worker during the workday and the difficulty in performing the required activities. The study did not show the influence of other factors such as age on the ability to work considering a multiple linear regression model, a fact that contradicts the specialized literature that puts this variable as the main responsible for the large variability of WAI. Other evidences were also raised as the presence of unhealthy habits related to the variability of WAI.

Keywords: Capacity for work, WAI, textile industry, embroiderers, outfits.

1. Introduction

The aging of the elderly population in the world is increasing very fast as compared to younger age groups. Considering the special case of Brazil, it is estimated that, between 1950 and 2025, the elderly population will increase 15 times, that is, 5 times more than in the other age groups, contributing to a significant change in the age structure of the country (CAMARANO, 2002).

The great question that arises on this phenomenon, in addition to the natural and social consequences of aging, is the aging relation to the work capacity. The decreasing in the functional capacity of the individuals, a result of their chronological aging, can lead to serious problems when considering the ability of the workers and for the demands of their work activities (BELLUSCI and FISCHER, 1999).

Many studies have shown that people who work have better health than the general population, while the unemployment worse the health conditions with higher mortality rates and a higher prevalence of psychiatric symptoms, hypertension and bad habits as high dependence of alcohol consumption and cigarettes (SAITO and MURAI, 2007) with great impacts in the deterioration of the health of the unemployed persons. In Brazil, work aging began only recently to be investigated and it is considered very complex usually depending on several influence variables, among them the presence of some diseases (MARTINEZ, LATORRE and FISCHER, 2010).

As the effects of aging in the worker population in their work ability are still little known in Brazil, the main goal of this study is to contribute to this understanding by evaluating the relationship between work ability and chronological age of workers based on a workers garment textile segment (seamstresses) in the Ibitinga city, a small town in São Paulo State, Brazil.

2 Ability to work

The ability to work could be measured by an index denoted in the literature as the Work Ability Index (WAI), which is a tool that assesses the needs, conditions and effects of the occupational health workers. This tool (self respondent questionnaire) was developed in Finland between the 1980 and 1990 years and has been translated into 23 languages (ILMARINE, 2006).

In Brazil, the Brazilian version of the Work Ability Index (WAI), was evaluated by Martinez, Latorre and Fischer (2009), especially related to their validity and reliability, showing to be an appropriate and satisfactory option to assess the ability to work both as in individual evaluations or in population surveys.

The WAI reveals how well a worker is able to perform his job compared to his best performance. It is an instrument (questionnaire) that considers the physical and mental demands of the job, as well as the health and resources of the worker. The answers to the 7 questions that make up the instrument, are weighed and their final composition (sum) may vary from 7 to 49, as showed in Table 1, depicting the concept that employees have about their own work ability (TUOMI et al., 2010).

3 Ergonomic demands of the textile sector

In this study, we assume that the ability to work is measured by the Work Ability Index (WAI), which is a tool that assesses the needs, conditions and effects of the health occupational worker (see Table 1).

Table 1 Measure issues of the Work Ability Index (WAI)

Item	Number of questions	Number of points (score) of responses
1. Current capacity for work compared with the best of all life	1	0 – 10 points (measured in the questionary)
2. Work ability in relation to job requirements	2	Number of points weighted according to the nature of the work
3.Number of current diseases diagnosed by a physician	1 (list of 51 diseases)	At least: 5 diseases = 1 point 4 diseases = 2 points 3 diseases = 3 points 2 diseases = 4 points 1 disease = 5 points (only diseases diagnosed by a physician are counted)
4. Estimated job loss because of illness	1	1 – 6 points (circled value in the questionnaire, the worst value is chosen
5. Absenteeism due to illness in the past year (12 months)	1	1 – 5 points (circled value in the questionnaire)
6. Own prognosis of work ability in the 2 years from now	1	1, 4 ou 7 points (circled value in the questionnaire)
7. mental resources (This item relates to life in general, both at work and during leisure time)	3	The points of the questions are summed and the result is counted as follows: Sum 0 – 3 points = 1 point Sum: 4 – 6 points = 2 points Sum: 7 – 9 points = 3 points Sum: 10 – 12 points = 4 points

Source: Tuomi et al, p.11 (2010).

4 Methods and sample

The field research, quantitative in nature, came from a convenient sample of 140 workers of both sexes (an observational study), all from the sewing industry from leading city firms, personally contacted between July and September of the year 2013 by one of the researchers who also is part of this universe (researcher worker). The activity of the workers are related to the finishing job in bedding, bath and table clothes that have specific names as "sheath", "bias", all linked to seams in general. All respondent volunteers perform their activities during the daytime, 8 hours a day with 1 hour for lunch, in the Ibitinga town, a small city in Brazil with many small textile industries.

The work capacity indexes, measured by WAI questionnaire were evaluated and related to chronological age of the respondents, through statistical analysis mainly using the ANOVA modeling approach and the MINITAB software. The responses obtained were selected by age, where the main goal was to raise evidence on the evolution of functional aging in the textile sector. The ability to work with the values obtained from the WAI was classified as low (7-27 points), moderate (28-36 points), good (37-43 points) and excellent (44-49 points).

5 Results

The statistical analysis was obtained from a preliminary descriptive data analysis and also using ANOVA models on transformed data (a logic transformation $Z = \log[Y/(1-Y)]$ after a transformation $Y= (WAI-7)/(49-7)$ to have the responses defined in the interval (0,1)). The data transformation was necessary to normalize the data, a required assumption to validate the obtained inferences as hypothesis tests and confidence intervals for the model parameters of interest. The descriptive sample evaluation with the participation of employees in different age groups, ranging from 16 to 60 years, is given in Figure 1.

Regarding gender, 16 of the 86 respondents are males representing 18.6% of the sample and 70 are females representing 81.4 % of the sample, showing a predominance of women in this industrial activity. This fact is justified by tradition in this activity passed from mothers to daughters especially for the embroiderers tradition in this region and in many cases due to the possibility to have a part time work at home. This fact contributes to the increase in family income while allowing for the housewife working since this activity permits the worker to stay at home. Statistical analysis showed no significant relationship between WAI and gender with a obtained p-value greater than 0.05 (observed p-value = 0.102). It is important to point out that this working class usually does not have high schooling where most workers are predominating educated at the child level, followed by the middle or elementary degrees, with percentages 46 % , 32

% and 22 %, respectively. One of the reasons for the predominance of low education in this population is the general need of the persons to start in the work activities to increase the family incomes since teen ages, which great difficulty to school attendance.

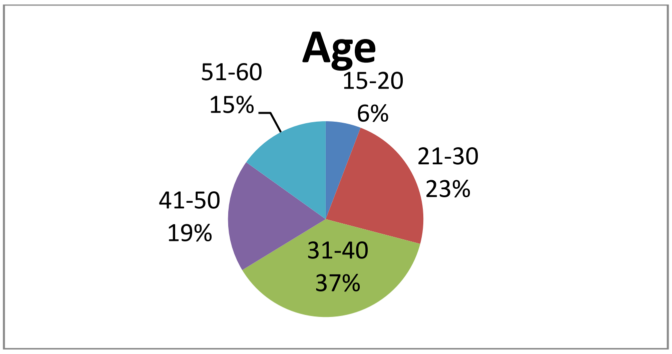


Fig.1 Percentage of age (in years) of the respondents

However, this reality has been changing in recent years, since we observe an increasing number of people interested in pursuing studies in search of better living conditions. The statistical analysis showed some relationship between WAI and the education factor (p-value = 0.063), a fact that was not observed with respect to time of experience (p-value = 0.671).

With regard to the marital status, 22 workers were single, 44 were married, 14 were living with a partner, one worker was separated, two workers were divorced and three workers were widowed. The statistical analysis showed no significant differences in the values of work ability in relation to marital status (p-value = 0.280).

The experience measured by work years ranged from 2 to 35 years was not associated with WAI (p-value = 0.671), in contradiction to some results found in the literature, since the length of experience is linked to age, the most important factor on work ability. A fact that drew attention was the loyalty of employees to the companies were they work. In general workers remain for many years in the same company, not seeking other opportunities.

The survey showed that the majority (69.7 %) of respondents own property, which can be explained in this study since it is a small city with low cost of living coupled with the fact that in general all the residences had a steady income; however it has not been showed association between the values of WAI and this variable (p-value = 0.597).

The respondents were also asked about the existence of some difficulties in performing some activities every day. Of the total respondents, 20 (23.3%) workers reported having trouble doing certain activities while 66 (76.7%) did not report any difficulties. The statistical analysis showed a significant difference between the values obtained from WAI for these two groups (p-value = 0.001), indicating that the rate of capacity for work actually measures the perceived limitations by the worker. The lowest figures were revealed by the WAI group that perceived some limitations in their activities compared to the other group. It was observed that workers in general have a high degree of fatigue after many working hours, combined with the fact that some typical features as sedentary lifestyle and high weight, spine problems greatly depending on prevailing posture (sitting) explain the greater difficulties in the handling activities.

A fact that has caught the attention of the researchers was the association between the presence of unhealthy habits and the ability to work. Workers who claimed to have unhealthy habits like smoking, alcohol , over-eating , among others, stated that this behavior can high influence the development of diseases such as diabetes, high blood pressure, alcohol dependence, shortness of breath, among many others. This association was evident in the statistical analysis (p – value = 0.007), pointing out that these workers had lower values for WAI as compared with the other group with healthier habits.

This association was also evident regarding the visit to the doctor (p-value = 0.032) showing that workers with greater frequency to the doctor showed higher values for the WAI. This fact may be associated with maintenance of the capacity of the worker through medical care, while those who make little use of this procedure, eventually discover their problems when they are already in advanced stages of diseases impairing their productive performance.

When the workers were asked about the demands of manufacturing activities, the most common response was quickly justified by the nature of the task (simple task, low value-added and high- repetition task), this remarkable feature of the local textile business. As the prospects for future activities after age 60, the main responses were: I will not arrange employment; I will be an elderly housekeeper or I will be a secretary. Respondents are concerned that these occupations which do not require a heavy load work and that permits to remain seated most of the day without repetitive stress, not having to carry weight, and depending on the situation working fewer hours per day, provide better conditions for rest as they expect for elderly persons.

Another research question was about the amount of activities performed throughout the day, that is, if the employee performs different activities throughout the day as sheath bias, sewing in general, among others. Workers generally could carry one, two or more different activities throughout the day. This factor has not been shown to have a significant association with WAI (p-value = 0.227).

As a way to supplement the described preliminary analysis obtained using ANOVA models and to verify the combined effect of all the variables on the ability to work of the employee, other statistical analysis was performed to find the influence of the age factor in WAI as well as the other variables that were significantly associated with WAI: the use of a multiple linear regression model.

The regression analysis relating the age factor and the rate of work ability (WAI) showed that the association of age and WAI is significant with p-value < 0.05.

To confirm the influence of the different covariates on WAI, a multiple regression model was assumed considering the factors that showed significative effects on the work activities in the preliminary analysis, for example, the difficulties in performing tasks or activities, the presence of unhealthy habits, the expectation of employment after age 60, the time function and age. Among all the covariates mentioned above, the multiple regression analysis confirmed only the amount of activities performed throughout the day and difficulties performing tasks as being significant in association with WAI (p-value = 0.019 and p-value = 0.020, respectively).

In summary, we observed that only the covariates associated to performed activities and difficulties in performing activities have significant effects on the WAI (transformed) as the p-values are smaller than 0.05; the covariate healthy habits have some significant effect on WAI (transformed) since the p -value is less than 0.10.

6 Concluding remarks

This case-study raised important evidences for the productive segment under study despite not establish some relationships already established by the literature, since the results showed no significant variation in WAI when compared to several aspects.

A fact worth mentioning was not finding association between age and WAI, as shown in many studies and several publications presented in the literature in several areas (FISCHER et al , 2005; MARTINEZ , LATORRE and FISCHER, 2010; MONTEIRO , ILMARINEN and ROCHA, 2005).

The survey showed that the number of different activities developed by the worker throughout his workday is related to the loss of capacity for the worker, but this fact deserves to be better analyzed, since the variation of activities is seen by scholars as beneficial as it helps in preventing related RSI / WMSD diseases. In the case of seamstresses, it is reasonable to assume that the change occurs in non appropriate ergonomic conditions, which has led this group of workers to realize a reduction in their ability to work. This should be inserted in future analyzes involving jobs and improvements to the manufacturing environment because it points clearly to the limitation that has imposed on the worker.

Another aspect of great significance especially for the management of the workers is the strong association between WAI and the difficulties experienced by the operators. This association shows that the perception of the worker actually reflects its productive state, which may contribute to the management policy of people's organizations.

On the other hand, the awareness that there is not considered healthy habits and its proven association with low levels of WAI worker pointed out the need to join forces and engage employees in awareness activities may lead them to better conditions of work and life.

7 References

Alves, L. C., Leite, I. D. C., & Machado, C. J. (2008). Conceituando e mensurando a incapacidade funcional da população idosa: uma revisão de literatura. Ciência Saúde Coletiva, 13(4), 1199-207.

Bellusci, S.M.; Fischer, F. M. (1999) Envelhecimento funcional e Condições de Trabalho em Servidores Forenses. Revista de Saúde Pública, São Paulo, SP, v.33, n.3, p.602-609.

Camarano, A. A.(2002) Envelhecimento da População Brasileira: Uma Contribuição Demográfica. Rio de Janeiro, RJ. Available: http://repositorio.ipea.gov.br/bitstream/11058/2091/1/TD_858.pdf. Cited 4 Nov 2013

Fischer, F. M; Borges, N.S.; Rotenberg, L.; Latorre, M.R.D.O.; Soares,N.S.; Rosa,P. L. F. S.; Nagai, R.; Landsbergis, P. A (2005) (in)capacidade para o trabalho em trabalhadores de enfermagem. Revista Brasileira de Medicina do Trabalho. Belo Horizonte, v. 3, n. 2.

Ilmarinen, J. (2006). The ageing workforce—challenges for occupational health. *Occupational Medicine*, *56*(6), 362-364.

Martinez, M.C.; Latorre, M. R. D.O.; Fischer, F.M. (2010). Capacidade para o Trabalho: Revisão de Literatura. Revista Cência & Saúde Coletiva, 15(supl. 1): 1553-1561, São Paulo, SP.

Monteiro, M.S; Ilmarinen, J; Rocha, J.G. (2005) Capacidade para o trabalho, saúde e ausência de doenças de trabalhadoras de um centro de pesquisa por grupos de idade. Revista Brasileira de Saúde Ocupacional, vol. 30, núm.112, pp.81-90. Fundação Jorge Duprat Figueiredo de Segurança e Medicina do Trabalho São Paulo, SP, Brasil.

Saito, J. M. F; Murai, H. C.(2007) A reinserção da população idosa no mercado de trabalho sob a ótica da enfermagem. Revista Enferm. UNISA; 8: 38-41.

Tuomi, K, et al.(2010) Índice de Capacidade para o Trabalho. Traduzido por Frida Marina Fischer (coord.). São Carlos, EDUFSCAR, 59p, SP.

088 Problems with Value Stream Mapping application detected in literature

Dal Forno AJ, Pereira F, Mählmann Kipper L, Cezar Bornia A

Ana Julia Dal Forno (✉ e-mail: anajudalforno@hotmail.com)

UniversidadeFederal de Santa Catarina. Centro Tecnológico. Brasil

Fernando Pereira (✉e-mail: Fernando.fep@gmail.com)

Liane Mahlmann Kipper (✉ e-mail: liane@unisc.br)

Antonio Cezar Bornia (✉ e-mail: cezar@deps.ufsc.br)

Abstract: Value Stream Mapping (VSM) is an important tool of the lean approach and is used to identify value-adding activities and activities considered waste in materials, information and people flow. The purpose of this paper is to investigate what are the mains difficulties and limitations encountered during the current state maps construction, analyzing what are the causes associated and to point out guidelines to facilitate the use of VSM to map processes. For this, we conducted a literature review methodology according to application area (factory floor, supply chain, product development and services) and approach (theoretical or practical). However, when not applied correctly, it can complicate the waste identification, lead to misinterpretations and assessment mistakes, as well as undermine the future improvements implementation. In results, this paper criticizes the VSM use, observing that important constraints have to be considered and that the tool can lead to mistakes that could create problems instead of benefits when used incorrectly. With the restrictions noticed, this paper suggests future works to improve the use of VSM to map processes.

Keywords: Value Stream Mapping, Lean Manufacturing, Literature Review.

1 Introduction

In the early 1990s, Womack, Jones and Roos (1990) reported that companies were Lean Manufacturing (LM) was applied had better results than companies that used other production systems. Besides the application in various manufacturing sectors including textiles, automobiles, ceramics and electronics, the Lean approach has also gained space in logistics, services, healthcare, product development, banks and even in agribusiness.

Considered a process map, VSM is inserted at the intermediate level to be able to deploy company management tactics at the operational level. VSM is described as a technique used for the diagnosis, implementation and maintenance of a Lean approach. Its main function is to identify opportunities for improvement and the elimination of waste with support from operational staff. The goal of VSM is to observe material flow in real time from the final customer to the raw material, to visualize losses in the process, using symbols to represent the process visually and clearly. VSM has three basics steps – construction of a current state map, construction of a future state map and development of an action plan.

Managing the Value Stream involves a process of understanding, measuring and improving the flow of materials and information and the interactions of all tasks, to keep a company's costs, services and quality products as competitive as possible (Keyte and Locher 2004). VSM is one of the valuable tools for understanding the current process status and identifying opportunities to make improvements (Dennis 2007). VSM is a useful tool for guiding improvements, based on a carefully considered and developed plan. Lean experts look at operations from the value stream perspective (Liker and Meier 2005). Lean implementation allows a company to reinforce the various stages that lead to operational excellence, continuous improvement and elimination of activities that don't add value. Thus, the influence of lean practices contributes substantially to a factory's performance and the use of lean tools amplifies these results (Álvarez et al. 2008).

The aim of this paper is to identify the main difficulties and limitations in VSM current state map construction, identify the major causes and identify guidelines for its use. A theoretical-conceptual approach was used, by conducting a bibliographic search with the words VSM and Lean. A total of 57 articles were classified. Because of space constraint, this paper is detailed in Dal Forno et al. (2014).

2 VSM Problems, Challenges and Limitations

VSM is conducted in locus at a factory in a hands-on process, and is highly dependent on the skill of the person who is executing the VSM. Liker and Meier (2005) highlighted the danger in using VSM like a cookbook. At Toyota, people spend years working on improvement projects before they reach the status of new on STP (Segmenting, Targeting, and Positioning). There is a lot to learn, and it is only possible to learn by doing.

A total of 57 papers were analyzed to identify problems during VSM implementation. These papers were classified into eleven categories (P1 to P11):

P1 - Low/ lack of integration between processes: cases that demonstrate difficulties or a lack of integration between processes, creating integration barriers within the plant;

P2 - Low/ lack of clarity of procedures: cases where the production processes are not clear. The materials and parts travel different paths within the production line;
P3 - Low/ lack of product modularity: cases where the products are not modularly designed, making them difficult to manufacture and assembly;
P4 - Low-skilled people: cases where low-skilled personnel impede understanding and tool usage;
P5 - Poor/ lack of process stability: cases where there is a lack of standardization and process stability;
P6 - Problems/ difficulties in measuring data in processes: cases where time data and quantity measurements are impractical due to layout problems, product complexity or process type;
P7 - Obsolescence of the current state map: cases where processes have changed, but there is no documentation about this;
P8 - Small batches with highly mixed production: cases where VSM application is compromised because there are many product types being assembled with the same infrastructure and production schedule uncapped (heijunka);
P9 - Production too flexible: cases where the production line is too flexible, constantly changing to adapt to market and product changes;
P10 - Process too intuitive: cases where process flow is too dependent on the operator, who decides in real time the way that the product should go into production;
P11 – Others problems: problems that do not fall into categories P1 to P10 are considered in this category. Examples found include authors who comment that VSM only shows the current state, and is either very pessimistic or very optimistic, depending on the level of stock and other factors that occur at the moment in which the process is mapped given that it is considered analogous to a photograph. Other problems cited were imbalances in processes, a lack of support from management for the execution of VSM, indicators that are not aligned with a Lean approach and a failure to consider the value of the client. Some of these problems are not related to the tool itself, but mainly to production problems.

Regarding the procedure, the papers were classified as *theoretical* when they were based on reviews or the literature, or *practical* when practical applications of VSM were described, for example, a survey, case studies or simulations.

According to the area, papers were classified in the following categories:

- Production – related to activities on the factory floor, works applied to manufacturing and the industrial environment;
- Supply Chain Management (SCM) – involve, in addition to manufacturing, involving a relationship with suppliers and logistics;
- Other areas – works applied to services, such as hotels or the administrative sectors at companies such as product development.

The term “VSM” began to appear in publications in 1999. Fifteen articles from 1999-2004 were analyzed (26%) 22 studies from 2005-2008 (39%) with 11 in

2007 alone. Since 2009, there were 20 studies (35%) with the search terminating in September 2013.

According to the survey, 79% of the papers are practical and 21% are theoretical, meaning that researchers are using the tool to make improvements at organizations. As for the field of application, 61% of the works were related to the factory-floor (production) 25% related to other application areas, 12% related with SCM and 2% with both production and SCM. Figure 1 illustrates the research results of the main difficulties reported in the papers on VSM, and that many of them discuss more than one type of problem. Figure 1 summarizes the problems identified according to Table 1.

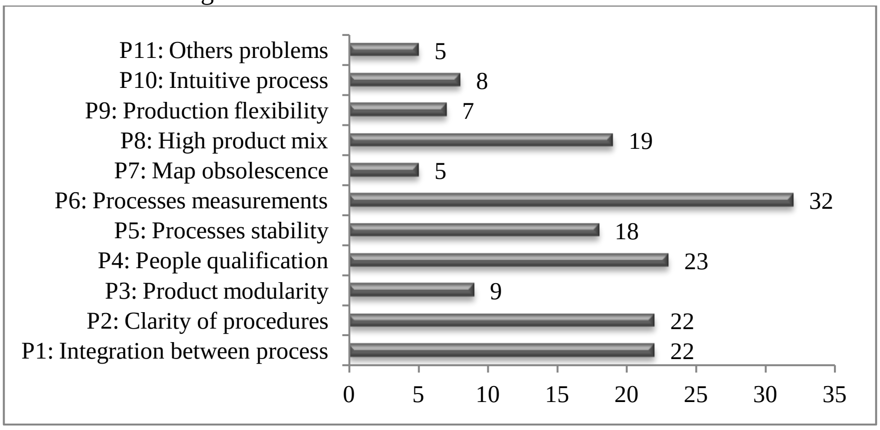


Fig. 1VSM frequency of problems identified in papers

Besides the reported problems, VSM implementation is still experiencing some challenges and limitations, as identified in the papers:

Product choice: from a lean manufacturing perspective, the process maps are used to eliminate wastes from the customers' perspective, and for this reason they are related to products. Products may take different paths during a single process. Therefore, a change in one process made to eliminate wastes for a specific product doesn't always eliminate wastes in other products. In some cases, it may even increase wastes, depending on how the process is organized. This makes it difficult to choose the product to be examined by the process map (Carr et al. 2008, Belova and Yansong 2008). Many authors indicate that this type of situation can be remedied with the use of techniques such as clustering products in families. However, the clustering practice only works if the products use the same production resources.

Processes with lack of stability: processes that are not stable are almost impossible to improve because the mapping does not represent the process' real situation, because each day the process behaves in a different way. This is why production process standardization is so important (Shingo 1988, Dennis 2007, Nash and Poling 2008). Before beginning the current state mapping, it is necessary to confirm if there is stability in the process.

Measurements of inadequate data in production process: failures in data measurements in production processes can lead to inconsistent data, which don't represent the true reality of a process. Cases may be stable, but if they are not properly measured, they will not correspond to reality. Like the stability in a process, the accuracy of data is also important in VSM. Some authors have cited transparency as a key element in current state mapping, understood as the accuracy of the information collected in the factory (Shen and Han 2007, Soto 2007, Childerhouse and Towill 2004, Klotz et al. 2008, Belova and Yansong 2008).

The need to have data flow processes that can be interpreted as economic data: the proper measurement of times and distances in processes results in analyzing how the production system is being used to produce a product. In this sense, a map that allows the systematic identification and quantification of wastes at a company is certainly useful for aiding the process of analyzing and improving the efficiency of internal processes (Sondalini 2006, Qui and Tannock 2010, Leopoulos et al. 2010) measured by assessing system costs.

Product complexity: product complexity is the level of difficulty associated with the production of a component, usually measured by the estimated total production man-hours required and difficulty involved with completing the tasks in series or parallel operations. According to Fernandes (2001) the word "complex" can be used to describe the level of difficulty associated with the manufacture or assemblage of a part. The increase in product or process complexity increases the difficulty in obtaining data for VSM preparation (Salzman 2002, Fernandes 2001, Frenkel 2004, McManus and Millard 2002, Mazur and Chen 2007, Belova and Yansong 2008).

Product and process obsolescence: many companies fail to apply the tool in time intervals compatible with the changes of products and processes. The mapping, which should be repeated often, takes time to be completed. The big problem with this practice is that with product lifecycles becoming shorter and shorter, information collected soon becomes obsolete because the production system needs to adapt to the market and customer changes (Childerhouse and Towill 2004, Sahoo, Singh and Tiwari 2007, Fernandes 2001, Salzman 2002).

3 Conclusion

It is undeniable that the application of VSM provides important benefits to the productive process. That is why it is a practice applied at so many companies and studied at several universities and research centers. Even with all its benefits, when mistakenly applied VSM can generate poor results that lead to bad decisions, both technically and financially. Therefore, many interesting opportunities exist for making more rational use of the VSM tool and thus provide more reliable results.

The time spent to obtain data for the construction of the current state map also compromises the continuous use of the VSM tool. Facilitating the production data measurement process can create opportunities for applying VSM frequently, making the tool more useful in continuous improvement processes (kaizen). The continuous data measurements can lead to the adoption of statistical methods for monitoring process performances and the results of future state maps.

This paper sought to identify problems concerning VSM implementation and investigate the possible causes. The paper identified future opportunities for VSM implementation, especially with regard to increased productivity and reliability of this Lean tool. In terms of problem identification, the biggest difficulty was in understanding and classifying problems identified in the studies researched, because they were not always clearly presented. Many authors described the importance of the tool and discussed its results; but only a few authors discussed difficulties in executing VSM. The identification of problems and difficulties in studies is an experience that can help to determine what went right and what benefits were obtained from each study.

4 Acknowledgments

We are grateful to financial support by funding and research agencie from Brazil – CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior).

5 References

Álvarez, R., Calvo, R., Peña, M.M., Domingo, R. (2008) Redesigning an assembly line through lean manufacturing tools, *The International Journal of Advanced Manufacturing Technology*, Vol.43, No (9-10) p. 949-958.

Belova, I. M., Yansong, Z. (2008) *Value Stream Mapping for Waste Reduction in Playing System Components Flow*, Dissertation. Jönköping International Business School, Jönköping.

Carr, A. S., Kaynak, H.; Hartley, J. L., Ross, A. (2008) Supplier dependence: impact on supplier's participation and performance, *International Journal of Operations & Production Management*, Vol.28, No 9, p. 899-916.

Childerhouse, P., Towil, D. R. (2004) Impact of reducing uncertainty in european supply chains, *Journal of Manufacturing Technology Management*, Vol.15, No 7, p.585-598.

Dal Forno, A. J., Forcellini, F. A., Pereira, F. A, Kipper, L.A. Value Stream Mapping: a study about the problems and challenges found in the literature from the past 15 years about application of Lean tools. *International Journal Advanced Manufacturing Technology*, 26 feb 2014.

DOI 10.1007/s00170-014-5712-z.

Dennis, P. (2007) *Lean Production Simplified*, Productivity Press, second edition.

Fernandes, P. A. (2001) Framework for a strategy driven manufacturing system design in an aerospace environment – Design Beyond Factory Floor. Aeronautics and Astronautics Dissertation. Massachusetts Institute of Technology, Massachusetts.

Frenkel, Y. M. (2004) Enterprise level Value Stream Mapping and Value Stream Analysis for aircraft carrier components. Mechanical Engineering Dissertation. Massachusetts Institute of Technology, Massachusetts.

Keyte, B., Locher, D. (2004) The Complete Lean Enterprise: value streams mapping for administrative and office process. New York: Productivity Press.

Klotz, L., Horman, M., Bi, H. H., Bechtel, J. (2008) The impact of process mapping on transparency. *International Journal of Productivity and Performance Management*, Vol. 57, No.8, p.623-636.

Kuhlang, P., Edtmayr, T., Sihn, W. (2011) Methodical approach to increase productivity and reduce lead time in assembly and production-logistic processes. *CIRP Journal of Manufacturing Science and Technology,* Vol.4, No. 1, p. (24–32).

Leopoulos, V., Voulgaridou, D., Bellos, E., Kirytopoulos, K. (2010) Integrated management systems: moving from function to organisation/decision view. *The TQM Journal*, Vol.22, No.6, p.594-628.

Liker, J.K., Meier, D. (2005) Toyota Way Fieldbook. McGraw-Hill.

Mazur, L. M., Chen, S. 2007. Understanding and reducing the medication delivery waste via systems mapping and analysis. *Health Care Manage Science*, 11 (1) p.55–65.

McManus, H. L., Millard, R. L. (2002) Value Stream Analysis and Mapping for product development. Proceedings of the International Council of the Aeronautical Sciences. 23rd ICAS Congress, Toronto

Nash, M. A., Poling, S. R. (2008) Mapping the total value stream: a comprehensive guide for production and transactional processes. Nova York: Productive Press.

Qui, Y., Tannock, J. D. T. (2010) Dissemination and adoption of quality management in China: case studies of Shangai manufacturing industries. *International Journal of Quality & Reliability Management*, Vol.27, No.9, p.1067-1081.

Salzman, R. (2002) Manufacturing System Design: Flexible Manufacturing Systems and Value Stream Mapping. Mechanical Engineering Dissertation, Massachusetts Institute of Technology, Massachusetts.

Shen, S. X., Han, C. F. (2007) China electrical manufacturing service industry value stream mapping collaboration. *International Journal of Flexible Manufacturing Systems*, Vol.18, No.(4) p. 285–303.

Shingo, S. (1988) *Non-Stock Production: The Shingo System of Continuous Improvement*. Productivity Press.

Sondalini, M. (2006) Profit Contribution Mapping. *Proceedings of the 1st World Congress on Engineering Asset Management* (WCEAM). Perth Area.

Soto, L. 2007. *Construction design as a process for flow: applying lean principles to construction design*. Management and Engineering Dissertation. Massachusetts Institute of Technology, Massachusetts.

094 Logistic Management Optimization in the ports

González MJ, Buiza G, Beltran J, Stanley MT, Veloqui M, Cerbán MM, Turias I

María José González (✉ e-mail: mjgonzalez@iat.es)
IAT (Andalusian Institute of Technology - Parque Científico Tecnológico Cartuja, C/ Leonardo da Vinci 2 - 41092 Sevilla.

Mariana Veloqui (✉e-mail: mariana.veloqui@uca.es)
Intelligent Modelling of Systems Research Group. University of Cádiz. Polytechnic School of Engineering (Algeciras) - Avda. Ramón Puyol s/n, Algeciras (Cádiz), 11202 Spain.

María del Mar Cerbán (✉ e-mail: mariadelmar.cerban@uca.es)
Research Group Transport and Innovation Economic. University of Cádiz. Faculty of Economics - Avda. Duque de Nájera s/n, 11002 Cádiz, Spain

Abstract: The aim of this paper is to show the results obtained and the methodology used to achieve better logistic organization of Mediterranean ports and logistics areas. Recently, we introduced a new methodology in the ports of Naples and Algeciras Bay in order to improve their logistics processes. This methodology was implemented as a part of the INTE-TRANSIT project, a MED program with the aim to improve logistic processes and increase technological integration in Mediterranean ports. The methodology used by the ports of Naples and Algeciras Bay consist of four parts, two of which include a tool called VSM. VSM stands for “Value Stream Mapping,” a tool to analyze and understand the flow of material and information that helps you see and understand a process and identify waste. Waste in this context, is defined as anything that adds cost to a product or service without adding value. The use of this methodology has allowed us to know in detail the problems in the process both the information flow and material flow. It was detected as the acquisition of new technologies could facilitate and expedite the process of receiving, location, internal movements and vessel loading.

Keywords: Logistics, Lean, port, optimization, model.

1 Introduction

Maritime transportation is the backbone to international trade and the global economy. Around 80% of global trade, by volume, and more than 70%, in value, is transported by sea and passes through ports world-wide.

The United Nations Conference on Trade and Development (UNCTAD) has recently published their report on 2013 Maritime Transportation that reflects on the progress and challenges which are facing this sector. This is a publication that has been publishing since 1968 with the aim to encourage the transparency of the maritime market and to analyze the development and tendencies in the international maritime trade field, transportation by sea, global fleets, ports, freight markets and the legal and regulatory framework of the transportation.

Among the most highlighted results in the 2013 Report, it notes the growth of international maritime trade that for 2012 registered an increase in volume of 4.3%, reaching for the first time in history 9.2 billion tons. The reason for this upward trend would is fuelled, according to UNCTAD, by the "increased domestic demand in China and by the increase in exchanges between Asian countries and between the southern Asian and southern European countries". Furthermore, it estimates the global port traffic in containers increased 3.8%, reaching 601.8 million units.

The importance of ports as links in the logistical chain and the transportation is supported by the following numbers: close to 60% of exports and 85% of imports pass through them, accounting for 53% of Spanish foreign trade with the European Union and 96% with non-member countries.

In addition, the activity in the national port system contributes for close to 20% of GDP in the transportation sector representing 1.1% of Spanish GDP. It also generates a direct employment of more than 35,000 jobs and some 110,000 indirectly.

The ports are important intermodal centers, yet there has existed a historic neglect towards the intermodality with the land modes (rail and road) that are now being corrected. This shift has been caused by factors such as the intention to expand the ports hinterland, the promotion of new services of short distance maritime transportation (SDMT) and, in general, is the result of the increased competition among ports (Foundation CETMO, 2005).

The ports are essential for transportation activity and competitiveness of Europe and have enormous potential in the creation of jobs and investments. The European ports are the gates to the European continent. 74% of non-European Union goods are sent through these ports. They are also important to inter-European trade: with 37% of European Union freights passing through these ports annually and 385 million passengers.

In the 70,000 kilometres of coasts in the European Union are where over 1,200 trading ports are located. Europe is one of the regions with highest density of ports in the world. It is forecasted that the traffic of goods that pass through these ports of the EU will increase 50% by 2030. This increase is an opportunity of economic growth and job creation: The Commission has estimated by 2030 they can create between 110,000 and 165,000 jobs in the ports. But the European ports must be adapted to face increased traffic (Bruselas, 2013).

Before all these observations and information, this article describes the methodology and first results obtained during the INTE-TRANSIT project, funded by the Regional European Development Fund under the MED program, which aims to achieve a better logistical organization in the MED ports and their areas of lo-gistical activities through the use of modern technology and to establish a frame-work of cooperation between interested stakeholders in MED countries for the ex-change of better practices, cooperation, and the personnel training.

The basic objective of INTE-TRANSIT is to improve the information management systems that are currently used in the ports and their logistical activities zones, through an integrated management model that involves public and private organizations and the production of both processes as a map of harmonized and common Mediterranean indicators. In addition, INTE-TRANSIT also will promote an ICT solution to improve the traceability, visibility, and transparency in the transportation of good in the Mediterranean zone. In specific, this article will make references to the work carried out in Algeciras Bay and in the Napoli port (CONATECO).

2 Methodology

There are in the literature a wide consensus on the positive impact of Lean in the operating results of the organizations that implemented, so we decided to use this tool for the analysis of port processes (Cua, McKone y Schroeder, 2001; Flynn y Sakakibara, 1995; Martínez y Pérez, 2001; Soriano-Meier y Forrester, 2002; Shah y Ward, 2003; Narasim-han, Swink, Kim, 2006). Although the Lean methodology is known and has been implemented in various industries like automotive, construction, healthcare, aeronautical, pharmaceutical, and even public enterprises still remains a methodology little applied in other sectors or even unknown. One major reason why companies do not decide to adopt Lean Management is the misconception that it is too costly to implement and there is no need for the organization to get better results. It is therefore vital that prior to the adoption of Lean Management, companies are aware of the potential benefits of its implementation (Sohal y Egglestone, 1994). For this reason, trained work teams participating in this methodology prior to the completion of the VSM ports. Thus the criteria for the identification of waste were unified. Waste in this context, is defined as anything that adds cost to a product or service without adding value, which can include: Transportation, Defects and Rework, Inventory, Waiting, Over processing, Overproduction and Motion.

In this project, the novelty of the methodology is based on the combination of tool VSM (Value Stream Mapping) with numerical modelling of the process by using the MATLAB tool.

In the literature review was not detected evidence of the application of these tools in a complementary way. These tools currently applied independently. In the port of Chennai (India) the VSM tool was used in order to identify the causes of downtime and losses on existing operations associated with the load of goods. The article concludes that after the study was not failed to reach consistent results (R. Akila, Dr. N. Thangavel, 2011).

There are references to the applicability of LEAN in ports and its benefits , but not all appear as this name, although because of the description and content of paper is easy detect that they are talking about this philosophy and especially to mention of the " agile " concept. About their benefits the reference mentions that allows ports to be able to anticipate the services that are desired by the markets, resulting the creating a proactive ports. It is claimed that by implementing of this philosophy in the ports, these become more efficient and effective, causing a reduction in operating costs and increased profitability, thus allowing invest in more advanced technologies (Y.H.V. Lun, K-H Lai, T.C.E. Cheng, 2010; Peter B Marlow, Ana C Paixão Casaca, 2003). Other benefit is that with the mapping ports are able to identify the real needs of information between the various actors involved, facilitating identify the most appropriate technologies to use or develop in port processes for the exchange of information (Adrian E. Coronado Mondragon, et al., 2011).

Regarding the simulation phase or time study, it is evident that for any process there are different tools, theoretical studies, algorithms and software.

As for the reference in port processes have been identified that have used specific software, such as ARENA or Witness, however was not detected evidence regarding the use of MATLAB (Zunfeng Liu, et al., 2013; Mariam Kotachia, et al., 2013; Zhuo Suna, et al., 2011; Alarcon Hernandez JA, et al., 2012; Ozhan Alper Almaz, Tayfur Altiok, 2012).

This leads us to provide a new methodology based on the combination of these two tools which independently provides good results and of which the combination can bring good results for decision making in any port process.

3 Case study

The application of these two techniques was conducted in the Bay of Algeciras and in CONATECO. The process chosen for the study in the Bay of Algeciras was Ro-Ro good (both full load units and trailers), being the study about the export process. In CONATECO the study was limited to the container terminal and was analyzed the export process in dry cargo. The stages of the methodology of work were:

1. First of all a Kick-off meeting was held where the activities were:
   - Selection of the coordinator and multidisciplinary team
   - Selection product family and definition of the project scope
   - Visit and observation of the process
   - Training and planning
2. Second, different activities are performed in order to know in detail the current process of the selected product family:
   - Observations and Collection of information and relevant data
   - Elaboration of the current VSM
   - Analyze the information and identify the wastes and bad practices
   - Time study via MATLAB, compare the outcomes of timing study with the VSM performed
   - Identify indicators more representative of the process
3. Finally the optimum flow was designed:
   - Elaboration of the future VSM
   - Identification of the proposed improvements
   - Identification new technologies to acquire or develop, in order to optimize the flow of information and material

To collect initial data several methods were used:

1. A questionnaire was prepared to collect data by port operators and logistic companies about their internal logistic management processes, the operational properties and the quality of their existing systems and the possible issues or congestions that they are facing.
2. Technical meetings were organized among pilot leaders accompanied with a visit or a survey in each pilot area.
3. Interviews with the stakeholders (port operators, customs, NGOs, etc.), from each partner's geographical area have been carried out in order to comprehend and analyze in depth, the specific needs of each pilot area, taking specific geographical and socio-economical parameters into consideration among others.

The two techniques applied in order to analyze all the information gathered were:

- Value Stream Mapping (VSM) is a visual management tool that represents the sequence of all operations and the flow of information and materials, as well as the main features of the whole process, from the raw material supplier to delivery to the customer, if it is the case. The analysis of the VSM along with the review of bibliography, norms and regulations, in addition to information teeming from interviews and work meetings, have led to the identification of KPIs (Key Performance Indicators) associated to the studied logistics processes in CONATECO and Port of Algeciras. Within the process, two types of VSMs are used: current and future. The current VSM analyzes the current processes and represents the current statuses of the chosen processes. The future VSM represents the ideal situation once any current waste is reduced or eliminated. Once a current VSM and waste is identified, the future VSM is used to create an Improvement Plan to define which wastes will need to be reduced first, and how said wastes will be reduced or if possible, eliminated.
- Numerical modeling. The MATLAB application was used to analyze the timing and queues associated to the logistics processes selected in CONATECO and the Port of Algeciras Bay, within the framework of INTE-TRANSIT. These studies have outlined the behavior of these processes by performing the corresponding simulations for varying parameters of each of these processes. This has allowed not only to confirm the results and conclusions obtained through the VSM technique but also to complete them. Specifically, they have been useful to identify and confirm the KPIs. The database provided by CONATECO has contained approximately 140,000 arrivals records within 2012, where truck arrivals, movements in yard, inspections and boarding times have been detailed. At the same time, a study in the Port of Algeciras was with a total of 3.566 registers within April and May 2013.

4 Results

Several improvement proposals were suggested on both ports. Regarding identification technologies both ports needed acquire some of them (OCR, RFID, GPS, etc.) in order to speed up, and avoid errors and delays in the different managements Documentary. A common factor was detected in the processes and it was the lack of an information system common in which all stakeholders could share and view information and data they need for their daily work.

On the other hand, in the study of time carried out in the port of Algeciras was extracted as an important result the fact that some vehicles stayed over 24h (14%) in the port. After analysing this information it was identified that these vehicles were using the terminal as storage, therefore an improvement proposal was to offer to these vehicles a location in an area outside the port for example in a close logistic area. Additionally, it is important to mention that a study on the optimal route connecting the LA El Fresno and the Port of Algeciras Bay has been developed. This study has identified the origin and final (destination) point and has characterized the critical sections (traffic volume, public/private ownership, length, estimated travel time, infrastructure, etc.). This information has been very useful in extracting the geographical parameters of the area between the Port of Algeciras Bay and its LA.

5 Conclusions

The difficulties encountered in the development of the project were mainly two:

- The difficulty of gathering all stakeholders in order to share their experiences. The main reason was the complexity to combine the agendas of all involved.
- Lack of registration of some data, this meant to have to measure some data in order to do of the time study.

To the presenting of the final results were all actors involved and they found it satisfactory and consistent.

The integration of the two modelling and simulation tools (MATLAB and VSM) has allowed us to simulate the project operational taking place in real time in the ports under study without interfering with your day to day. Like any simulation tool will allow us to further explore all alternatives and variants of processes playing only those elements for improvement and modification.

6 References

Adrian E. Coronado Mondragon, Chandra S. Lalwani, Etienne S. Coronado Mondragon, Christian E. Coronado Mondragon, Kulwant S. Pawar, (2011): “Intelligent transport systems in multimodal logistics: A case of role and contribution through wireless vehicular networks in a sea port location”. Int. J. Production Economics, Elsevier, http://www.journals.elsevier.com/international-journal-of-production-economics

Alarcon Hernandez JA, Sung-woo CHO, Myong-sop PAK, (2012): “Fuel Consumption within Cargo Operations at the Port Industry A simulation Analysis on the Case of S Port Company in the UK”. The Asian Journal of Shipping and Logistics Volume 28, Issue 2, Pages 227–254. http://www.sciencedirect.com/

Comisión Europea, Bruselas, (2013), http://europa.eu/rapid/press-release_MEMO-13-448_es.htm

Conferencia de las Naciones Unidas sobre Comercio y Desarrollo, (2014), “In-forme sobre el Transporte Marítimo 2013”, http://www.lsansimon.com/las-tendencias-del-transporte-maritimo.

Cua, K.O., McKone, K.E. y Schroeder, R.G. (2001): “Relationships between im-plementation of TQM, JIT and TPM and manufacturing performance”. Journal of Operations Management, Vol. 19, nº 2, págs. 675-694.

Flynn, B.B., Sakakibara, S. y Schroeder, R.G. (1995): “Relationship between JIT and TQM-practices and performance”. Academy of Management Journal, Vol. 38, nº 5, págs. 1325-1360.

Fundación CETMO, (2005): “El transporte en España, un sector estratégico. In-forme sobre la aportación del transporte y sus retos futuros”. www.fundacioncetmo.org

Mariam Kotachia, Ghaith Rabadib , Mohammad F. Obeid, (2013): “Simulation Modeling and Analysis of Complex Port Operations with Multimodal Transportation”. Procedia Computer Science 20; 229 – 234. ScienceDirect, www.sciencedirect.com

Martínez-Sánchez, A. y Pérez-Pérez, M. (2001): “Lean indicators and manufacturing strategies”. International Journal of Operations and Production Management, Vol. 21, nº 11, págs. 1433-1451.

Narasimhan, R., Swink, M. y Kim, S.W. (2006): “Disentangling leanness and agil-ity: an empirical investigation”. Journal of Operations Management, Vol. 24, nº 5, págs. 440-457.

Ozhan Alper Almaz, Tayfur Altiok, (2012): “Simulation modeling of the vessel traffic in Delaware River: Impact of deepening on port performance”. Simulation Modelling Practice and Theory. Volume 22, March 2012, Pages 146–165. http://www.sciencedirect.com/

Peter B Marlow, Ana C Paixão Casaca, (2003): “Measuring lean ports performance”. International Journal of Transport Management. Volume 1, Issue 4, 2003, Pages 189–202. http://www.sciencedirect.com/

R. Akila, Dr. N. Thangavel, (2011): “A Study On Lean Management In Chennai Port”. International Journal of research in computer Application & Management, Volume nº. 1 , Issue nº. 6 (August); ISSN 2231-1009.

Shah, R. y Ward, P.T. (2003): “Lean manufacturing: context, practice bundles and performance”. Journal of Operations Management, Vol. 21, nº 2, págs. 129-149.

Sohal, A.S. y Egglestone, A. (1994): “Lean Production: Experience among Aus-tralian Organizations”. International Journal of Operations and Production Man-agement, Vol. 14, nº 11, págs. 35-51.

Soriano-Meier, H. y Forrester, P.L. (2002): “A model for evaluating the degree of leanness of manufacturing firms”. Integrated Manufacturing Systems, Vol. 13, nº 2, págs. 104-109

Y.H.V. Lun, K-H Lai, T.C.E. Cheng, (2010): “Shipping and Logistics Management”. Springer London Dordrecht Heidelberg New York. Págs 205-217; ISBN 978-1-84882-996-1 e-ISBN 978-1-84882-997-8

Zunfeng Liu, kai Kang and Chunling Zhang, (2013): “Resources Optimization Model and Application in Port”. Information Technology Journal 12 (19): 5160-5165. ISBN 1812-5638

Zhuo Suna,, Loo Hay Leeb, Ek Peng Chewb, Kok Choon Tanc, (2011): “MicroPort: A general simulation platform for seaport container terminals”. Advanced Engineering Informatics Volume 26, Issue 1, January 2012, Pages 80–89. ScienceDirect, www.sciencedirect.com

097 Hospitality operation in Restaurants of a touristic region: a study of a client fidelity impact

Pozo H, Wada E K, Bueno M

Hamilton Pozo (✉e-mail: hprbrazil@hotmail.com)
Dpto. de MestradoemHospitalidade. UniversidadeAnhembiMorumbi.Rua Casa do Ator, 275045-001, São Paulo/BR.

Elisabeth KyokoWada (✉e-mail: ekwada@anhembi.br)
Dpto. de MestradoemHospitalidade. UniversidadeAnhembiMorumbi.Rua Casa do Ator, 275 045-001, São Paulo/BR.

Marielys Bueno (✉ e-mail: marielysbueno@gmail.com)
Dpto. de MestradoemHospitalidade. UniversidadeAnhembiMorumbi.Rua Casa do Ator, 275 045-001, São Paulo/BR.

Abstract: The objective of this research is to analyze the effect of hospitality operation in a restaurant with the client's emotions, customer satisfaction and brand loyalty, using structural equation models. The research also examines the applicability of the model in the five factors in hospitality operation scale for a restaurant. Empirical data were collected with the use of questionnaires in six typical restaurants of Campos de Jordão-SP. This research confirms five personality dimensions typical of a tourist-focused restaurant. Also, the results suggest that emotions directly impact customer satisfaction and brand loyalty about hospitality.

Keywords: hospitality, restaurant, emotion, customer satisfaction, loyalty.

1 Introduction

The customers often make decisions about restoring parts based on various attributes, such as location, quality of food, service, price, hospitality and brand (Jiang, Dev, and Rao 2002). Recently, research began to analyze the effect of hospitality perceived by customers in the use of services by the behavior of these (Yik, 2001). The hospitality is defined as a set of attributes to raise and maintain socials relations or environment that the person shall be meaning, raising identity and shared memory. The hospitality can provide a link between emotional benefits and self expression of a product and the service, which happens to be considered as a basis for improving the treatment associated with customers, creating brand differentiation.

The emotions evoked me hospitality customers, which is consistent with the conclusion Yik (2001) that the most enduring actions affect the personality and influence, and these, in turn lead to the behavior of customer satisfaction. The positive emotional state of customers will positively influence the number of items purchased, the time spent in the store, and the monetary value spent in the store) considering that emotion is an antecedent to customer satisfaction (Desai; Mahajan, 1998).

Consumer behavior is portrayed as a stimulus to a response system of the body. These stimuli are outside the person and consist of two variables of the marketing mix and other environmental inputs. Thus, the person ability of the brand can be used as an incentive. Then can encourage clients in their abilities and actions and thus, increase the levels of brand personality and loyalty (Fournier, 1994). Thus, it is very important that the typical restaurant entrepreneurs know more about the behavior of their customers and how they can be influenced by the hospitality and for their emotional needs.

Same as the hospitality and excitement generated by it are recognized in the literature as important in the relationship marketing factors, little empirical research has been conducted on the effects of brand personality on clients in the behavior of the post purchase. This study investigates the operacionidade gives hospitality to a restaurant and its role in creating value for the customer satisfaction and loyalty through consistent mediating role of customer emotions. There are many studies that covers hospitality as variables such as sincerity, excitement, competence, quality, sophistication; service can affect the emotional state of the client. It is important to stress that the results of this study have theoretical and practical implications. Theoretical implications include better understanding of the factors operation procession of the hospitality on the emotional state of clients within the sector.

Emotions. The emotions of a person can be positive and negative. Those positive emotional states tend to decrease the complexity of their decision and have taken less time decision that people in negative emotional states. To be concentrate on emotional aspects of the consumption experience for a better understanding of the evaluation process to customer service (Mattila, Patterson, 2004). Dubé and Menon (2000, p.288) suggest that emotions are effective responses to consumption and the perception of different attributes which make up the evidence of a product or service. The emotional component satisfaction is thus independent of the overall sense of emotional gifts to customers during the period of time in service (Ruyter, Bloemer, 1999). Studies, show two different ways of understanding emotion subjacentes characteristics of consumption, ie, the category and the structural dimension (Ho; Ko, 2008) are identified. Several studies have supported the reliability and validity of measuring consumption by emotion categories emotion, essential in their studies (Batra, Holbrook, 1990).

Hospitality. For Connolly (2005) the word hospitality in the university is often used in a common sense. Yet as Connolly (2005) outlines three alternatives that the notion of hospitality opens for the study of the tourist experience: as social fact, as ritual and as ethics gifts in hotel tourist organizations. Considering the relationship between employee and employer, the study of hospitality in other organizations also happens in these three alternatives: work as a social fact, the ritual of hospitality in the relations between people and ethics in hospitals practices as matching factor. The hospitality and all the complex it yet hat makes communiqué character to en compass the individuals a central element of its definition Ashley and Morrison (2004). It is the individual whose sis considered something hospitable or not, using perception as a measure of this definition.

Customer satisfaction. Customer satisfaction is fundamental to the concept of marketing and the concept of meeting the needs and desires of consumers (Spreng, Mackenzie & Olshavsky, 1996; Hsu, 2009). The definition of customer satisfaction varies along the marketing literature. Customer satisfaction in cognitive perception may be suitable buyer or inadequately rewarded for the sacrifices that he can perceive. The definition of a result against the sacrifices received by the experience of consumption and customer satisfaction, same mo as the summary psychological state resulting from the excitement surrounding expectations is associated with previous consumer sentiment about the consumption experience (Oliver 1992). The results of customer satisfaction when you want to confirm your expectation before buying a service or not confirm positively their expectations regarding the services purchased, bying consulting a level of service after purchase, affect their experience in relation to the supplier Report and Jaworski,(2005). The way in which customer satisfaction is measured has been discussed in terms of scales that are used and the form of the questions (Wilson, 2002). Customer satisfaction can be measured by one or several alternatives. Consequently, it is acceptable when multi alternative scales are you used, it must be considered that customer satisfaction is total, because the scales of multiple alternatives can capture more knowledge on customer satisfaction, from the perspective of consumers themselves in only one item of time. Several items can also provide reliability in stable empirical scale when compared with a single item (Gilbert; Veloutsou, 2006). In this study, customer satisfaction is measured in terms of overall satisfaction. Large part of research onto the hospitality focuses on defining and measuring factors that attitude and its association in long term of relationships between buyers and sellers. Yu and Dean (2001) suggested that there is a high correlation between customer loyalty and emotional components and positive emotions. Studies suggest that emotion enfluye in retaining customers and in vonluntad buy (Baker, Grewal, Levy, 1992).

Variables. One questionnaire was developed in bibliographic review and a study center. To ensure the reliability and validity of the scales, tests were also performed. Related to personalidade restaurants were grouped baseado 42 items in the study of Aaker (1997) concerning the personality and brand. They are identified in terms of five dimensions: sincerity, excitement, competence, sophistication and ruggedness. A Likert scale classified in five positive items : unhappy, happy, lively, very happy and very satisfied; and five negatives items: irritated, unhappy, ignored, irritated and anxious. The study was conducted with 540 customers who had dined at the typical restaurants of Campos de Jordão-SP-BRchosen for the study. The type of restaurant is nationally recognized as a family friendly establishment with average price for lunch and dinner. The research was conducted in six restaurants conveniently selected based not only on location and turnover, was also based on their billing and equivalence of services during the period of one month. Interviews were delivered to customers during lunch and dinner every day of the week. A total of 90 interviews were conducted with customers in each of the restaurants while in the local levels, with a total of 540 questionnaires, that 512 were being returned. The number of responses to be used was 480, obtaining a 89 % response.

Analysis of the investigation. As shown in Table 1, the exploratory factor analysis with Varimax rotation for the hospitality of the restaurant revealed five factors based on a cut of eigenvalue 1. These five factors explained a cumulative 74.02 % of the total variation in the data. The interpretation of these factors is in the following dimensions of brand personality of the restaurants (the variations are dimensioned in parentheses) : Competition (17.69%), robustness (15.82%), sincerity (15.61%), excitement (12.61%) and sophistication (12.9 %).

Table 1. Results of factor analysis and reliability test of the participants factor

Factor load	Auto Value		Variation	Name of Factor	Correlation Total	∝
Business	0.81	2.89	17.69	Competence	0.70	0.81
Success	0.79				0.69	
Technic	0.81				0.72	
Effort	0.87				0.75	
Confidence	0.73				0.64	
Robust	0.66	2.69	15.82	Sturdiness	0.58	0.79
Resistance	0.79				0.69	
Sincerity	0.88	2.66	15.61	Sincerity	0.71	0.77
Honest	0.85				0.75	
Realistic	0.75				0.66	
healthy	0.89				0.81	
Independent	0.71	2.22	12.61	Excitation	0.62	0.73
Unit	0.73				0.71	
Young	0.74				0.59	
Lovely	0.86				0.73	
Female	0.89	2.01	12.29	Sophistication	0.79	0.75
Variety	0,81				0.72	
Smoothness	0.82				0.71	

Variation Total			74.2			

Source: Researchdata

Refinement was performed on the scale and also by analyzing total correlation to improve the reliability of the results. This led to the retention of 19 items, representing five dimensions: competition factor (5 items, $\alpha = 0.81$), robustness factor (4 items, $\alpha = 0.79$), factor of sincerity (4 items, $\alpha = 0.77$), excitation factor (3 items, α=0.73), and factor of sophistication (3 items, α=0.75).

The hospitality has a positive effect on the positive emotion ($\gamma 11 = 0.57$, t = 8.76 value), statistically significant at $p < 0.01$. This result was consistent with the conclusion of Izard et al. (1993) that the hospitality is positively related to positive emotion. Positive and negative emotions were associated with customer satisfaction. Customer positive emotion about the restaurant had a positive effect and very significant in satisfaction (β 31 = 0.57, t value = 11.13, $p < 0.01$). Otherwise, the negative emotion had a negative effect on customer satisfaction (β 32=-0.15, t=-3.38 value, P<0.01). Further analysis of the indirect effects was in diced to investigate whether the hospitality had an effect on the satisfaction and loyalty through the mediating role of customer emotions. The hospitality was an indirect positive effect on satisfaction (0.37, p value =6.93, p <0.01) and loyalty (0.53 , p value = 9.41 , p < 0.01). In addition, the empirical results show that positive emotions also had an indirect positive effect on loyalty (0.37, p value = 6.93, p <0.01). This factor is consistent with the study findings Ruyter and Bloemer (1999) that when a customer has experience of positive affect in a restaurant, the customer is willing to return and repeat the experience of the service provided and, therefore, become faithful the restaurant. And finally, a negative emotion had indirect negative effect on loyalty and hospitality (- 0.10 ; value t = - 3.29, P < 0.01), it comes to have a direct and positive effect on loyalty by suppressor variables.

2 Conclusions

This research provides empirical evidence for the development of the wrapping the childs behavior in relation to brand loyalty Restaurant, positive and negative emotions and customer satisfaction with the operation of hospitality.

The results confirm the positive effects of the operation of positive emotion com hospitality and customer satisfaction, as well as they. The results supported the conclusion that customers perceive the positive hospitality and increases its degree of pleasure in relation to it. In turn, the results indicate also a positive intention simper commitment to return to the restaurant.

It also confirms the five dimensions of the hospitality of a restaurant: sincerity, excitement, competence, sophistication and ruggedness, as in the study of Aaker (1997). The results of this research were also consistent demonstration that the hospitality has a significant impact on the individual people and emotion influence their consumption behavior. The present study has several limitations. First, the results can not be generalized to other segments of the restaurant. Therefore, future studies should be developed in a systematic project that best represents the universe.

3 References

Aaker, J. L. (1997). Dimensions of brand personality. *Journal of Marketing Research*,*34*(3):347-356.

Batra, R.; Holbrook, M. B. (1990).Developing a typology of affective responses to advertising. *Psychology and Marketing 7*:11-25.

Baker, J., Grewal, D.; Levy, M. (1992).An experimental approach to making retail store environmental decisions”.*Journal of Retailing*, *68*(4):445-460.

Connolly, D. J. (2005). In self servicetakesoff: Hospitality industry selservice technologystudy. Randolph, NJ: Edgell Communications.

Desai, K. K.; Mahajan, V. (1998).Strategic role of affect based attitudes in the acquisition, development, and retention of customers. *Journal of Business Research*, *42*(3):309-324.

Dubé, L.; Menon, K. (1993).Multiple roles of consumption emotions in post purchase satisfaction with extended service transactions. *International Journal of Service Industry Management*, *11*(3):287-304.

Fournier, S., (1998). Consumers and Their Brands:Developing Relationship Theory in Consumer Research.Journal of Consumer Research, 24:343-373.

Gilbert, G. R.; Veloutsou, C. (2006).A cross-industry comparison of customer satisfaction.*Journal of Services Marketing*, *20*(5), p.298-308.

Ho, S., &Ko, Y. (2008). Effects of self-service technology on customer value and customerreadiness: The case of Internet banking. Internet Research, 18: 427-446.

Hsu, C. (2009). Hospitality and tourism education in Asia-Pacific: Trends,developments and a look into the future. *Paper presented at 2009 I-CHRIE Conference, San Francisco, CA*.

Jiang, W., Dev, C. S.; Rao, V. R. (2002).Brand extension and customer loyalty. *Cornell Hotel and Restaurant Administration Quarterly*, *43*(1):5-16.

Lashley, C. Morrison, A. (2004).Embusca da hospitalidade :perspectivaspara um mundoglobalizado. Barueri, SP: Manole, 2004.

Mattila, A. S., & Patterson, P. G. (2004). Service recovery and fairness perceptions in collectivist and individualist contexts.*Journal of Service Research*, 6(4): 336-346.

Oliver, R. L. (1997). *Satisfaction: A behavioral perspective on the consumption*. New York: McGraw-Hill.

Rayport, J., &Jaworski, B. J. (2005). Best face forward: Why companies must improvetheir service interfaces with customers. Boston, MA: Harvard Business School Press.

Ruyter, K., and J. Bloemer (1999).Customer Loyalty in Extended Service Settings. International Journal ofService Industry Management 10:320-336.

Spreng, R. A., Mackenzie, S. B.; Olshavsky, R. W. (1996).A reexamination of the determinants of consumer satisfaction. *Journal of Marketing*, *60*(3), p.15-32.

Wilson, A. (2002). Attitudes towards customer satisfaction measurement in the etail sector.*International Journal of Market Research*, *44*(2): 213-222.

Yi, Y. (1990). A critical review of consumer satisfaction. In V. A. *Review of marketing* (p.68-123). Chicago: American Marketing Association.

Yik, M. S. M. (2001).Predicting the big two of affect from the big five of personality. *Journal of Research in Personality*, *35*(3):247-277.

Yu, Y.T; Dean, A. (2001). The contribution of emotional satisfaction to consumer loylty. International Journal of Service Industrial Management. 12(3): 234-250.

100 Historical Considerations about Health and Safety

Gonçalves F, Poletto A, Másculo F

Fernando José Fernandes Gonçalves (✉ e-mail:fernandojose@ifsc.edu.br)
Santa Catarina Federal Institute of Education, Science and Technology,Florianópolis-SC, Brazil.

Angela Regina Poletto (✉e-mail: angelapoletto@ifsc.edu.br)
Santa Catarina Federal Institute of Education, Science and Technology, Florianópolis – SC, Brazil.

Francisco Soares Másculo (✉ e-mail: masculo@producao.ct.ufpb.br)
Production and Systems Department, School of Engineering, Paraíba Federal University, Brazil.

Abstract: This article aims to conduct a review of historical fact relating to safety and health at work with a focus on world affairs over time. The methodology used for this study was the literature review, based on documentary records and major authors who addressed the subject from antiquity to the 21th century. The studies were based on the history of health and safety throughout the ages, mainly from crystallization of industrialization, recovering some of the records that expose knowledge about occupational risks and their impacts on workers. It was observed throughout history that treatment aimed at workers in the current period, is still far short of what advocates knowledge of science and technology, with regard to the adequacy of labor to human nature activities. It is hoped that the historic rescue provoke reflections and transformations in the means of production and society, and that these reflections will contribute to this knowledge serve as input to promote prevention of occupational risks as a component of social and productive culture.

Keywords: safety; health, history; work; occupational risks.

1 Introduction

The transformations that occurred over time, in humanity, are marked by dates and isolated without situating them in the larger context to which they belong facts, and when located are directed by the interests of those registers. Study the history, causes epistemological curiosity, research and moves dormant knowledge that emerge in order to contribute to the understanding of the transformations in the lives of men. In history, the conquest of rights and duties of a citizen is men seeking a permanent and rights, gradually achieved until today, and obtained with much struggle and resistance. The recognition by the social collective, the historical significance related to the safety and health of workers facts, as an object of importance, many changes that have occurred, and many still take place in the respect to the physical, psychological and social weaknesses of men is critical to reflections on safety and health in work activities. This article aims to conduct a review of historical fact relating to safety and health at work with a focus on world affairs over time. The information explored in this research centered mainly from the crystallization period of industrialization in society. The choice of this period is due to its representation as a historical inflection point at which they occurred and continue to develop transformations in the field of labor and social processes.

2 Historical Facts of the Health and Safety Work World

The approach of some of the historical records of the Health and Safety in the world, from ancient times to the present reality, demonstrates that knowledge relating to occupational risks observed long ago and unfortunately, today its prevention is not effective in productive activities. In addition to these risks were originated others regarding the organization of work, the misuse of science and technology and others that originated from industrialization and cause misfortunes related work activities victimizing millions of people each year.

2.1 From Antiquity to the 21th Century

Man has always lived with occupational hazards and always has been subject to accidents and diseases caused by them. Therefore, in course of time, the understanding of working conditions and hence occupational hazards and development to control these conditions in order to overcome the unhealthy, dangerous and arduous labor activities, constitute, in a part of history of human and social examples and relating to Health and Safety, before the period of industrialization, dating from antiquity. The first records of the association between work and their linkages with health observed in the papyri of the Egyptians, concerning the Babylonian Empire people, and textual discourses of Greek-Roman society. Other papyri, as Seler II and Anastasi V, respectively date from 2360 BC and 1800 BC. The first relates the inherent risks of certain working environments and the second called "*Satire of Trades*" sets the professions of the era and its consequences for the unhealthy, danger and hardship. Then, in 1750 BC, again in the Babylonian Empire, the "*Code of Hammurabi*” established nearly three hundred articles in this report established respect of labor relations. (Mattos, 2011:6-7).Table 1 provides some history records of safety and health at work from antiquity to the Middle Ages.

Table 1*: History of Work Safety of antiquity to the Middle Ages*

Period	Origin	Contribution
4^{th} Century BC	Hippocrates (460-375 BC)	Revealed the origin of occupational diseases affecting workers in the tin mines.
	Platão (428-348 BC)	Found and presented specific skeletal diseases that afflict certain workers in the line of duty.
	Aristotle (384-322 BC)	Studies devoted to the care of diseases and prevention of diseases of workers in mining environments.
2thCentury BC.	Galeno (201-129 BC)	Worried with poisoning by metals.
1th Century BC	Plínio (23-79 BC)	Published natural history, which first issues relating to job security were treated. He talked about lead, mercury and dust. Mentioned the use of masks by workers of these activities.
11^{th} Century BC	Avicenna (980-1037)	Was concerned about lead poisoning and indicated as a cause of colic caused by work on paintings that used lead-based paint.

Source: Webster, M. F. (2001). A Continuous Improvement Model Applied to Risk Reduction in the Workplace. Master Thesis. Production Engineering. Federal University of Santa Catarina. Florianópolis.

The records of accidents and diseases cases and their linkages with the work from the sixteenth century made by attending physicians in patients corporations crafts. Historians claim that in 1556, George Bauer (Georgii Agricolae), published the book *De Re Metallica*, which reported in studies on the various issues related to the extraction of gold and silver ores and smelting. The last chapter of this work is devoted to accidents and the most common diseases among miners. As observations Agricolae in some extractive regions, "women came to marry seven times, which were stolen from their husbands, the premature death found in the occupation exercising." The Agricolae himself knew how these problems could be avoided. It was not a medical issue, but rather, a problem of technological nature, resulting from the work process used, whose modification, plus the introduction of means to improve ventilation inside the mine, could, as a prophylactic measure to protect the workers from inhaling harmful dusts. (Nogueira, 1981). One of the few records that have this period date 1567, in which the scientist called Paracelsus describes numerous observations relating to methods of work, or the handling of substances with the development of disease in workers (mercury poisoning). These pioneering studies practically ignored and had little influence for the improvement of health and safety in those days. (Nogueira, 1981). In 1700, Italian physician Bernardino Ramazzini (considered the Father of Occupational Medicine, by pioneering and its scientific records) wrote a work in which established nexus of a number of diseases with 50 professions. The Hippocratic imperative questions on history of that time, he added a new one: "What is your occupation?" (Ramazzini, 2000). Some of the impacts of the *First Industrial*

Revolution that occurred in Europe mainly on the life and health of persons have been studied. These studies record the plight of the productive activities that resulted in severe, crippling and fatal accidents in addition to acute poisoning and other health problems afflicting workers, including women and children, who favored by the possibility of them being paid higher wages discount. Accidents were often a result of improvisation, daily working hours without limits, among others. (Webster, 2001:12). The weaknesses of social cohesion worsened due to a new component, the poor working conditions in factories. There were many demonstrations and popular uprisings, motivated by the improvements of living conditions, especially in Europe. With emphasis on the French Revolution, for having established the Declaration of the Rights of Man and of the Citizen, 1789, this was the first document to provide guidelines for citizenship, to introduce rights civil, political, and social relations in this troubled period duties. (DDHC, 1789). The situation continued dramatic in productive industries and workers after numerous protests environments, approved in England in 1802. The first law to protect workers, titled "Health and Morals of Apprentices Act," which set the limit of 12 hours of work per day, prohibiting night work, forcing employers to wash the walls of the factories twice a year and forced ventilation in the industrial park. The law did not solve the minimum portion of the problem, and it was followed by additional laws emerged in 1819. (Mattos, 2011:10; Nogueira, 1981). In the year 1830, comes the first industrial medical service in England, due to the dramatic situation of workers, especially children. A report published in 1831 by a parliamentary commission of inquiry investigated the wretched state of health of workers and provoked strong impact on public opinion, and so, in 1833, promulgated in England, the *Factory Act*, which should be considered as the first truly effective legislation in the field of worker protection. It applied to all textile companies who used hydraulic or steam force. Prohibiting night work for persons under 18 years and restricting the working hours of these, 12 hours a day. The demands also included that all factories make available schools for compulsory attendance of all children under 13 employees. Established the minimum age of nine to work and development of children should be accompanied by health services work. (Nogueira, 1981). It appears that industrialization was driven in the United States in the late nineteenth to the twentieth century, the first study of scientific management proposed by Taylor (1856-1915) arises. This scientist proposed changes that have revolutionized the means of production worldwide: the meticulous planning of tasks in order to plan each phase in detail, through a study of methods and times, the design and supervision of each stage of production, and devised to employ their techniques that the workers should have physical strength, and not needed a highly developed cognitive sense. These characteristics of his principles of scientific management, critics say benefit the economic system and do not consider the need to promote adequate working conditions, thus exploiting the workers to produce intense, often repetitive and monotonous and reduce development and cognitive skills of workers.(Raymundo, 1992:17). During this period, the Jules Henry Fayol (1841-1925), also contributed to the development of scientific management, and hence to the transformations of the means of production. The highlight of his work, administration or business management, was the structuring of these institutions from their basic duties to meet the needs of productive organization. The structuring of a company to Fayol configures itself from the operational and technical areas of the business activities of the security services and procedures for financial, accounting and administrative control (Raymundo, 1992:19). During this period, Ford (1863-1947), perfected the method of Taylor, introducing the means of production in the automotive industry, the production line, or series production. Ford believed that consumerism would be the solution to the "welfare" from the capitalist economic model. His practice as an employer of many people was to improve the living conditions of workers, to be consumers. In 1914, he began a transformation in their companies, and some of the measures were the reduction of the hours of daily work for 8 hours. Another innovation in the workload was the establishment of five working days a week for the employees. (Ford, 1995).In the United States, despite industrialization have evolved significantly, from the second half of the nineteenth century, health services in enterprises remained virtually unknown. Employers did not provide adequate attention to the health problems of their workers. However, in the early twentieth century with the introduction of legislation on compensation for accidents at work, forced employers to establish the first health services for industrial companies (Nogueira, 1981). That same year, there was the Peace Conference in Paris, in conditions which would be made to countries defeated the First World War. The main document produced by the Conference was the Treaty of Versailles, which, created the International Labour Organization (ILO). The organization originated with the purpose of directing the labor issues, a standardized treatment with foundations in techno-scientific and social knowledge in order to promote the prevention and protection of workers, through the establishment of conventions and recommendations that constitute rights applied to the social means of production. Later that year, six agreements were approved with clear purpose of protecting the health and physical integrity of workers, dealing with the limitation of working hours, unemployment, maternity protection, night work for women, minimum age for admission of children and night work of minors. These first initiatives to establish parameters to be respected, related to working conditions, followed triggered changes in the relations between worker and employer. (Nogueira, 1981). In 1926, started on the first studies of accidents involving damage to property, devised by Heirinch and Blake. Heirinch developed his studies with information from the insurance company where he worked, and his research started from the closed cases of accidents at work, seeking information on companies that insured accidents occurred, raising its additional costs beyond claims paid by insurance. The introduction of the concepts of direct cost and indirect cost originated in these investigations, including the well-known relationship that the indirect cost is, on average, four times the direct cost of workplace accidents. Other important innovations search Heirinch to the area refers to the concept of accident without injury and the realization of the importance of treating accident data, as information to be used for prevention, not only for the purpose of remediation (Soares, 2013:150). The post-World War II (1939-1945), triggered geopolitical transformations, besides intensifying industrialization, using Science and Technology. Organizations of the United Nations, in 1948, established a team led by the United States and the Soviet Union committee that drew up a new code of principles for a decent life for men, in addition to the rights of the French Declaration of 1789. Including the rights and social duties as conditions for the development of citizenship from that period, and titled Universal Declaration of Human Rights (UN, 2013). The International Labour Organization, in 1959, in conjunction with the World Health Organization, through - Occupational Health Services Recommendation - (Recommendation 112) defines the functions, organization and means of action of medical services work. (Mattos, 2011:13). The vindicated movements of workers through trade union mechanisms in the 60s, to the improvement of working conditions, such as rights to citizenship resonated in various nations. In consequence of these events, in Italy, in 1970, was instituted, the law entitled "Statuto dei Diritti Lavoratori" (Workers' Statute), which among other things, addressed the right to information workers about occupational risks. Years later, subsidized laws of countries like Brazil, establishing the obligation of Environmental Risk Maps, with the function of disseminating information to employees about the risks of industrial activities. (Silva, 2008:122). During this period, comes a revolution in Japan the means of production, after the defeat in the second war. A new model of production and significant technological advances, which served small claims, due to the tiny market of the country and enabled the production of different products in small quantities, was developed. The production system called *Toyotism* also included the ancient culture of this people facing adversity. The designation must be the automaker's vehicles, Toyota Japanese industry, which developed the system between 1950 and 1970, based on the improvement of the system introduced by Ford. The technological advancement from robots, programmable logic controllers, computers, computer aided manufacturing, and early development of computing as a new means of communication and storage of developed knowledge. (Joffily, 1993). Among the historical information of the global context, we highlight other important conventions that have been established by the ILO, during the 70s and 80s. The C148 Post-Stockholm (1977), which deals with health, safety and the working environment, in which the term environment and their imbrication was introduced with the working conditions, the C155 (1981) concerning the general safety, health and the working environment, and C161 (1985) titled "Occupational Health Services Convention". This was the first time that the name was used for health and not medicine, to address these issues with consensus of all signatory nations of the document. (ILO, 2013; BRASIL, 2013).Still on impulse, after Stockholm, in 1987, began the negotiations for the establishment of ecological rights and duties. Inflated by global meeting organized in the city of Rio de Janeiro, in 1992, called the Eco -92, with production of Agenda 21 document for nations achieve sustainable development and effective actions that originated a few of the most industrialized countries. The studies continued for the development of a new document to mark human interactions with natural resources, these studies conducted by a group of scientists from various countries have established the *Earth Charter* and published in 2000 in the Netherlands. (CT, 2000).In 2006, the International Committee for Education and Training on Prevention of the International Social Security Association, which was attended by members of the ILO and WHO, drafted the "Berlin Declaration to develop a culture preventive safety and health: from school to work". (ISSA, 2006). The most recent statistics, 2008, include the numbers of the sad reality of working citizens. The data reveal that killed nearly 2.34 million victims of accidents and diseases related work activities per year. That number, approximately 2.02 million people die affected by occupational diseases, accounting estimates, 5500 of the 6300 daily work-related deaths. Still, according to ILO estimates, each year, 160 million workers develop non-lethal diseases associated professional activities. Among the major occupational diseases listed pneumoconiosis caused by inhaling dust, musculoskeletal disorders, back pain and mental disturbances. (ILO, 2013:4).

The current reality is the crisis in the economy and the productive sector, resulting in rising unemployment rates in Europe, in the United States that cause the deterioration of labor activities. Despite the advance working conditions in some countries and sectors of the industry, but the reality for most workers is that they have to interact with the risks observed since antiquity, and be affected by the misfortunes arising from these conditions.

3 Conclusion

Historical records presented show that the knowledge about the existence of the main risks that trigger pneumoconiosis are ancient. However, according to the ILO today is a major cause of occupational diseases in the world. This finding reveals the absence of effective measures to prevent such risks that affect people's lives, in social organization on the environment and the economy.

Treatment aimed at workers in the current period, is still far short of what advocates knowledge of science and technology, with regard to the adequacy of labor to human nature activities. All movement of knowledge to build a future in which prevails the rights and duties of citizens in the development of professional activities in a dignified manner and with respect for their weaknesses, these events are presented, examples of atrocity and resilience, to social transformation, in search of humanization of professional activities.

4 References

International Social Security Association – ISSA (2006). Berlin Declaration – For The Development of A Culture of Prevention in Health And Safety: From School to Work. 3rd International Seminar of the International Prevention Section of the ISSA on Education and Training for Prevention. International Labour Organization (ILO) and the World Health Organization (WHO). Avaliable: http://www.issa.int/Resources/Resources/Berlin-Declaration. Cited: 17 dec. 2011

BRASIL (2013). Convenções da OIT ratificadas pelo Brasil. Disponível em: http://portal.mte.gov.br/rel_internacionais/convencoes-oit-brasil-ratificadas.htm. Acesso em: 10 dez. 2013

Carta da Terra – CT (2000). O texto da Carta da Terra. Disponível em:<http://www.cartadaterrabrasil.org/prt/text.html>. Acesso em: 10 dez 2013

Declaração Francesa de Direitos do Homem e do Cidadão – DDHC. (1789). Biblioteca Virtual de Direitos Humanos. São Paulo: Universidade de São Paulo (USP). Disponível em:<http://www.direitoshumanos.usp.br/index.php/> Acesso em: 15 dez 2013

Ford, Henry (1995). Minha vida e minha obra. In: FORD, Henry. Henry Ford: por ele mesmo. São Paulo: Martin Claret.

International Labour Organization - ILO (2013). The prevention of occupational diseases. Genebra. ISBN: 978-92-2-127446-9

Joffily, B. (1993). Tecnologia e Microeletrônica: Uma revolução que desafia os sindicatos. Revista “De fato”. São Paulo: Cut (p. 14 a 25). Disponível em:<http://www.cefetsp.br/edu/eso/globalizacao/textocut.html>. Acesso em: 12 mar 2013

Mattos, U. A. de O. (2011). O acidente de trabalho e seu impacto socioeconómico-ambiental. In Mattos, U. A. de O. & Másculo, F. S. (Org.). Higiene e Segurança do Trabalho. Rio de Janeiro: Elsevier/Abepro

Nogueira, D. P., (1981). Histórico. Curso de Engenharia de Segurança do Trabalho. São Paulo: Fundacentro. 6v.

Ramazzini, B. (2000). De e Morbis Articum Diatriba. Tradução de Raimundo Estrêla. São Paulo: Fundacentro

Raymundo, P. R. (1992). O que é administração? São Paulo: Brasiliense

Silva, J. A. R. de O. (2008). *A saúde do trabalhador como um direito humano*. São Paulo: LTr

Soares, F. R. (2013). Prevenção e Controle de Perdas. InterfacEHS – Revista de Saúde, Meio Ambiente e Sustentabilidade. V. 8, n.1. ISSN 1980-0894. http://www.revistas.sp.senac.br/index.php/ITF/article/viewFile/317/307

United Nations – UN - (2013). The Universal Declaration of Human Rights. Avaliable: http://www.un.org/en/documents/udhr/history.shtml Cited: 12 dez 2013

Webster, M. F. (2001). Um modelo de melhoria contínua aplicado à redução de riscos no ambiente de trabalho. Dissertação de Mestrado. Engenharia de Produção. Universidade Federal de Santa Catarina

104 Information Quality and its antecedents: A case study with information systems´ users in an electric substation environment

Santos G D, Moser E F, Oliveira G A

Gilson Ditzel Santos (✉ e-mail: ditzel@utfpr.edu.br)
Department of Business Management, Federal Technological University of Paraná, Via do Conhecimento, km 1, PatoBranco, Paraná, Brazil.

Abstract: The aim of this study was to evaluate information quality (IQ) perceptions of users of information systems applied to the control and maintenance of electrical substations of an electric power supplier. It was evaluated the perceptions of IQ according to the PSP/IQ Model, and the influence of individual and job characteristics on these perceptions. Quantitative research was conducted through self-applied printed questionnaires. The results indicate differences in perception between the various dimensions of IQ, and point out individual and job characteristics that influence users' perceptions of IQ dimensions.

Keywords: Information Quality, Individual Characteristics, Job Characteristics, Information Systems.

1 Introduction

Organizations that consider information a valuable resource align the use of information to their strategic goals. And the optimization of the information usage goes through the management of the information technology (IT), of the employees and of the information itself.

The research on the impact of IT on organizational performanceevolves in the direction of the understanding of the relationship between people and contexts with the information systems (IS). Similarly, the investigation of the impact of IQ on organizations evolves in the same way.

The objective of this work is to assess the information quality (IQ) perceived by IS users working at an electric power sector company, and to identify which individual and job characteristics influence it. Better ways of measuring the antecedents of IQ help the process of planning pre and post-implementation of IS.

To measure IQ it was used an adaptation of the PSP/IQ Model (Kahn et al., 2002). In order to measure Job Characteristics it was used an adaptation of the construct proposed by Morris and Venkatesh (2010). The data collection was made through a printed self-applied questionnaire with closed questions. Moreover, the data analysis included arithmetic mean and Kruskall Wallis Test.

2 Information Quality

Kahn et al. (2002) extended the model proposed by Wang and Strong (1996), and included the service aspects which are inherent to the information, and this resulted in the PSP/IQ model, illustrated in Fig.1.

In this model, two definitions of quality are given based on the conformity with specifications and on the situation of meeting or exceeding consumer expectations. The first definition refers to the technical characteristics of the information and is strongly related to its acquisition and manipulation. The definition corresponding to the second column in Figure 1 has more subjective characteristics, which are difficult to quantify, and refer to the necessity of the user to add value to the performed activity.

	CONFORMITY WITH SPECIFICATIONS	**MEETS OR EXCEEDS CONSUMER EXPECTATIONS**
PRODUCT QUALITY	**Soundness** • Free-of-error • Conciserepresentation • Completeness • ConsistentRepresentation	**Usefulness** • AppropriateAmount • Relevancy • Understandability • Interpretability • Objectivity
SERVICE QUALITY	**Dependability** • Timeliness • Security	**Usability** • Believability • Accessibility • EaseofManipulation • Reputation • ValueAdded

Fig.1 PSP/IQmodel
Source: Kahn et al (2002).

Considering the large amount of research focusing on the measurement of parameters in specific problems of IQ, Pipino et al. (2002) developed a general methodology that combines subjective and objective measurements. In order to guide the subjective measurements of the IQ, Pipino et al. (2002) proposed the application of a questionnaire presented by Kahn et al. (2002), which is based on the definitions of the IQ dimensions in the PSP/IQ model.

3 Individual and Job Characteristics

According to Seddon (1997), different stakeholders with specific interests and necessities expect different results from the information systems and ignore the information that do not interest them, causing the users to differently evaluate the same set of results.

Venkatesh*et al.* (2003) proposed and validated an IT acceptance model named Unified Theory of Acceptance and Use of Technology (UTAUT). The model presents four tested moderating variables: experience, voluntariness of use, sex and age.

Santos et al. (2010) studied the influence of individual and context characteristics in the IS user perception of the IQ and individual impact (II). Among the observed exogenous variables, education was the only one that had a negative influence on the IQ perceptions. More specifically, respondents with a level of specialist or with a lower educational level tend to assess more positively the IQ than those respondents having a master or doctor degree. In only one of the researched organizations, the positive influence of age and time of work on the perception of the IQ and the influence of the hierarchical level on the perception of II have been confirmed (the evaluation of II is more positive if the hierarchical level of the respondent is higher). Gender influence could not be confirmed. The authors observed that the organizational context (in the specific case, a public company and a higher education institution) determined the individual characteristics that influenced the perceptions of the IS users.

Venkatesh and Bala (2008) extend the research about interventions that can improve the adoption and use of IT, and present and validate an integrated model with determinants of perceived usefulness and ease of use. The data were collected from four organizations in different sectors during a period of five months. 156 responses from each of the four sample sets were gathered. The analysis was performed by means of structural equations with a partial least square (PLS) approach. It was stated as conclusions that: experience moderates the influence of perceived ease-of-use over the perceived usefulness; none of the perceived ease-of-use antecedents (self-efficacy, external control, anxiety, playfulness, enjoyment, objective usability) have significant effects on the perceived usefulness; none of the perceived usefulness antecedents (social influence, image, results demonstrability, job relevance, results quality) have significant effects on the perceived ease-of-use; the intention to use is influenced by the perceived ease-of-use and perceived usefulness, while the relationship between perceived ease-of-use and perceived usefulness is moderated by the experience; intention to use is a predictor of the IS use.

Venkatesh and Bala (2008) also present preimplementation and post implementation interventions to be conducted by the organization which can influence the determinants of perceived ease of use and usefulness. The preimplementation phase is characterized by the initiation stages, adoption, organization and adaptation – while the post implementation phase, which is treated in the present research, entails the user acceptance, routinization of the systems use and the infusion (integration of the IT to the processes related to the organization's work system). The preimplementation interventions can be: identification of the need to use the system; organizational decision to adopt and install the new system; and promotion of the adequacy of the system and the processes in the work system. On the other hand, the postimplementation interventions could be: training, organizational and peer support. Since every intervention produces impacts on the perceived ease-of-use and perceived usefulness antecedents, it is necessary that one defines which antecedents must be worked following the needs and priorities of the organization.

The study of Morris and Venkatesh (2010) demonstrated that the implementation of a new Enterprise Resource Planning (ERP) system in an organization is able to mediate the influence of three job characteristics, namely: Skill Variety - at what extent a work requires the use of distinct abilities; Autonomy - freedom granted to the employee in a way that he/she can decide when and how to perform a job; and Feedback - access given to the employee with clear information on his/her performance. However, there is no change in the perceptions of the other two job characteristics, namely, Task Significance- impact on the other employees or society, and Task Identity - acquisition of observable results that positively interfere on the satisfaction related to the job.

The review of the literature presented in this section will provide support to the discussion about the influence of individual and job characteristics on information quality perceptions.

4 Research Method

To measure IQ it was used an adaptation of the PSP/IQ Model (Kahn et al., 2002). From the original 16 IQ dimensions shown on the PSP/IQ Model, Santos (2009) showed in his research, conducted in the same organization as this present research, that Appropriate Amount, Interpretability and Value Added dimensions can be excluded. The author found out that these dimensions overlap other IQ dimensions.

To measure Job Characteristics it was used an adaptation of the construct proposed by Morris and Venkatesh (2010).

To collect data, it was used a printed self-applied questionnaire with closed questions, which were divided into three groups:

• Respondents´ characteristics - gender, age, time at work, education, hierarchical level, work sector, Used IS, and frequency of IS use.

• Respondents´ perceptions about Job Characteristics (Morris and Venkatesh, 2010)– one item (Likert Scale ranging from [1] strongly disagree to [5] strongly agree) for each of the following constructs: Task Significance, Task Identity, Skill

Variety, Autonomy, Feedback and Self-efficacy.

• Respondents´ perceptions of Information quality- 13 items (Likert Scale ranging from [1] strongly disagree to [5] strongly agree) derived from an adaptation of the PSP/IQ Model (Kahn et al., 2002) as described above.

To analyze the collected data it was used arithmetic mean, and Kruskal Wallis test.

4.1 Data Collection

The case study was developed in one organization that belongs to the electric power sector (generation, transmission and distribution). The organization is a state-owned company but participates in the Brazilian Stock Exchange Market, and is one of the 50 largest companies in Brazil, employing around 5300 people. It is located in Paraná State, in the south of Brazil. This research was conducted in one of the regional branches of the company.

The population of the study is formed by 52 employees that use a combination of two IS to control and/or maintain electric substations. These are the two used IS:

- Maintenance Management (GMT) - System used by maintenance teams and operation managers that provides information regarding: planned/scheduled/performed maintenance; modified equipment; equipment preventive evaluation; history of damage to equipment; and other correlated information.
- Operation Management (GOP) – System that provides real-time technical information to operators and managers of substations. The provided information includes: open/closed circuits; demand load; data from sensors of temperature, current, voltage, and others; inactive equipment/circuits; and other correlated information.

Both systems share the same database and are synchronized.

From the 52 questionnaires sent, 37 were returned, resulting in a participation ratio of 71.2 %.

The general profile of the respondents in this study corresponds to a person of the male sex (97.3%), with over 40 years of age (59.4%), which has over 20 years of work in the company (51.4%), works at the operational level (75.7%), has a technical degree (62.2%), and uses both IS (51.4%).

In the following section are presented and discussed the results of this research.

5 Data Analysis and Results

Then the results and analysis of perceived IQ and the influence of individual characteristics are presented.

5.1 PSP/IQ Model

None of the dimensions of IQ is perceived as lower than 3, what means that nobody disagrees with the affirmatives presented in the questionnaire. On the other hand, only Relevancy is above 4, that mean agreement with the affirmative. Believability (mean=3, 87) and Reputation (mean=3, 71) have also comparable levels of agreement. However, Consistent Representation has the lowest level of agreement (mean=3, 1), what means that information may have problems related to the format. In the next topic it is discussed the influence of individual characteristics on IQ perceptions.

5.2 Influence of Individual Characteristics on IQ perceptions

To verify the influence of individual characteristics on each IQ dimension, it was used the Kruskal Wallis test. The influence of gender, age, hierarchical level, and frequency of use could not be verified. According to time of work in the company, there is a significant difference between groups for perceptions of Reputation (sig. =0.02). The ones who have been working in the company for 1 to 10 years perceive Reputation as lower (mean=3.3; n=16) than those with more than 20 years (mean = 3.95; n = 19). What implies that employees with greater experience tend to have a better perception of Reputation, probably because they know better the sources of information. Considering education, there are significant differences among groups according to perceptions of Believability (sig. =0,025) and Reputation (sig. =0,038). Moreover, the technicians tend to evaluate Believability (mean=3, 48; n= 23) and Reputation (mean = 3, 26) lower than the ones with higher education level (mean=4 approx.). This is contrary to what has been observed in previous researches. However, the explanation could be that the majority of the respondents work in the operational level and at this level IQ is usually perceived as lower. The system used by the employees also creates different groups according to their perception of Timeliness (sig. =0,019), Believability (sig. =0,049), and Reputation (sig. =0,025). The ones who use only GMT (Timeliness - mean=2.7; Believability – mean=3, 3; Reputation -mean=2, 9; n=10) tend to evaluate IQ as lower than the ones who use GOP (Timeliness - mean=3.88; Believability – mean=4; Reputation - mean=3.75; n=8). The ones who use both system have 3, 63; 3, 84 and 3, 84 (n= 19). Then, it is possible to observe that GMT has lower perceived IQ than GOP. This research also considered the influence of users´ perceptions of their job characteristics on IQ dimensions, as it is described here. Task identity influences Consistent Representation and Security. The ones who agree that Task Identity is high also perceive Consistent Representation as high (mean=3, 62), however, the ones who totally agree, perceive Consistent Representation as low (mean=2, 17). Considering the influence of Task Identity on Security, the ones who disagree that their job is a complete one, perceive Security as high (mean=3,71, n=14). The ones who agree perceive Security as lower (mean=3, 54, n=13). Skill variety influences Believability. The ones who perceive their tasks as non repetitive perceive Believability as lower (mean=3, 68, n=19) than the ones that perceive them as repetitive (mean=4, n=10). Probably they depend on different sources of information. Autonomy influences Concise Representation, Completeness and Believability. The ones who agree that they have Autonomy perceive Believability as higher (mean=3, 88, n=17) than the ones who disagree (mean=3, 73, n= 11). The opposite is true in relation to Concise Representation and Completeness. The ones who agree that they have autonomy perceive Concise Representation (mean=3, 47, n=17) and Completeness (mean=3, 24, n=17) as lower than the ones who disagree (mean=3, 73 and mean=3, 64). The ones who agree that they have immediate feedback, perceive Concise Representation (mean=3, 74, n=23) and Completeness (mean=3, 57) as higher than the ones who disagree (mean=3, n=3and mean=3, 33). The ones who agree that they have self-efficacy perceive Concise Representation as higher (mean=4, n= 3), then the ones who disagree (mean= 3, 74, n=19).

6 Conclusions

Although the respondents agree only with the Relevancy dimension of IQ, there are no disagreements, considering all IQ dimensions. Relevancy, Believability and Reputation being among the three higher scored dimensions indicates that the strengths of the systems are related to Usefulness and Usability. However, as Consistent Representation has the lowest level of agreement the information may have problems related to format.

The results show that Time of work, Education and System Used influence perceptions of Reputation, Believability and Timeliness. All of them are IQ dimensions related to Information as service, and Believability and Reputation are Usability dimensions.

The variables related to the users´ perceptions about their work, Task Identity, Autonomy, Feedback and Self-Efficacy, influence perceptions of IQ dimensions classified as Sound Information. That means that these job characteristics are related to the more technical aspects of IQ, and to the information as product. On the other hand, Skill Variety influences Believability that is associated with Usability.

Considering academic implications of this research it is possible to observe that it shows an application of PSP/IQ in an electric power organization and shows that possible antecedents of IQ are variables derived from individual and job characteristics.

The practical implications of this research are that knowing previously the individual characteristics of the employees makes it possible to plan interventions in order to improve perceived IQ.

As a main limitation of this study it is necessary to say that it was not allowed to the authors the access to detailed complimentary information about the two IS used in the studied sector of the organization. If the access was granted, it would be possible to identify reasons of the findings of this research. Thus, as it is necessary to understand and explain the detailed relationship among individual and job characteristics and IQ, it is suggested a qualitative approach future study through unstructured interviews with IT staff and some specific respondents of this present research.

Acknowledgements

We are grateful to CAPES for their financial support, which enabled this study to be conducted.

7 References

Kahn BK et al (2002) Information Quality Benchmarks: Product and Service Performance. *Communications of the ACM*, 45 (4), pp. 184-192.

Morris MG,VenkateshV (2010)Job Characteristics and Job Satisfaction: Understanding The Role of Enterprise Resource Planning System Implementation. *Mis Quarterly*, *34*(1).

Pipino LL et al (2002) Data quality assessment. *Communications of the ACM*, 45 (4).

Santos GD(2009) *Estudo Empírico da Relação entre Qualidade daInformação e Impacto Individual no Contexto Organizacional*.2009. 258 f. Tese(Doutorado em Administração) - Faculdade de Economia, Administração e Contabilidade, Universidade de São Paulo, São Paulo.

SantosGD et al (2010) Validação de modelo teórico da relação entre qualidade da informação e impacto individual no contexto organizacional, in XXXIV Encontro da ANPAD (ENANPAD 2010), ANPAD, Rio de Janeiro, RJ.

Seddon PB (1997) A respecification and extension of the DeLone and McLean model of IS success. *Information Systems Research*, 8 (3), p. 240-253.

Venkatesh V et al (2003) User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27 (3), p. 425–478.

Venkatesh V, Bala H (2008)Technology Acceptance Model 3 and a Research Agenda on Interventions, *Decision Sciences*, 39 (2).

Wang RY, Strong DM (1996) Beyond Accuracy: What data quality means to data consumers.*Journal of Management Information Systems*, 12 (4), p. 5-33.

107 Propuesta de un marco conceptual para el análisis comparativo de las redes de distribución de dos supermercados *online*

Proposal of a conceptual framework for the comparative analysis of the distribution networks of two online supermarkets

Guerrero-Lorente J, Ponce-Cueto E, Blanco EE

Javier Guerrero Lorente (✉ e-mail: guerreloja@gmail.com)
Dpto. de Ingeniería de Organización, Administración de Empresas y Estadística. ETSII. Universidad Politécnica de Madrid.

Eva Ponce Cueto
Profesora Titular. Dpto. de Ingeniería de Organización, Administración de Empresas y Estadística. ETSII. Universidad Politécnica de Madrid.

Edgar E. Blanco
Research Director. Center for Transportation and Logistics. Massachusetts Institute of Technology.

Abstract: In this article the network configuration for fulfillment and distribution of online orders of two British retailers is analyzed and compared. For this purpose, it is proposed a conceptual framework that consists of the key following aspects: network configuration, transportation management and location of demand. As a result is not obvious to determine the ideal centralization degree in each case. Finally, it is suggested the future development of an analytic tool that helps to choose the most appropriate model.

Resumen En este artículo se analiza y compara la configuración de red para la preparación y distribución de pedidos *online* de supermercado de dos distribuidores británicos. Para este fin se propone un marco conceptual que comprende los siguientes aspectos clave: configuración de la red, gestión del transporte y localización de la demanda. Como resultado no resulta evidente determinar el grado ideal de centralización de la red de distribución para cada caso. Finalmente se sugiere el futuro desarrollo de una herramienta analítica que ayude a escoger el modelo de distribución más adecuado.

Keywords: fulfillment, online, supermarkets, network, distribution

Palabras clave: fulfillment, online, supermercados, red, distribución

1 Introducción

En España, las ventas de comercio electrónico representaron en 2012 un 2% de la venta total minorista y se prevé que en 2017 alcancen un 4 % (Forrester Research, 2012). Se trata, por tanto, de un sector del mercado en creciente expansión que está sustituyendo progresivamente el acto físico de la compra presencial.

Entre las diversas categorías de productos que se comercializan por internet, los pedidos de productos de supermercado se caracterizan por un significativo número de referencias y un margen bruto limitado, lo cual implica unos costes significativos en su preparación y transporte a los consumidores con un notable impacto en los beneficios de las compañías que los distribuyen. En este contexto, la adecuación de las redes de distribución de pedidos online, es estratégica, no solamente para cumplir con el servicio prometido al cliente sino también para que el negocio *online* sea viable.

El objetivo principal de este artículo es realizar un análisis comparativo de la red de preparación y distribución de pedidos de dos supermercados online. Para ello se han planteado los siguientes objetivos específicos: analizar la literatura sobre redes de distribución de comercio electrónico; proponer un marco conceptual que ayude a entender los aspectos claves a tener en cuenta a la hora de diseñar estas redes de distribución; analizar dos casos de estudio de acuerdo con el marco conceptual propuesto; extraer conclusiones del análisis comparativo.

La metodología propuesta para alcanzar estos objetivos se basa en el análisis en profundidad de casos de estudio. De acuerdo con Yin (1984) el estudio de casos permite analizar un fenómeno dentro de su contexto real. En este artículo, se han seleccionado los casos de estudio de Ocado y Tesco.com porque ambos suman aproximadamente, dos tercios de las ventas de alimentación online en el Reino Unido y se consideran representativos del sector. En dicho país, un 13 % de la venta minorista es a través de internet y se prevé que en 2017 aumente hasta un 15 % (Forrester Research, 2012).

En el epígrafe 2 se exponen varios artículos clave relacionados con los modelos de distribución de pedidos de *e-commerce* que conforman la base del marco conceptual utilizado para analizar los casos de estudio de los epígrafes 3 y 4 de este artículo. Finalmente, en el epígrafe 5 se presentan las conclusiones y los futuros desarrollos.

2 Revisión de la literatura y marco conceptual

En la siguiente figura se representa el marco conceptual utilizado para el análisis de las redes de distribución de los dos casos de estudio:

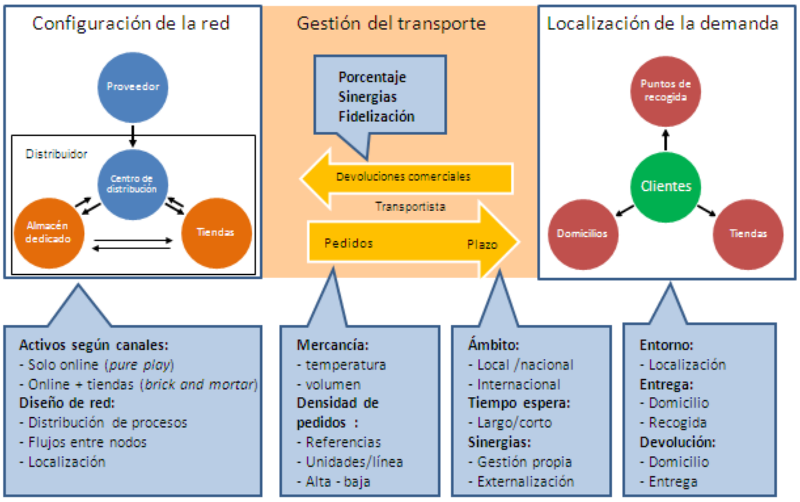


Fig. 1 Marco conceptual para el análisis de redes de distribución con entregas de comercio electrónico. Fuente: elaboración propia

De Koster (2003) estableció que la estrategia de distribución de pedidos *online* se caracteriza por la forma en que son gestionados e interrelacionados los canales de distribución, definidos por la localización de la preparación de pedidos, el área de entrega cubierta por el servicio *online* y el grado de subcontratación del almacenamiento y/o la preparación de pedidos y/o su expedición. En este sentido, se presenta un primer bloque de configuración de la red integrado por los proveedores y los distribuidores, ambos suministradores de mercancía. La organización de su red logística se caracteriza por:

- la titularidad de activos físicos, representados por tiendas y/o centros de distribución o centros de preparación de pedidos. Un distribuidor *brick and mortar*, como Tesco, a diferencia de un distribuidor *pure play,* como Ocado, cuenta con tiendas físicas en las que puede preparar los pedidos *online*. .
- el diseño de la red, que determina la localización y capacidad de los centros de trabajo, las inversiones asociadas y los flujos de pedidos y devoluciones entre estos centros y los consumidores. Lummus y Vokurka (2002) plantearon varias localizaciones alternativas en centros de distribución, almacenes dedicados o tiendas, entre otros, que un distribuidor o un proveedor pueden adoptar para atender la demanda de pedidos online y cómo éstas pueden afectar a la calidad del servicio al cliente y al coste de las operaciones. Yrjölä (2001) estimó el

volumen de ventas online a partir del cual un distribuidor de alimentación con tiendas físicas puede centralizar la preparación de pedidos en una plataforma dedicada.

En el bloque de gestión del transporte los agentes son los transportistas mientras que los pedidos y las devoluciones comerciales entre los proveedores / distribuidores y los consumidores son los objetos de esta actividad, que está sujeta al cumplimiento de un plazo máximo. Los pedidos se caracterizan por el tipo de mercancía, como la temperatura de conservación o el volumen ocupado y su densidad, es decir, el número de referencias o líneas por pedido. El plazo de entrega de los pedidos depende del ámbito geográfico del servicio ofertado y del tiempo de espera que requiere la disponibilidad del producto, en función de la localización del inventario. Los gastos de transporte de última milla y los plazos de entrega condicionan el grado de centralización de una red de distribución. Bendoly et al. (2006), estudiaron a partir de qué umbrales de actividad debe centralizarse en un almacén dedicado la preparación de pedidos online de un distribuidor *brick and mortar* y qué parte debe seguir preparándose en las tiendas. Las devoluciones comerciales, que pueden ser recogidas en la misma red de distribución de pedidos, son reconocidas como un factor decisivo en el servicio al cliente (Mollenkopf et al., 2007).

El tercer bloque de la localización de la demanda representa la conveniencia de los consumidores, que requiere el transporte y la recogida de los pedidos y devoluciones. Como alternativa a la tradicional entrega a domicilio, Lee y Whang (2001) explicaron que el concepto de *clicks and mortar,* en el que un distribuidor utiliza sus tiendas como puntos de recogida de los pedidos *online*, es una de las estrategias que permiten a estos distribuidores ser más competitivos, disminuyendo los costes de la última milla y paralelamente aportando conveniencia al consumidor.

Varios autores han analizado ya casos de estudio de supermecados *online*. Boyer y Hult (2005) estudiaron la problemática de la integración del marketing, tecnologías de la información y operaciones de cuatro enseñas de venta de supermercado por internet representativas de cuatro tipos de canales de distribución, según se preparen los pedidos en las tiendas o en un almacén dedicado y según se subcontrate o no el transporte a los clientes. Más adelante, Lunce et al. (2008) enfatizaron la importancia de dicha integración como clave de éxito en el negocio del comercio electrónico desde la perspectiva de distribuidores *pure play* (sin tiendas físicas) comparando la corta y fallida experiencia de Webvan con la viabilidad de negocio de Peapod.

Los casos de Ocado y Tesco, que se presentan y comparan a continuación, son especialmente significativos por tratarse de dos distribuidores maduros en un mercado también maduro, con una importante cuota de ventas por *internet*.

3 Caso de estudio 1: Ocado

3.1 Introducción y cifras de negocio

Ocado es un distribuidor *pure play* que fue fundado en 2001. Dispone de un catálogo de más de 20.000 referencias de alimentación y droguería así como otros artículos como flores, juguetes y revistas. Las ventas de Ocado en 2012 fueron de 892,9 millones de euros y el beneficio neto de 6,6 millones de euros (se ha considerado 1,22 €/£ como tipo de cambio medio de 2012), un 0,74 % de las ventas (Ocado Group PLC).

En el Reino Unido el supermercado *online* representaba en 2011 una cuota de mercado de un 4 % respecto a las ventas totales del sector y se prevé que en 2015 alcance un 6,9% (Sverker Lindbo, 2011). Ocado representa aproximadamente un 20% de participación sobre dicho negocio.

3.2 Análisis de la red de distribución

La preparación de los pedidos de los clientes de Ocado está centralizada en dos almacenes regionales propios localizados en Hatfield y Dordon (inaugurados en febrero de 2013) desde los que se distribuyen los pedidos *online* de los clientes a casi todos los condados del Reino Unido.

Además de que los pedidos de supermercado dejan un beneficio neto menor que otros tipos de producto, como los artículos de electrónica, también se caracterizan por contar con varias decenas de referencias de mercancía a temperatura ambiente, productos refrigerados y congelados. Esto requiere, por un lado, que ambas plataformas están sectorizadas en tres ambientes diferenciados y por otro, que se hayan instalado sofisticados sistemas de manejo de materiales para reducir el coste unitario de preparación de pedidos.

Las entregas dentro de un radio de 120 km con centro en estas dos plataformas se expiden directamente a domicilio. El resto de entregas son arrastradas en *trailers* a 10 centros de tránsito para su posterior expedición a domicilio. Una flota propia de vehículos tri-temperatura transporta los pedidos a domicilio, en el mismo día, al día siguiente o varios días después de que fueron emitidos, en tramos horarios de una hora.

Aunque no se ha podido cuantificar el porcentaje de devoluciones comerciales, su nivel es relativamente bajo, por tratarse de mercancía de supermercado y, en caso de realizarse, tienen lugar en el momento de la entrega.

4 Caso de estudio 2: Tesco.com

4.1 Introducción y cifra de negocios

Según Enders et Jelassi (2009) Tesco, distribuidor con tiendas físicas, o *brick and mortar*, se estableció formalmente en 2000 como Tesco.com para atender pedidos online de supermercado.

Con un catálogo de más de 30.000 referencias de supermercado, las ventas totales de 2012 ascendieron a 58.823 millones de euros (se ha considerado 1,22 €/£ como tipo de cambio medio de 2012) y las ventas del canal de comercio electrónico para la mercancía de supermercado fueron de 2.806 millones de euros, es decir, un 4,77 % del total (Tesco PLC, 2013). Su cuota en la venta *online* de productos de supermercado en el Reino Unido, es de un 48% (Halliwell, 2013).

4.2 Análisis de la red de distribución

Laura Wade-Gery, antigua directora de Tesco.com, explicaba en 2009 que, a excepción de Londres, con una red de 306 tiendas en las que se preparaban los pedidos online, Tesco cubría prácticamente la totalidad del Reino Unido. En la actualidad este modelo sigue vigente. En el caso de Londres, durante los últimos ocho años, cuando varias tiendas han visto sobrepasada su capacidad de preparación de pedidos, Tesco ha optado por traspasar su actividad a una plataforma dedicada para la preparación de pedidos online. Estos centros, denominados *dark stores* o *dot com only stores,* disponen de tres temperaturas de trabajo (ambiente, refrigerado y congelado) para preparar los pedidos de supermercado y sirven aproximadamente un 15 % de los pedidos (IGD Retail Analysis, 2012).

En 2006 se abrió la primera tienda *dot com only*, localizada en Croydon, y en 2008 la localizada en Aylesford. En 2014 cuentan con un total de 6 centros, los dos mencionados más otros cuatro localizados en Greenford, Enfield, Crawley y Erith. Estos últimos disponen de sofisticados sistemas de manipulación de materiales para reducir el coste unitario de preparación de pedidos.

Los pedidos de supermercado son transportados al domicilio de los clientes en un determinado tramo horario a partir del día siguiente a la emisión de pedidos. El reparto se realiza mediante una flota propia de vehículos de reparto tri-temperatura. Existe también la posibilidad, mediante el servicio *click and collect*, de que los clientes recojan su pedido en un supermercado Tesco.

Aunque no se ha podido cuantificar el porcentaje de devoluciones, su volumen es relativamente bajo y son recogidas en el domicilio de los clientes en el momento de la entrega o, en el caso del servicio *click and collect*, en los supermercados en el momento de la recogida del pedido.

5 Conclusiones y futuros desarrollos

Se han presentado, conforme al marco conceptual, dos configuraciones de redes alternativas para la preparación y distribución de pedidos *online* de supermercado. La configuración centralizada de Ocado permite alcanzar a los consumidores del Reino Unido en el mismo día en el que realizan el pedido mientras que en la configuración descentralizada de Tesco.com los pedidos son enviados a domicilio o recogidos en los supermercados a partir del día siguiente de su emisión. Es previsible que Tesco.com acabe ofreciendo el servicio de entrega en el mismo día dada la mayor proximidad a los consumidores de los lugares de preparación de pedidos. De hecho, como publicó Creevy, J. (2013), ya se han iniciado pilotos en algunas localizaciones.

Debido a que ambas configuraciones son competitivas, no puede asegurarse con rigor si sería más conveniente para Tesco.com o para Ocado abrir *dark stores* en los alrededores de otras ciudades o centralizar la preparación y distribución de pedidos para varias ciudades con un diseño de red centralizada. Paralelamente es probable que Ocado pueda utilizar puntos de recogida de mercancía, para ofrecer mayor conveniencia a sus clientes, basándose en la alianza con otro distribuidor *brick and mortar* o con un operador de tiendas de gasolinera. Sin embargo no resulta trivial determinar el número y la localización de estas instalaciones.

En ambos casos, para determinar la idoneidad de la configuración de las redes de distribución, sería necesario desarrollar un modelo cuantitativo en el que se consideren la localización de la demanda, los costes de transporte, de preparación de pedidos, de inversiones asociadas, del reaprovisionamiento de la mercancía y del espacio utilizado, entre otros factores.

6 Referencias

Bendoly, E., Blocher, D., Bretthauer, K. M., & Venkataramanan, M. a. (2007). Service and cost benefits through clicks-and-mortar integration: Implications for the centralization/decentralization debate. European Journal of Operational Research, 180(1), pp. 426–442.

Boyer, K., & Hult, G. (2005). Extending the supply chain: Integrating operations and marketing in the online grocery industry. Journal of Operations Management, 23(6), pp. 642–661.

Creevy, J. (2013). Tesco begins same-day delivery pilot for online groceries. Retail Week. 27/11/13.

Enders, A; Jelassi, T (2009). Leveraging Multichannel Retailing: The Experience of Tesco.com, University of Minnesota, MIS Quarterly Executive, 8 (2).

De Koster, R. B. M. (2003). Distribution strategies for online retailers. IEEE Transactions on Engineering Management, 50(4), pp. 448–457.

Forrester Research (2012). Online Retail Forecast 2012 (Western Europe).

Halliwell, J (2013. Tesco dark stores to get Dematic picking and handling system. The Grocer. 5/1/13

IGD Services, Ltd. (2012) "The evolving Tesco.com model: what it means for suppliers". IGD Retail Analysis.

Lee, H. (2001). Winning the Last Mile of E-Commerce. MIT Sloan Management Review; Summer 2001; 42.

Lindbo, S.(2011). Ocado: compra de productos de alimentación por Internet. Congreso de Supply Chain 2011 de AECOC.

Lummus, R.R., Vokurka, R.J. (2002). Making the right e-fulfillment decision. Production and Inventory Management Journal, 43 (1/2).

Lunce, S. E., Lunce, L. M., Kawai, Y., & Maniam, B. (2006). Success and failure of pure-play organizations: Webvan versus Peapod, a comparative analysis. Industrial Management & Data Systems, 106(9), pp .1344–1358.

Mollenkopf, D.A, Rabinovich, E., Laseter, .T. M, Boyer, K. K (2007). Managing Internet Product Returns: A Focus on Effective Service Operations. Decision Sciences, 38(2).

Ocado Group plc (2013). Annual report 2013

Tesco plc (2013). Annual report 2013

Wade-Gery, L. (2009), "Tesco.com: growth and returns", Retailing Services Seminar, 19-20 noviembre 2009

Yin, R.K. (1984). Case Study Research. Design and Methods. Newbury Park, CA: Sage
Publications.

Yrjölä, H. (2001). Physical distribution considerations for electronic grocery shopping. International Journal of Physical Distribution & Logistics Management, 31(10), pp. 746–761.

115 A Simulated Analysis for Job Scheduling in Stochastic Environments

Wanitwattanakoso lJ, Sopadang A

Jirapat Wanitwattanakosol (✉ e-mail: jirapat.w@cmu.ac.th)
College of Arts, Media and Technology. Chiang Mai University. 50200 Chiang Mai.

Apichat Sopadang
Department of Industrial Engineering. Faculty of Engineering. Chiang Mai University. 50200 Chiang Mai.

Abstract: In stochastic environments, control of balance by card-based navigation (Cobacabana) controls lead time and delivery reliability by balancing the workload stations.This paper presents simulated results of Cobacabana. Verification and validation techniques were performed to accredit the simulation model. Main purposes to analyze the scheduled results of Cobacabana via a simulation technique. The best value was 29.22 days for lead time and 68.65% delivery reliability by setting workload ratio and release period length relate to 2 and 2. These results showed that Cobacabana should be dedicated to a job shop scheduling environments.

Keywords: Simulation; Cobacabana; Workload ratio; Release period length.

1 Introduction

Wastes always appear in a production planning and control (PPC) system. A number of scheduling has been proposed for elimination of wastes. Earliest due date (EDD) is a classical schedule approach for using widely in practice (Kim et al., 1998). A traditional pull-based scheduling method as Kanban has been implemented by emphasizing simplified scheduling and synchronized flows in a mass production industry. However, this tool cannot be directly applied in a high variety of products as make-to-order (MTO) environments (Stevenson et al., 2005).

Workload control (WLC) is a comprehensive production control concept designed for turbulent manufacturing system. This concept buffers the shop floor against the dynamics of arriving orders by using input/output control (Thurer et al., 2011). The WLC philosophy is based on creating predictable and short throughput times for workstations. Land (2009) elaborated the control of balance by card-based navigation (Cobacabana) by using the WLC concept. Nevertheless, this proposed tool has a number of topics to further researches.

This work aims to analyze the scheduled results of Cobacabana via a simulation technique. The paper is structured as follows. In Section 2, a card-based system review is briefly afforded. Section 3 describes a research methodology. Simulated results and discussion are given in Section 4. Final section provides conclusions and perspectives for future research.

2 A Card-based System

A card-based control system is a visual mechanism which gives shop floor operators to control production process. The popularity of this system has enlarged in many fields of industry over the last decennium. A major contribution of the visual mechanism is not only transparent but also easy to understand (Riezebos, 2009).

Kanban, which means card, manipulates and limits the release of parts to obtain better control of raw materials, work in process and finished goods (Price et al., 1994). Junior and Filho (2010) reviewed and classified variations of the Kanban system. The ease of implementation has made it attractive for academics and practitioners in mass production application.

Spearman et al (1990) coined CONWIP (Constant Work In Process) and introduced it to control production system in different ways of the former card-based control system, Kanban. The mechanism combines pull-and-push production schemes and coordinated with completions to hold the WIP in constant level (Li et al., 2010). CONWIP has been implemented mainly in make-to-stock (MTS) environments.

POLCA stands for Paired-cell Overlapping Loops of Cards with Authorization (Suri, 1998). POLCA uses two-type authorization mechanisms which comprises of a normal card system that limits the amount of WIP and a release list to control the pairs of cells flow. POLCA intends to make the principle better applicable in MTO situations, but it has been applied attention to the design mainly in MTS companies (Riezebos, 2009).

Cobacabana's mechanism elaborates on the WLC concept to apply norms into numbers of cards transformation. Order acceptance and order release are key decisions that support the planner to operate on the shop floor. Stevenson et al. (2005) summarized the PPC system in a selection matrix and demonstrated that WLC is the most appropriate approach for MTO environments.

3 Research Methodology

In-depth interview with experts and practitioners of a case study had provided useful information. Operation flows, processing times, due date allowance and order quantities were gained by observing company's historical records.

Then, an existing scheduling approach of the case study was evaluated via simulation study. A model was kept as simple as possible to avoid any noise that affected the results. The simulation comprised five sub-modules: the entry level, release level, dispatching level, production level and statistics.

When a simulation model is built, verification is concerned with ensuring that an error-free computer program has been used. It is known as debugging the model. This study adopted a structured walkthrough technique to verify the simulation model. Event validity and internal validity of the model were used in determining model validity. If the simulated results were comparable with existing systems output data to determine similarity, then the simulation model had event validity.

Next, an application of the Cobacabana was simulated. The key factors for making a decision in Cobacabana comprised workload norms, planned station throughput times, time limits and release period length (Land and Gaalman, 1996). Time limits should be established as infinity for releasing a set of orders (Land, 2006). Realized throughput times should be adopted for setting planned station throughput times (Wanitwattanakosl et al., 2013).

The simulation model was run with all parameter values of workload ratio and release period length at ten replications for forming outputs of lead time and delivery reliability. One hundred observations on lead time and delivery reliability were recorded. The ARENA was run with obtained parameter values at approximate replications to achieve a confidence interval with a pre-specific desired half width for forming outputs of lead time and delivery reliability as Equation 1.1. Finally, Cobacabana results were compared with EDD rule.

$$n \cong n_0 \times \left(\frac{h_0^{\,2}}{h^2} \right) \tag{1.1}$$

where n_0 is the number of initial replications and h_0 is the half width from initial replications, h is a pre-specified desired half width.

4 Result and Discussion

The simulation model was performed on a computer with an Intel® Core™2 Duo CPU P8700 running at 2.53 GHz with 4 GB of RAM. Common random numbers were adopted to diminish the variance across experiments. Statistical distributions were tested by using goodness-of-fit tests (the Kolmogorov-Smirnov test or the chi-square test). Six selected products were manufactured on eight different workstations and performed on a route variety at between three to five workstations as shown in Table 1.

Table 1 Manufacturing flows of six selected products

Product	Workstation							
	A	B	C	D	E	F	G	H
1	1		2		3	4		
2	1	2	3		4	5		
3	1		2		3	4		
4	1				2		3	4
5				3	1	2		
6	1	2		3	4	5		

The Input Analyzer was used to analyze the observed data to fit for proper distribution and estimate parameters. Order quantities were distributed with a gamma distribution (Corresponding p-value = 0.108). A simulated distribution of processing time was important. If the processing times model with 2-Erlang distribution, it might be a better approach than other distributions. Thus, the processing time was modeled using a 2-Erlang distribution for all machines as shown in Table 2. These distributed processing times were validated by the engineering manager. Orders arrived could not be retrieved from the company's data. Thus, interviews with the engineering manager was conducted and led to the assumption that inter-arrival times could be described as an exponential distribution. All jobs were sequenced on a first-come-first-served basis in the queue of each workstation.

Table 2 Operation processing time in 2-Erlang distributed (unit: minute)

Workstation	**Product**					
	1	2	3	4	5	6
A	(2,2)	(4/3,2)	(6/5,2)	(1,2)		(6/5,2)
B		(1,2)				(1,2)
C	(3,2)	(2/3,2)	(4/5,2)			
D					(20,2)	(18,2)
E	(1/2,2)	(1/3,2)	(1/5,2)	(1/2,2)	(0.5,2)	(1/3,2)
F	(37.4,2)	(83/5,2)	(10.1,2)		(96/5,2)	(32,2)
G				(8,2)		
H				(9.9,2)		

The simulated existing approach model was verified by adopting a structured walkthrough technique to verify the simulation model. Event validity was done by comparing results from the simulation model and actual system, for example, actual throughput time of product two was 19.80 minutes, then, the simulation output data were compared with this result. The mean average throughput time of the simulation model was 19.95 minutes with the half width of 1, as displayed in Fig. 1. The model throughput differed from the historical throughput by less than one percent. Thus, it appeared that the model was reasonably valid.

User Specified

Tally

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Delivery Reliability	0.3762	0.02	0.2776	0.4330	0.00	0.7960
Lead Time	17.0818	0.91	13.1642	21.2968	0.2500	40.2815
On Time Delivery	0.9394	0.01	0.8975	0.9627	0.00	0.9952
System Utilization	0.4053	0.01	0.3590	0.4298	0.1250	0.4505
Throughput Time	19.9516	1.00	15.4702	24.3100	0.4607	45.6538
WorkStation 1 Throughput	178.61	9.89	131.32	214.52	0.00	425.70
WorkStation 2 Throughput	1.9112	0.25	1.1884	3.2198	0.00	3.5765
WorkStation 3 Throughput	6.5827	0.77	4.4518	10.5315	0.00	11.7296
WorkStation 4 Throughput	0.3756	0.03	0.2524	0.5186	0.00	0.6265
WorkStation 5 Throughput	151.21	10.60	108.75	198.14	0.00	458.69
WorkStation 6 Throughput	0.00	0.00	0.00	0.00	0.00	0.00
WorkStation 7 Throughput	0.00	0.00	0.00	0.00	0.00	0.00
WorkStation 8 Throughput	0.00	0.00	0.00	0.00	0.00	0.00

Fig. 1 The user specified report for product two

Next, an application of the Cobacabana was performed in the accredited simulation model. The simulation testing consisted of ten independent replications for parameters as workload ratio and release period length.Each termination replication was determined at 172,800 time unit. The parameters were considered starting from 0.5 to 5.0.Some parts of the experiments are displayed in Tables 3 and 4. The simulation generated the best pathway as workload ratio equals 1.5 and release period length equals 4.5.However, the half width of this experiment represented 5.03 days or a 22.73% error in the point estimate 22.1304 days. It should be noted that "half width" was used to determine the simulated results reliability.

To reduce the variance, a number of replications might be adjusted instead of ten replications to $n \cong 10 \times \left(\frac{5.03^2}{0.92^2} \right) = 299$ replications. Hence, three hundred replications were replaced to run the simulation model for updating lead time and delivery reliability. Selected results are displayed in Tables 5 and 6, respectively.

Table 3 The simulation results for lead time by using ten replications

Lead time	Release Period Length (Day)						
Workload Ratio		0.5	1	1.5	2	2.5	3
	0.5	-	23.0508	21.3161	21.5104	21.0626	21.3804

	1	22.3371	22.4792	22.5749	22.3401	22.4037	22.3204
	1.5	23.8898	23.3490	23.2144	22.9577	22.6081	23.3085
	2	24.9313	24.1751	23.3789	23.5805	23.4600	24.1768

Table 4 The simulation results for delivery reliability by using ten replications

Delivery reliability	Release Period Length (Day)						
Workload Ratio		0.5	1	1.5	2	2.5	3
	0.5	-	0.5186	0.5697	0.5418	0.456	0.5235
	1	0.6984	0.6235	0.6552	0.6508	0.6408	0.644
	1.5	0.7116	0.6649	0.6868	0.7029	0.6595	0.6617
	2	0.7138	0.6892	0.6995	0.6776	0.6764	0.7082

Table 5 The simulation results for lead time by using three hundred replications

Lead time	Release Period Length (Day)				
Workload Ratio		1.5	2	4.5	5
	1.5	28.8681	28.6862	28.794	28.8449
	2	29.5285	29.2255	29.5119	29.5797

Table 6 The simulation results for delivery reliability by using three hundred replications

Delivery reliability	Release Period Length (Day)				
Workload Ratio		1.5	2	4.5	5
	1.5	0.6705	0.6657	0.6616	0.6697
	2	0.6875	0.6865	0.6833	0.6843

The case study constraints comprised of the delivery reliability had to greater than or equal to 67.57 % and lead time should be less than 30 days. These constraints were employed to measure the performance of the proposed approach.

When the workload ratio was tightened, lead time significantly decreased because of the contribution from load balancing function and timing function. Contrary, delivery reliability appeared notably reduction. Next, the effect of release period length was also observed. Different release period lengths influenced both balance and timing. It was found that this parameter fluctuated not only lead time, but also delivery. For a larger release period length, load balancing could improve opportunities for selecting jobs. Timing function also increased the opportunity for releasing jobs in the time sequence. The main obstacle of a large rolling horizon was shown in the pool delay of jobs.

The best value obtained was 29.22 days for lead time and 68.65% delivery reliability. In addition, workload ratio and release period length related to 2 and 2, respectively. It should be noted that workload ratio and release period length related to 0.5 and 0.5 performed an undefined result. A planner could not schedule and release production orders. Hence, lead time and delivery reliability appeared to be the worst-case performance.

The best result was compared to a result of EDD rule. Results obtained by the EDD algorithm were 30.55 days for lead time and 44.02% delivery reliability. Fig. 2 shows the comparison of both simulation approaches. Cobacabana controlled lead time and delivery reliability better than EDD.

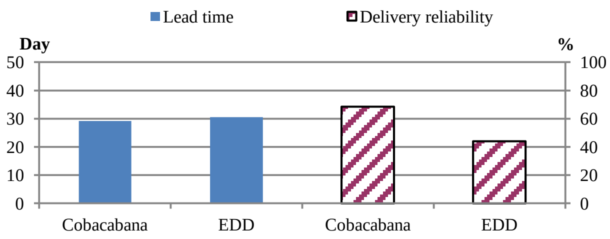


Fig. 2 Comparison of results of Cobacabana and EDD

5 Conclusions

This paper analyzes the simulated scheduled results of Cobacabana and EDD. The workload norms and release period lengths were investigated regarding the performance of lead time and delivery reliability. Input random variables were determined by the Input Analyzer, literature reviews and interviews. This simulation model was verified by adopting the structured walkthrough technique. Event validity was done by comparing results from the simulation model and actual system.

This paper also explains how Cobacabana can serve as the approach to control lead time and delivery reliability in MTO environments. The workload ratio played an important role in the workload-based job release system. Release period lengths performed the fluctuant phenomenon. The best parameter setting of Cobacabana dominated lead time and delivery reliability better than EDD. A practical implication should be researched in the future.

Acknowledgements

Financial support from the Thailand Research Fund through the Royal Golden Jubilee PhD Program (Grant No. PHD/0117/2552) to Jirapat Wanitwattanakosol and Assoc.Prof.Dr.Apichat Sopadang is gratefully acknowledged.

6 References

Junior ML, Filho MG (2010) Variations of the kanban system: Literature review and classification. INT J Prod Econ 125:13–21

Kim YD, Kim JU, Lim SK, Jun HB (1998) Due-date based scheduling and control policies in a multiproduct semiconductor wafer fabrication facility. IEEE T Semiconduct M 11:155–164

Land MJ, Gaalman G (1996) Workload control concepts in job shops-A critical assessment. INT J Prod Econ 46-47:535–548

Land MJ (2006) Parameters and sensitivity in workload control. INT J Prod Econ 104:625–638

Land MJ (2009) Cobacabana (control of balance by card-based navigation): A card-based system for job shop control. INT J Prod Econ 117:97–103

Li N, Yao S, Liu G, Zhuang C. (2010) Optimization of a multi-Constant Work-in-Process semiconductor assembly and test factory based on performance evaluation. Comput Ind Eng 59:314–322

Price W, Gravel M, Nsakanda, AL (1994) A review of optimisation models of Kanban-based production systems. Eur J Oper Res 75:1–12

Riezebos J (2009) Design of POLCA material control systems. INT J Prod Res 48:1455–1477

Spearman ML, Woodruff DL, and Hoop WJ (1990) CONWIP: A pull alternative to Kanban. Int J Prod Res 28: 879–894

Stevenson M, Hendry LC, Kingsman BG (2005) A review of production planning and control: The applicability of key concepts to the make to order industry. Int J Prod Res 43: 869–898

Suri R (1998) Quick response manufacturing: A company wide approach to reducing lead times. Productivity Press, Portland

Thurer M, Silva C, Stevenson M (2011) Optimising workload norms: the influence of shop floor characteristics on setting workload norms for the workload control concept. Int J Prod Res 49: 1151–1171

Wanitwattanakosol J, Sopadang A, Shi J (2013) An enhanced lean tool performance formake-to-order industry by using hybrid optimal algorithm. INT J Logist Econ Globalization 5:30–42

123 Analysis of the R&D Collaboration Network in the European Renewable Energy Sector

Larruscain J, Río-Belver R, Cilleruelo E, Garechana G, Gavilanes J

Jaso Larruscain (✉ e-mail: jaso.larruscain@ehu.es)
Rosa Río-Belver(✉ e-mail: rosamaria.rio@ehu.es)
Javier Gavilanes-Trapote(✉ e-mail: javier.gavilanes@ehu.es)
Foresight, Technology and Management (FTM) Group. Department of Industrial Engineering, University Basque Country UPV/EHU, c/ Nieves Cano 12, 01006 Vitoria, Spain

Ernesto Cilleruelo(✉ e-mail: ernesto.cilleruelo@ehu.es)
Foresight, Technology and Management (FTM) Group. Department of Industrial Engineering, University Basque Country UPV/EHU, Alameda Urquijo s/n, 48030 Bilbao, Spain

GaizkaGarechana(✉ e-mail: gaizka.garechana@ehu.es)
Foresight, Technology and Management (FTM) Group. Department of Industrial Engineering, University Basque Country UPV/EHU, c/ Elcano 21, 48030 Bilbao, Spain

Abstract: One of the challenges of “Smart cities” is to combine the ability of the innovation networks shared by the main actors involved, through collaborative relationships at emerging and multidiscipline renewable energy (RE) sector. By considering R&D RE projects as a social network of organisations and using Text Data Mining and Social Network Analysis, both organisational and evolutionary patterns to be used by policy makers when drawing efficient and long lasting policies are empirically evaluated. The objective of this article is to make a contribution towards the understanding of the relationship between public and private participants in RE sector in Europe from 2000 to 2013. Empirical findings show that although universities and research centres remain the centrality and influence, firms tend to become key actors which play a crucial role in innovation. Policy makers should pay more attention to them in order to promote useful organisational networks for this sector which are key point in the development of future “Smart cities”.

Keywords: Renewable Energy, Social Network Analysis, Organizational Structure, R&D Collaborative Projects, Smart cities.

1 Introduction

One of the challenges of "smart cities" is to combine the ability of the innovation networks shared by the main actors involved, through the formation and management of collaborative alliances at many levels (Lee et al. 2013), including the emerging and multidiscipline renewable energy (RE) sector.

The innovation networks can be defined as the union of two or more parts, institutions, or public or private individuals, whose purpose is to develop technological projects (Hagedoorn et al. 2000, Brockhoff 1992). The extensive literature on collaborative R&D indicates that the first step towards analysing these networks is understanding their organisational structure (Arranzand Arroyabe2012) as defined by the actors themselves and the interconnected links between them (Sakakibara 1997). The result of analysing these organisational collaborative structures is an understanding of the dynamics of the innovation networks (Giuliani and Bell 2008).

Despite the fast growth in the development of "smart cities", only certain authors (Nam and Pardo 2011) consider their success from a holistic or typological viewpoint and use a technological dimension. The European Union finances most R&D collaborative technological projects in Europe, particularly the ones relating to RE with slower innovation cycles than those from other sectors, long lead time ventures (McCauley and Stephens 2006) and relatively weak position newcomers with a high percentage of public support (Hvelplund 2006).

The objective of this article is to make a contribution towards the understanding of the relationship between public and private participants in RE sector in Europe from 2000 to 2013, and therefore predict their potential ability to perform in future "smart cities". By considering R&D projects as a social network of organisations and using Social Network Analysis, both organisational and evolutionary patterns to be used by policy makers when drawing efficient and long lasting policies are empirically evaluated.

2 Methodology

The methodological strategy has been developed in two phases. First, theoretical study is addressed focusing on collaborative-innovation networks and social networks analysis tool. Second, empirical study is carried out choosing the source of data with text data mining tools and obtaining the results from social network analysis method.

2.1 Theoretical Study

This section explores main structural features of collaborative and innovation networks as well as emphasizes advantages of using social network analysis.

2.1.1 Collaborative and Innovation Networks

To identify the efficient configuration of cooperation in innovation networks, which are multidimensional constructions (Arranzand Arroyabe2012), based on the analysis of synergy patterns that, when applied, promote the capacity for innovation.

The structure of interrelations between partners, firms, universities and research centres (Miotti and Sachwald 2003) acts as a mechanism for managing the network itself with the purpose of determining the transfer of knowledge (Gulati et al. 2000), which leads to a process of development of the innovation (Löfsten and Lindelöf 2005) linked to the theoretical framework of the proximity concept. It is essential to integrate the organisational (similar group of firms), intellectual (same basic knowledge) and social (belonging toa social network) proximity in emerging technological fields such as RE (Boschma 2005) in the area of European R&D. In addition, innovation-minded collaboration is considered as an effective tool for internalising asymmetric knowledge spill-overs, supporting the dissemination of the tacit knowledge of the partners (Dyer and Nobeoka 2000).

It is necessary to analyse the two-side collaborations because, since one-side collaborations are imports from technology or direct investments, they tend to only promote the transfer of products of the innovation and not the basic technological knowledge (Paulsson 2009).

2.1.2 Social Network Analysis

SNA is widely proven and accepted as a tool to analyse groups of projects with a bilateral relationship, considering them as social networks. It is used as an empirical method to obtain information about the dynamic and structural properties of the relationships between partners (Batallas and Yassine 2006, Greve and Salaff 2001).

Each pair of partners within the project group creates a temporal sustainable link which can be represented in a network by an edge, where the partners themselves are the nodes (Glänzel and Schubert 2004). Among the structural properties are: size (total number of nodes), average clustering coefficient (the mean of the density of all nodes' open neighbourhood), density (the overall closeness of the nodes), centralisation (the inequity of the centrality values of individual nodes) and structural holes (absence of tie between an alter and the third party) (Nooy et al. 2009).

2.2 Empirical Work

In this section theoretical approaches are empirically developed.

2.2.1 Data Base Choice and Text Data Mining Process

Using the criteria of amount of information and its availability (Garechana et al 2012), the Community Research and Development Information Service (CORDIS) database, which stores and centralises all the information about research and development (R&D) projects financed wholly or partly from the European Union Budget since 1980, was chosen for this research. As of the 17.02.2014, this database stores global and reliable information for 97,992 projects of which 73,993 are European.

Even though it is a partially structured database, there is the need to develop a strategy to capture the information on RE projects, utilising various filtering and text data mining (TDM) techniques. Selecting "Energy" in the Subject Index Classification Codes (SID) field and removing all entries corresponding to "Nuclear Fusion", "Nuclear Fission" and "Fossil Fuels", 29,728 projects that include: "Renewable Sources of Energy", "Energy Storage, Energy Transport", "Energy Savings", "Biofuels", "Hydrogen and Fuel Cells", and "Other Energy Topics" were found. Since the objective is to determine only the specific areas of RE, TDM is applied.

TDM can be defined as the application of text mining tools to technology information, informed by an understanding of technological innovation processes (Porter and Cunningham 2005). Bearing in mind the limitations of the different works (Ozcan and Islam 2014) and how they are implemented for a specific technological area (Kostoff 2006), a combination of "Boolean Search Logic" together with "Specific Area Classification Sources" have been chosen.

In addition to what has been proposed by Porter et al. (2008), the fields to be used will be Keywords, Title and Activity Area because they contain more entries: 52%, 100% and 76% of the total respectively."Compilation of terms, adjusting retrieved items to renewable energies and final structure" as well as the "precision and recall process" were obtained by adapting the methodology developed by Garechana et al. (2012) to the area of RE, using Vantage Point TDM software.

Wind, Solar, Biomass, Geothermic, Tidal/Wave and Hydroelectric sectors were analysed, discarding Hydrogen sector since, from the 350 projects for the whole period, 95% are not related to RE but other research area (Hekkert et al. 2005).

To identify the type of organisation according to the classification defined by Leydesdorff and Etzkowitz (2003) as university, firm, government, research centre and others, the official codes used by each European country will be applied, due to the fact that currently 66.15% of 163,664 partners is not available.

The database being created contains 6,703 R&D projects with an average of 9.76 partners per project. In Table 1, they are classified by their activity area for the yearly interval 1980-2013.

Table 1 Renewable Energy European R&D projects (1980-2013)

Period	Nª of active projects	Wind	Solar	Biomass	Geothermal	Tidal/Wave energy	Bioenergy	Hydroelectric
1980-1990	2155	423	1224	344	274	1	0	0
1990-2000	3493	721	1759	466	215	19	31	29
2000-2013	2301	301	932	320	47	37	30	9

2.2.2 Social Network Analysis Results

To convert created data base into the input for social networks analysis (relational data), firstly, data is rearranged as 2-mode network data matrix of partners, defining the relationship between partners and projects as an affiliation relationship. Then, 2-mode matrix is converted into a one-mode matrix (Kang and Park 2013), allowing to analyse 185,815 partner-partner relationships for the yearly crucial interval 2000-2013 when a pan-European policy frame was fully introduced by all European members to achieve the target to increase the percentage of RE in the European energy mix to 20% by 2020 (Kitzing et al 2012); prior to 2000, only 15 countries introduced RE support schemes.

Analysis section consists of two parts. First, consolidating the overall partnership structure of actors and their evolution over time through structural attributes of nodes (see figure 1 and tables 2-3). Second, comparing centrality indicators, that are determinant in social network analysis, such as degree, between's and structural holeto measure the importance, influence and prominence of actors within the network (Kang and Park 2013).

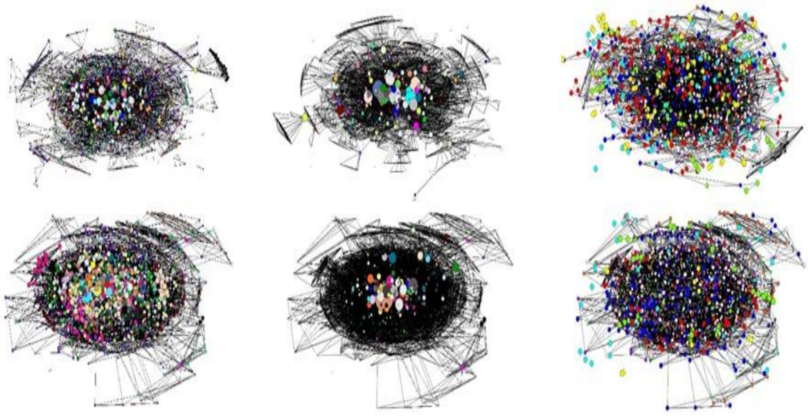


Fig. 1 Evolution of RE Network of R&D in Europe. In rows 2000and 2013 years. In columns network degree partition in terms of degree, betweenness and structural hole centrality.

3 Conclusions

Based on the comparison and analysis of the networking properties of RE projects' partners for each targeted year from 2000 to 2013using Pajek software, some key characteristics, findings and conclusions can be derived.

First, from 2000 to 2007, the number of partners collaborating through projects tends to rise slightly while from 2008 to 2013 the tendency is changed. Nevertheless, the average tie strength between any two partners, measured by the density indicator, shows a little fluctuation but remains almost constant.

Second, according to the role played by partners, as the average clustering coefficient remains higher than the overall density, the collaboration process tends to cluster around a few partners (Kang and Park 2013). The results above confirm the key role of universities and research centres in RE sector research.

Table 2 Network indicatorsin Renewable Energy R&D projects (2000-2006)

Net Indicator	2000	2001	2002	2003	2004	2005	2006
Centrality degree	0.083	0.089	0.118	0.122	0.157	0.143	0.141
Centrality betweenness	0.110	0.073	0.088	0.095	0.144	0.123	0.138
W-SCoef.	0.889	0.896	0.903	0.901	0.914	0.920	0.924
ClusterCoef.	0.378	0.469	0.501	0.480	0.513	0.527	0.532
Nº actors	1356	1648	1925	1999	2240	2260	2431
Nº links	18296	29491	40855	42975	51996	52177	63995
Density	0.018	0.020	0.021	0.021	0.020	0.020	0.021
Average degree	26.985	35.790	42.447	42.996	46.425	46.174	52.649

Table 3 Network indicators in Renewable Energy R&D projects (2007-2013)

Net Indicator	2007	2008	2009	2010	2011	2012	2013
Centrality degree	0.135	0.114	0.097	0.139	0.177	0.179	0.218
Centrality betweenness	0.159	0.137	0.128	0.162	0.162	0.153	0.208
W-S Coef.	0.920	0.919	0.928	0.929	0.925	0.920	0.916
ClusterCoef.	0.533	0.536	0.556	0.520	0.471	0.417	0.394
Nº actors	2602	2580	2588	2530	2182	2468	2094
Nº links	65535	65535	64847	57784	49544	58168	48897
Density	0.019	0.019	0.019	0.017	0.020	0.018	0.021
Average degree	50.373	50.802	50.114	45.679	45.412	47.138	46.702

Third, rising of the degree of centrality (the number of links incident upon a node) reveals that concentration of relationships around few partners is strengthened by time (Kang and Park 2013). Furthermore, betweenness centrality (significance of the actor in the network) also tends to rise slightly.“University of Stuttgart”, “National Technical University of Athens”, “Centre National de la Recherche”, “DanmarksTekniskeUniversitet” and “Energy Research centre of the Netherlands” are key organisations for overall studied period according to partner degree and betweenness centrality ranking. However, only “Centre for Renewable Energy Sources”, “Energy Research Centre of the Netherlands” and “Fraunhofer Institute “appear as a leader for each year.

Finally, the firms, being 40.3% of the total of RE partners, account for 43.37% of total sum value related to the structural holes indicator that represents the efficiency and effectiveness of connections in the network.

According to this research, an increase in information flows and innovation networks in RE sector depends more on the type of organisation rather than country, role or even period of time. Although universities and research centres remain the centrality and influence, firms tend to become key actors which playa crucial “bridge” role in innovation. Public institutions and government should pay more attention to them in order to promote useful organisational networks for RE sector that are key point in the development of future Smart cities.

An additional analysis of these partners in terms of structural and organisational indicators, using financial data bases such as Amadeus, will be valuable in further research to complete the research on their direct impact inside these networks and clarify which is leading smart cities’ development.

4 References

Arranz N, Fdez. deArroyabe JC (2012) Can innovation network projects result in efficient performance? Technological Forecasting & Social Change 79:485–497

Batallas DA, Yassine AA (2006) Information leaders in product development organizational networks: social network analysis of the design structure matrix. IEEE Transactions on Engineering Management 53 (4):570–582

Boschma R (2005) Proximity and innovation: a critical assessment. Regional studies 39(1):61-74

Brockhoff K (1992) R&D cooperation between firms. A perceived transaction cost perspective, Manage. Sci. 38 (4):514–524

Dyer JH, Nobeoka K (2000) Creating and managing a high-performance knowledge-sharing network: the toyota case. Strategic Management Journal 21 (3):345–367

Garechana G, Rosa R, Cilleruelo et al (2012) Tracking the evolution of waste recycling research using overlay maps of science. Waste Management 32:1069–1074

Giuliani E, Bell M (2008) Industrial clusters and the evolution of their knowledge networks: revisiting a Chilean case, Technical report, SPRU Electronic Working Paper Series

Glänzel W, Schubert A (2004) Analyzing scientific networks through co-authorship. In: Moed HF, Glänzel W et al (Eds.) Handbook of Quantitative Science and Technology Research. Kluwer Academic Publishers, Dordrecht, London, pp.257–276

Greve A, Salaff JW (2001) The development of corporate social capital in complex innovation processes. Research in the Sociology of Organizations: Soc. Cap. of Organizations 18:107–134

Gulati R, Nohria N, A. Zaheer (2000) Strategic networks. Strateg. Manag. J. 21 (3):203–215

Hagedoorn J, Link A, Vonortas N (2000) Research partnerships. Res. Policy 29:567–586

Hekkert M, Giessel JF, Ros M et al (2005) The evolution of hydrogen research: Is Germany heading for an early lock-in? International Journal of Hydrogen Energy 30:1045-1052

Hvelplund F (2006) Renewable energy and the need for local energy markets. Energy 31:2293–2302

Kang MJ, Park J (2013) Analysis of the partnership network in the clean development mechanism. Energy Policy 52:543–553

Kitzing L, Mitchell C., Morthorst P.E. (2012) Renewable energy policies in Europe: Converging or diverging? Energy Policy, 51(0):192-201

Kostoff RN (2006) Systematic acceleration of radical discovery and innovation in science and technology, Technol. Forecast. Soc. Chang. 73 (8):923–936

Lee JH, Hancock MG, Hu MC (2013) Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco, Technol. Forecast. Soc. Change, http://dx.doi.org/10.1016/j.techfore.2013.08.033

Leydesdorff L, Etzkowitz H (2003) Can't the public be considered as a fourth helix in university-industry-government relations? Report on the Fourth Triple Helix Conference. Science and Public Policy 30 (1):55-61

Löfsten H, Lindelöf P (2005) R&D networks and product innovation patterns—academic and non-academic new technology-based firms on Science Parks. Technovation 25 (9):1025–1037

McCauley SM, Stephens JC (2006) Green energy clusters and socio-technical transitions: analysis of a sustainable energy cluster for regional economic development in Central Massachusetts, USA. Sustainability Science 1 (1), Sustain Sci DOI 10.1007/s11625-012-0164-6

Miotti L, Sachwald F (2003) Co-operative R&D: why and with whom? An integrated framework of analysis, Res. Policy 32: 1481–1499

Nam T, Pardo TA (2011) Conceptualizing Smart City with Dimensions of Technology, People, and Institutions, In: Proceedings of the 12th Annual Digital Government Research Conference, 282–291

Nooy W, Mrvar A, Batagelj V (2009) Exploratory Social Network Analysis with Pajek. Structural Analysis in the Social Sciences (27). Cambridge University Press

Ozcan S, Islam N (2014) Collaborative networks and technology clusters - The case of nanowire. Technological Forecasting & Social Change 82: 115–131

Paulsson E (2009) A review of the CDM literature: from fine-tuning to critical scrutiny? International Environmental Agreements: Politics, Law and Economics 9 (1):63–80

Porter AL, Cunningham SW (2005) Tech mining: exploiting new technologies for competitive advantage. Wiley-Interscience, United States of America

Porter AL, Youtie J, Shapira P et al (2008) Refining search terms for nanotechnology. Journal of Nanoparticle Research, 10(5):715–728

Sakakibara M (1997) Evaluating government sponsored R&D consortia in Japan: who benefits and how? Res. Policy 26 (4–5):447–453

130 Integration of Discrete-event Simulation Model and Optimisation Method for Solving Stochastic Job Shop Dynamic Scheduling Problem

Silva M, Grassi F, Pereira F

Marilda de Fátima de Souza da Silva (✉ e-mail: marilda.silva@uninove.br)
Department of Informatics, Universidade Nove de JulhoFrancisco Matarazzo, Av. 612 Água Branca, São Paulo, Brasil

Flavio Grassi (✉ e-mail: flaviograssi.fg@gmail.com)
Industrial Engeneering Post Gaduation Program, Universidade Nove de JulhoFrancisco Matarazzo, Av. 612 Água Branca, São Paulo, Brasil

Fabio Henrique Pereira (✉ e-mail:fabiohp@uninove.br)
Industrial Engeneering Post Gaduation Program, Universidade Nove de JulhoFrancisco Matarazzo, Av. 612 Água Branca, São Paulo, Brasil

Abstract: This work presents an integration of a simulation model with an optimisation method in order to solve the stochastic job shop dynamic scheduling problem. The proposed model integration is accomplished using out-of-process components, through the ActiveX Automation technology and the Visual Basic for Application, in which a simple Genetic Algorithm runs as a free-standing application. Results were compared with some common dispatching rules and show that simulation optimization method can solve the scheduling problem efficiently, achieving results up to 40% better compared with common dispatching rules.

Keywords: Simulation optimization, stochastic scheduling problem, job shop.

1 Introduction

Scheduling can be understood as the process of assigning one or more resources to perform certain activities whose processing will require a certain amount of time (Lukaszewicz, 2005). In a manufacturing environment the resources are represented as machines and a job is defined as a set of one or more activities, also known as tasks. The scheduling problem has been known as one of the main and hardest problems faced by the contemporary manufacturing systems, especially in job shop production environments, in which every job is unique with pre-established and different routes, and it is processed at least once on each of the machines. The problems within this environment are known as Job Shop Scheduling Problems (JSSP). Due to its practical importance and hard computational complexity, the JSSP has been extensively studied. Over more than half a century, different optimization techniques for solving such scheduling problems have been developed. However, the vast majority of papers address the deterministic and/or static problem, which does not take into account the stochastic processing times and/or the dynamic arrival of jobs that reflect more appropriately real-world industry situations. So, it is possible to see a large gap between job shop scheduling theory and practice (Ouelhadj and Petrovic, 2009). On the other hand, the application of such optimization techniques requires a representation of the real production environment and its constraints. Due to the features of real environments, such as complex constraints and uncertain factors, they are too complex to be modeled analytically. In these cases, discrete event simulation has proven to be a suitable choice, since it can tackle randomness and dynamicity efficiently. However, from few papers that addressed the stochastic and dynamic characteristics of the problem it is possible to see that the development of the simulation model and, mainly, the integration of the simulation model with the optimization method are not well established (Terekhov, Tran, Down, and Beck, 2013). As, in general, each specific integrated application uses its own representation of the system, it makes difficult the data exchange and demands the development of dedicated interfaces (Iassinovski, Artiba, Bachelet, and Riane, 2003). Additionally, integrations of optimization and simulation are sometimes based upon very general methods from the deterministic metaheuristic literature that, as already discussed, may be not suitable for real-world problems (Fu, 2002).

This work presents the details of the integration of a simulation model with an optimization method in order to solve the stochastic job shop dynamic scheduling problem. Using the control facilities within and across applications, through the ActiveX Automation technology and the Visual Basic for Application (VBA), the model is integrated with an optimization method. The proposed model integration is accomplished using out-of-process components, in which the optimization method runs as a free-standing application. As an example, the model is integrated with a C++ application and used to evaluate the candidate solutions to Genetic Algorithm method.

2 Stochastic and Dynamic Job Shop Scheduling Problem

In contrast to the static scheduling problem, in which all jobs are ready to start at time zero, in dynamic scheduling jobs can arrive at some known or unknown future times. Furthermore, if processing times are random then the problem is also classified as stochastic. So, stochastic dynamic scheduling problem can be defined according to the following two characteristics (Zhang, Yi and Xiao, 2005): (1) The time between arrivals of the orders are consider as a random variable, which means that jobs arrive at the system dynamically; (2) The processing times of the jobs fluctuates stochastically at each machine.

3 The Simulation Module

According Banks (2000), simulation is the imitation of the operation of a real-world system over the time. One of the main advantages of such technique is to be able of integrating the diverse system restriction, which can be coupled to the simulation model. There are many different methods for modeling and simulation of complex systems, one of which is the discrete-event simulation. In such case, the representation of the system is defined to take into account those discrete points in time in which the changes of the state of the system occur. In this paper, the simulation module has been developed based on discrete-event simulation through the software ARENA 12. The simulation module is used to (1) evaluate the candidate solution to the schedule problem generated by the optimization module, (2) construct a schedule taking into account all the constraints, (3) assess the performance of the common dispatching rules at stochastic and dynamic shop floor conditions (for comparison purposes). The simulation model was built based on a stochastic and dynamic production scenario made up of 8 machines and 10 types of orders with pre-established routes and estimated production total times determined according to Table 1. The model considers the random behaviour of the orders arrival and the stochastic production times in this kind of environment.

Table 1 Estimated total production time and route data for Job Shop environment

#	Route	Time(min)	#	Route	Time(min)
1	1,2,3,6	16.9	6	1,2,4,3,1,2,4,5,7	36.0
2	1,3,7,8	16.4	7	2,6,5,6,8	20.7
3	1,5,8	11.6	8	1,2,4,5,7	19.7
4	1,2,3,5,6,7,8	27.3	9	2,3,4,6,7	21.0
5	3,4,6,7	16.3	10	1,2,4,5,8	20.6

The principal parameters of the simulation model are presented in Table 2, and the details of its development and validation are presented in (Silva, Costa, Silva et al, 2014). The mean of the exponential distribution of the time between arrivals of orders is chosen to reach a desired utilization level on all machines. Operational validation was accomplished according (Leal, Costa, Montevechi et al, 2011).

3.1 The Format of the Scheduling Solutions

The developed simulation module recognizes a solution of the scheduling problem through a sequence of priorities of the jobs on each of the machines. So, a solution is represented inside the module as a list of *k* integer number, where *k* is the number of operations. It is important highlight that it is independent of the representation adopted by the optimisation module, in which can be used any available approach. Moreover, as different jobs should have different priority values in a given machine the values are taken from the list considering the occurrence instead of the position. Inside the model, each job has a process plan defined as a sequence according to the route in Table 1. Each steps of the process plan for all jobs has an assignment named priority whose value is stored as an object of the model in a specific module and it is changed during the solution process.

Table 2 Parameters of the proposed simulation model (std = standard deviation)

Parameter	Expression	Description/source
Time between arrival of orders	EXPO(11)	Exponential distribution of 11 minutes average (Hildebrandt, Heger, and Scholz-Reiter, 2010)
Processing time	NORMAL(4, 0.4)	Normal distribution of 4 min average and 0.4 min. std (Santoro and Mesquita, 2008)
Confidence factor	k = 0,3	confidence factor with regards to the due date (Santoro and Mesquita, 2008)
Estimated total production time	t0	Estimated by *processing time* x *number of operation* of job (Santoro and Mesquita, 2008)
Due date	NORMAL((1+k) *t0, 0.1*(1+k)*t0)	Normal distribution of (1+k) *t0 average and 0.1* (1+k)*t0 std (Santoro and Mesquita, 2008)

3.2 The Model Logic

One of the main objectives of the simulation module is to evaluate the solution from an optimisation module. Here, the solutions created by the optimisation module are inputted into the model using the Visual Basic for Application in ARENA. The VBA project has access to the simulation model through the *This Document* object that contains many ARENA built-in VBA events in which the code is activated. These built-in events fall into three categories that define the exact moment during the simulation that the VBA code is executed (Kelton, Sadowski and Sadowski, 2004): (1) Pre-run events (e.g., Document Open); (2) Arena-initiated run events (e.g., RunBegin, RunEndReplication); (3) Model/user-initiated run events (e.g., UserFunction, VBA_Block_Fire). An illustration of the sequence of these VBA events, with instructions for inserting a sequence of priorities into the model, is presented in Fig. 1.

4 The Optimisation Module

Discrete event simulation is a useful tool to evaluate a given design, but it needs an optimisation method in order to find an improved solution. Due to the complexities of the systems frequently addressed by the simulation, metaheuristic approaches, such as Genetic Algorithms, have been the most common choice for solving practical problems. The genetic algorithm (GA) mimics the evolutionary process that occurs with biological organisms in nature. The algorithm is based on the process of natural selection, in which individuals better adapted to their environment can reproduce more frequently, passing their genetic traits to offspring. So, the GA uses computational models of the natural process of evolution of the life beings as a tool to solve problems.

```
1. RunBegin
    2. Arena checks the model and initializes the simulation
    3. RunBeginSimulation
        Define an ARENA model variable:
        Define an ARENA module variable:
        Define an Input File:
        Save in an array the priority values created by optimisation module:
        Set the current model:
        Find the module in which the priority values are stored:
        Set the priority values for all Jobs
    4. RunBeginReplication
    5. RunEndReplication
        Define a SIMAN object in which the results are available:
        Get the results from SIMAN (makespan, total tardiness and number of tardy jobs):
        Save the results to a file:
    6. RunEndSimulation
7. RunEnd
```

Fig. 1 Illustration of the sequence of VBA events. Priority values are inputted into the appropriate field before the simulation begins and the results are saved after each model replication.

Although there are several models within this area, all of them share the same fundamentals based upon concepts of selection, mutation and reproduction, which are usually named as genetic operators. However, GA presents peculiar aspects in relation to other optimisation methods, such as (Mitchell, 1997): (i) working with coding of parameters rather than original variables of the problem, (ii) search the optimal solutions from a set of potential solutions and not from just a starting point, (iii) use an evaluation function for the different solutions and (iv) using probabilistic rules in finding new solutions.

5 Integration Environment

The integration has been accomplished using the control facilities within and across applications, through the ActiveX Automation technology and the Visual Basic for Application. ActiveX is a kind of Component Object Model (COM) that enables an inter-applications communication independently of the programming language. The control of the simulation module is performed by the C++ application. Besides performing the usual operations of the optimisation method, such as the genetic operators, the application controls the execution of the model whenever a new candidate solution needs to be evaluated. The process is shown in Fig. 2.

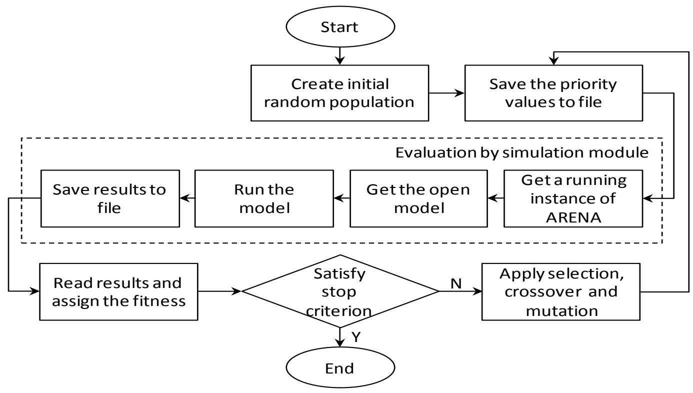


Fig. 2 Flowchart of the integration environment

6 Numerical Experiments

In this paper the optimisation module is developed based upon the C++ library of Genetic Algorithm Components GAlib (Wall, 1996). However, as the proposed integration is accomplished using out-of-process components, in which the optimisation method runs as a free-standing application, the simulation module can be readily integrated with any other applications developed in any programming language like C++, Visual Basic, or Java. Table 3 summarizes the GA parameters that were adopted to run the proposed integration.

Table 3 Parameters used in the experiments.

Parameter	Adopted Value	Reason
Chromosome Representation	Ordered operation-based	Lei (2011)
Selection	Steady State	Yamada (2003)

Replacement Rate	80%	Mitchell (1997)
Population Size	20	Experiments
Crossover	Partial Match (90%)	Mitchell (1997)
Mutation	Swap (5%)	Mitchell (1997)
Total Number of Generations	100	Experiments
Stop Criteria	Number of Generations	Mitchell (1997)
Fitness Function	Simulation Model	Proposed integration

Despite the proposed simulation model enables a multi-objective optimisation, the three performance measures (makespan, total tardiness and number of tardy jobs) were treated separately. Results of the proposed method were compared with some common dispatching rules. A list of the dispatching rules is as follows: the shortest processing time (SPT), the least work next queue (LWQ), the first in first out (FIFO) and the last in first out (LIFO).

7 Numerical Results and Discussion

The experiments using a simple GA were performed primarily to illustrate the operation of the proposed integration. However, any hybrid and more efficient optimization approach can be used in this integration. Table 4 summarizes the mean values of make span, total tardiness and number of tardy jobs obtained from the proposed methodology and from some common dispatching rules used to compare with. Despite using a simple GA method, the numerical tests show that simulation optimization method achieve results up to 40% better compared with common dispatching rules.

Table 4 Mean values of make span, total tardiness and number of tardy jobs from the proposed approach and from some common dispatching rules. Ten replications of the optimization module have been accomplished in each case.

	Makespan	Total tardiness	Number of tardy jobs
LIFO	23.7	51.6	11.3
FIFO	23.2	28	9.8
LQW	23.2	27.9	9.8
SPT	23.7	51	10
GA	22.6	16.2	7

8 Conclusions

In this paper we propose simulation optimization integration in order to solve the stochastic job shop scheduling dynamic problem. The integration was accomplished using out-of-process components, in which an optimization method runs as a free-standing application allowing other methods to be easily integrated later by user. Using the control facilities within and across applications, through the ActiveX Automation technology and the VBA, enables a model integration with other metaheuristic application, or any other general-purpose code to handle external events in a real-time simulation. Numerical tests were provided to illustrate the efficiency of the proposed integration. Despite using a simple GA method, the numerical tests show that simulation optimization method can solve the scheduling problem efficiently, achieving results up to 40% better compared with common dispatching rules. The only drawback observed was related to the computational time, mainly due to the file exchange procedure. However, this can be reduced by using a message broker solution that mediates communication amongst applications, in order to be able to exchange messages.

9 Acknowledgements

The authors would like to thank Uninove and CAPES for the scholarship and the financial support to participate in this Conference.

10 References

Banks J (2000) Introduction to Simulation. In: Proceedings of the Winter Simulation Conference, Orlando, FL, USA.

Fu MC (2002) Optimization for Simulation: Theory vs. Practice. INFORMS Journal on Computing 14(3):192–215.

Hildebrandt T, Heger J, Scholz-Reiter B (2010) Towards improved dispatching rules for complex shop floor scenarios—a genetic programming approach. In: Genetic and Evolutionary Computation Conference GECCO '10, 257-264.

Iassinovski S, Artiba A, Bachelet V et al (2003) Integration of simulation and optimization for solving complex decision making problems. International Journal of Production Economics 85(1):3–10.

Kelton WD, Sadowski RP, Sadowski DA (2000) Simulation With ARENA, 2ª ed. McGraw Hill.

Leal F, Costa RFS, Montevechi JAB et al (2011) A practical guide for operational validation of discrete simulation models. Pesquisa Operacional 31(1):57-77.

Lei D (2011) Simplified multi-objective genetic algorithms for stochastic job shop scheduling. Applied Soft Computing Journal 11(8):4991–4996.

Lukaszewicz PP (2005) Metaheuristics for job shop scheduling problem, comparison of effective methods. Master Thesis - Aarhus School of Business, Aarhus, 123p.

Mitchell TM (1997). Machine Learning. New York: McGraw-Hill.

Ouelhadj D, Petrovic S (2009) A Survey of Dynamic Scheduling in Manufacturing Systems. Journal of Scheduling 12:417–431.

Santoro MC, Mesquita MA (2008) The effect of the workload on due-date performance in job shop scheduling. Brazilian Journal of Operations and Production Management 5(1):75-88.

Silva EB, Costa MG, Silva MFS et al (2014) Simulation study of dispatching rules in stochastic job shop dynamic scheduling. Submitted for publication.

Terekhov D, Tran TT, Down DG et al (2013) Integrating queueing theory and scheduling for dynamic scheduling problems. Submitted for publication.

Wall M (1996) GALIB: A C++ library of genetic algorithm components. Mechanical Engineering Departament, Massachussetts Institute of Technology. Available at http://lancet.mit.edu/ga/dist/

Yamada T (2003) Studies on metaheuristics for jobshop and flowshop scheduling problems. PhD diss., Kyoto University.

Zhang B, Yi L-X, Xiao S (2005) Study of stochastic job shop dynamic scheduling, Proceedings of the Fourth International Conference on Machine Learning and Cybernetics, Guangzhou, 18-21 August.

134 Importance of Inventory Management in SMEs

Buiza G, González MJ, Ruiz R, García M, Thomas M, Beltrán J

Gracia Buiza (✉ e-mail: gbuiza@iat.es)
IAT (Andalusian Institute of Technology). Parque Científico Tecnológico Cartuja, C/ Leonardo da Vinci 2 - 41092 Sevilla.

Rocío Ruíz Benítez (✉e-mail: rruiben@upo.es)
Dpto. Dirección de Empresas del Área de Organización de Empresas, miembro del Grupo de investigación SEJ-111 "Información, Entorno y Cambio organizativo". Universidad Pablo de Olavide. Carretera de Utrera Km 1, 41013 Sevilla.

Abstract: This paper focuses on the management of inventory between the suppliers and the Small and Medium Enterprises (SMEs). The research was conducted by interviewing various SMEs in Andalucía and broken down into three sections: the allocation of resources and tools used in the management and control of inventory, the implementation of methods to support decision making in the supply chain process, and lastly, the accessibility to the necessary information. With this research, we are able to evaluate the current importance of the inventory management and control, and also to provide specialized data to identify the areas that require more focus on the inventory management of SMEs.

Keywords: inventory, management, policy, SMEs.

1 Introduction

As result of the current competitive environment, companies must be constantly working for improving their services level as well as reducing costs. Operation costs represent a high percentage of these costs thus their reduction must be key objective for companies. Aware of the operating costs optimization relevance, some companies focus on the reduction of these costs through the improvement of their business activities (e.g. production, warehouse and transport). With this goal, companies must consider the problem from a strategic and operational perspective and design policies aligned with the situation and environment of their business. Thus, for example, the design of an adequate inventory policy will result in the improvement of the company's service level and inventories cost. This type of action is possible for companies that own the needed resources. Therefore, usually large companies carry out these actions while the smaller ones face numerous difficulties to perform them.

On the other hand, during the study, no unanimous utilization related to the terminology or the expenses to be considered for calculating the inventory costs has been identified in the reviewed literature (the most relevant: Muller, M. (2003); Parra Guerrero, F. (2005); Viale, J. et al.(1996); Zermati, Pierre (2001)). On the base of this review, the research team of this project decided to divide inventory costs into three groups: 1) Order costs (includes all the expenses related to the orders until the placement of the products in the warehouse); 2) Possession costs, also called maintenance costs (cost for maintaining stocks in the warehouse and all the expenses generated by its management); 3) Rupture of stock costs (produced when the stock does not satisfy the demand).

When businesses interested in optimizing their costs deal with their calculations, they find out that they do not know how to do it. Occasionally they estimate values that do not represent the reality or obviate the calculation, as it is shown in the results below.

In this study we will focus on inventory control and management as a source of cost reduction. We study the level of implementation of suitable policies and tools for inventory management and control. And we focus on three potential barriers to the implementation of good practices in this field: the access to the necessary information, the training of the staff and the use of methods and tools.

2 Inventory Management and Control. Integration with the Orders Policies

Regarding the inventory management and control, we focus on two basic aspects: the demand forecast and the orders policy. These two processes should go hand in hand as demand forecast should be input for the methods to decide how much and when to order and define the orders policies (Cohen and Dunford, 1986).

The forecasting of inventories is an extensively studied topic in the academic field. Numerous studies have developed diverse methods and techniques for the calculation of predictions. Fildes et al. (2008) and Syntetos et al. (2009) offer recent reviews on all of these methods.

On the other hand, numerous academic studies have focused on the optimization of decisions linked to inventory management. They have developed some quantitative methods for calculating the optimal order points that minimize the costs associated to inventories. They also provide some decisions such as lot size or time between orders. They have demonstrated that an adequate inventory policy produces a significant improvement for the companies (Syntetos et al., 2010). However, the majority of these studies are theoretical and with inapplicability in the reality due to the complex implementation or to the restrictive number of hypothesis that moves the solved problem away from the real one. As Harvey (2002) mentions, despite the extensive work on models research to manage the inventories, the developed theories are not practical and there is currently no clear understanding of which methodologies should be used to improve the inventory management using quantitative tools.

To deal with the inventory manage and control, many software programs have been developed focusing on making this type of decisions easier: forecasting calculation demand, orders size, frequency of orders, etc. (Küsters et al., 2006). Nevertheless, there are few computer tools that incorporate all of these functions in the same package. That is, there are business planning systems where forecasts are calculated inaccurately and demand forecasting that cannot be included as input in the planning system of the company (Küster et al., 2006).

The majority of the small and medium enterprises do not have the necessary tools to establish an appropriate replacement policy. In this type of business, the decision-making in this field is subject to the preferences or the opinion of the person in charge, making decisions solely based on the intuition. Nevertheless some studies have demonstrated notable improvements in the companies when they apply quantitative methods for inventory management (Goti-Elordi et al., 2010).

3 Conducted Study

In this work we conducted an exploratory study of the practices that are currently performed by SMEs regarding the orders and the inventory control. We will not focus on the implementation of information systems in the warehouse but the tools to support the decision-making.

The scopes of the study are the Andalusian SMEs, and the population has been chosen from a database of businesses that, aware of the importance of the costs associated to logistics processes and the supply chain management, has shown an active interest for these practices improvement. We distinguished between micro, small and medium sized enterprises according with the definition provided by the European Commission (2003).

The technique applied in this study has been personal telephone interviews with those in charge of activities related to the orders and inventory management in businesses. A structured questionnaire has been used. We contacted a total of 84 companies (email and telephone) to arrange a telephone interview with the corresponding responsible in the company. In this previous contact the questionnaire was already sent. 53 companies responded (the response rate was 63%).

The issues addressed are focused on 3 aspects: 1) human resources assign to deal with orders and inventory control; 2) implementation of methods that support the decision-making; and 3) accessibility to information.

This study is part of a larger research project focused on the improvement of logistics activities in Andalusian SMEs called "Investigation for the Sustainability of Products and Industrial Processes" (INSOPRO). This project was submitted to the so called "Incentives to Agents of the Andalusian Knowledge System" Program by the General Directorate of Research, Technology and Business. The project INSOPRO aimed to research the different ways to reduce the impacts of sustainability in industrial processes, paying special attention to three key areas of improvement in these processes: the supply chain, the design of the process and/or product and the possibility of using new materials to achieve this reduction.

4 Results

The distribution of companies participating in the study was: 17% micro, 57% small and 26% medium sized companies. The 41% were from the distribution sector, 38% from the production one and the rest of them from services sector.

4.1 Tools for the inventory management and control

This first section studies the activities related to the inventory management and control carried out by businesses and the use of tools that facilitate these tasks.

First, we try to find out if the businesses use any resource or method to know the status of the stock, that is, what is in stock and where it is located. These resources include a simple Excel file where inputs and outputs of products are indicated to customized software programs. We also observed that many companies intend to have these tools integrated into their ERP. However it is worth mentioning that the fifth of the companies do not use any resource to know about the content of their warehouses nor plan what, how many and when to order.

Furthermore, we observed the medium-sized companies use support tools with a higher percentage than small and micro businesses. All of the medium-sized companies interviewed that use support tools for warehouse management (inventory level and location) also use support tools to order. In the case of the small and micro businesses, support tools are used in a lower extent and the majority of them are for warehouse management.

The majority of the companies (87%) have among their core activities the forecasting of the number of units of each item they will need in the future. Occasionally this forecast is the base for the decisions related to the orders and inventory policy. However, almost half of the companies (42%) forecast on the base of their experience and past sales without using any software tool, which are available in the market and have proven to be effective in practice.

According to Table 1, the breakdown by company size shows that all the medium-sized companies forecast the future demand while this percentage drops when it focuses on the small and micro companies. This relationship is also true regarding the use of software for the forecasts (78% of medium-sized companies use it against the 53% of small companies and 44% of micro companies).

Table 1 Tools for the inventory management and control according the SME´s size.

Items	Micro	Small	Medium
Use of tools to know what is in warehouse and where.	89,9%	76,7%	85,7%
Use of methods to know what, how many and when to order.	77,8%	80%	85,7%
Demand forecasts.	77,8%	86,7%	92,9%
Use software programs to forecast the demand.	44%	53%	78%

Other key issue related to the inventory management and control that place it among the key activities to save costs, it is the calculation of the costs associated to the inventory. Many companies do not calculate these costs, or do not know how to calculate them. Due to the fact that companies do not know their real costs, this activity does not reach the importance it should have. In our study, 45% of the businesses do not calculate the costs associated to the inventory, thus, it is difficult for these companies to be aware of their importance. Additionally, it is difficult to establish control and improvement mechanisms without a benchmarking as a reference that facilitates measuring the improvements. Accordingly, it is interesting to highlight the companies have difficulty to identify the costs intervening in the inventory/warehouse and orders management. This makes the majority of these costs to be associated to fixed costs. In this case, there is barely a difference between the medium and small businesses (57% and 56% respectively). Nevertheless, the micro businesses fail in this issue (33%).

4.2 Human Resources in the inventory management and control

Other relevant issue in the inventory management and control is the human resources dedicated to deal with it (which is sign of the importance that a company attributes to these activities). Since they are SMEs, we cannot expect that there have too many resources assign to these activities. Aligned to this, we find that inventory and warehouse management and ordering are centralized in the same staff (57% of the participating companies).

Regarding the training of the staff in charge of the inventory management and the orders, it is interesting to highlight that only 34% of the staff assigned to these activities has a high education degree. 40% have a medium degree equivalent to a "diplomatura" in Spain and 26% have a lower level degree (secondary school graduate or professional training module). Only 51% have specialized training in logistics. Thus, we observe that the logistics training is still an unresolved issue for many companies that do not see it as important for the performance of inventory management functions.

4.3 Information Accessibility

A key issue to implement inventory management and control policies, as well as improvement policies, is the accessibility to "critical" business information. Very few companies attach importance to the good practices in information gathering and storing. The problem faced by many companies is the lack of protocols to store relevant information that can help them to make decisions in the areas of inventory management and order. Few companies perceive the need to generate databases of quality, easy to access and to deal with.

We have identified various essential facts for the inventory control, the generation of demand forecasts and the design of inventory policy. Then we have researched on how easy or difficult it is for a company to access to this data.

Access to historical demand data becomes essential when you want to apply methods of demand forecasting based on time series. Here we must distinguish two types of demand: satisfied demand and unsatisfied demand, being the real demand the sum of these two. It is interesting to highlight that few companies take into account the unsatisfied demand in their demand forecasts. In terms of historic satisfied demand, 63% of the companies find easy or very easy to obtain this data. However, when we asked about historic unsatisfied demand this percentage fell to 51%. It is also important to know the fluctuations in the price of the products; this information is difficult or very difficult to obtain for 16% of the companies.

An important data to establish an effective and efficient inventory policy is the delivery average time of each provider. Without this data, the company will always tend to have more inventory than necessary to avoid the rupture of stock and the inventory costs will be higher. Only 71% of the companies could obtain this data easily, while for 21% this data would be difficult or very difficult to obtain.

To conclude, other data that also can be relevant for the implementation of management and inventory control methods is the number of orders per year and the monthly stock of each item, which are easy or very easy to obtain in 79% of the companies.

5 Conclusions and Limitations of the Study

The study conducted allowed us to identify the issues that require special attention by the SMEs managers. Despite the progress made academically in regards to inventory management and the development of decision-making support tools in this field, they still exists a lack of application of these tools. There are several conclusions to be drawn from this study.

First, even though the majority of companies develop activities for the inventory control and plan and the necessary forecasts (around 81%-87%), there are only few companies that use specialized software programs for these tasks (only 58%). Therefore, there is a gap regarding the IT tools for the management of these tasks. The problem may reside in that many of these IT programs are too difficult to implement for SMEs. In our study, we have found three common elements for these programs: 1) they are very difficult to understand, so the staff performing these jobs are not capable of using it or need to spend a lot of time on training to use it correctly; 2) the company may not have the data/ inputs that the program needs; 3) the program offer utilities and tools that exceed the needs of the company. Thus, there are very few companies that choose to invest in specialized software for the inventory management and control.

Second, the companies do not calculate or know how to calculate the costs associated to inventory. So in many cases they are not aware of the importance of establishing an efficient inventory policy addressed to minimize these costs. Almost half of the businesses do not calculate the costs associated to the inventory. When we try to calculate these costs in some of the participating companies, we found the lack of real data as a difficulty. We were able to estimate the three types of costs. Regarding the maintenance costs, it was really complicated or almost impossible to calculate the storage expenses (calculations of average inventory and the human and materials resources involved in this concept).

Third, the training of the staff in charge of the inventory managing and controlling is pushed into the background and do not seem important for the companies. Only 34% of personnel assigned to these tasks have a higher education degree and 51% is trained in logistics specifically.

Finally, we have observed there are not many companies aware of the need of a quality historic database as support for the decision-making and business management improvement. There is some relevant data for the design of inventory policy and the inventory management and control that is difficult for companies to get and, therefore, cannot be used for the improvement. Thus, it would be relevant to provide to companies with some protocols for the data collection and storage in such a way that the company can have a complete historical database at minimum cost.

This study, conducted to identify the current state of the inventory management and control in companies, has an exploratory character. We have not found similar studies (going into detail of the real SMEs´ problems regarding the design of the inventory policy and its management and control) in the literature. A clear limitation is the geographical factor. This study has focused on a database of companies in the Andalusian region. Perhaps there are cultural factors that differentiate the management of these companies from the rest of the country. The results of this study will be also able to approach future frameworks to improve the competitiveness of the SMEs. This would be an interesting topic for further studies. Another factor that restricts this study is the relatively small number of participating companies.

6 References

Cohen, R.; Dunford, F. (1986) “Forecasting for Inventory Control: An example of when “simple” means “better””, Interfaces, Vol. 16, núm. 6, p. 95-99.

European Commission (2003). Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium sized enterprises. Official Journal of the European Union. L 124/36.

Fildes, R.; Nikolopoulos, K.; Crone, S.F.; Syntetos, A.A. (2008) “Forecasting and operational research: a review”, Journal of the Operational Research Society, Vol. 59, p. 1150-1172.

Goti-Elordi, A.; García-Sánchez, A.; Ortega-Mier, M.; Uradnicek, J. (2010) “Optimización del punto de pedido: Solución realista a un problema extensa-mente estudiado, pero pobremente resuelto”, Dyna, Vol. 85, núm. 6, p. 473-479.

Harvey, W.M. (2002). “And then there were none”, Operations Research, Vol. 50, p. 217-226.

Küsters, U.; McCullough, B.D.; Bell, M. (2006) “Forecasting software: past, present and future”, International Journal of Forecasting, Vol. 22, p. 599-615.

Muller, Max;(2003), “Essentials of inventory management”; American Management Association, Editorial AMACOM

Parra Guerrero, Francisca, (2005), “Gestión de stocks”, Editorial ESIC, ISBN: 9788473564298

Syntetos, A.A.; Babai, M.Z.; Davies, J.; Stephenson, D. (2010) “Forecasting and stock control: A study in a wholesaling context”, International Journal of Pro-duction Economics, Vol. 127, p. 103-111.

Syntetos, A.A.; Boylan, J.E.; Disney, S.M. (2009) “Forecasting for inventory planning: a 50-year review”, Journal of the Operational Research Society, Vol.60, p. S149-S160.

Viale, J. David Carrigan, Christopher; (1996); “Inventory Management: From Warehouse to Distribution Center, Editorial: Course Technology Crisp.

Zermati, Pierre (2001), “Gestión de stocks” Ediciones Pirámide. ISBN: 84-368 1842-3.

138 The Challenges of Sustainable SCM through the Systematic Literature Reviews

Garrido N, Mejías AM

Nuria Garrido (✉ e-mail: nuria.garrido@uvigo.es)

Ana M. Mejías (✉e-mail: mejias@uvigo.es)
Grupo OSIG. Business Organization Department. Industrial Engineering School. University of Vigo. C/ Maxwel S/N, 36310 Vigo.

Abstract: The aim of this paper is to develop a systematic literature review on the discipline of sustainable supply chain management (SSCM). The level of maturity that currently presents the study of this concept has led to developing a number of papers focused on classify rigorously the existing knowledge of this field. We present a synthesis of these studies and collect its proposals for further research.

Keywords: systematic literature review, supply chain management, sustainability.

1 Introduction

Over the past two decades, there has been a growing body of research of sustainable supply chain management (SSCM). From the academic perspective, the application of the sustainability concept to the SCM is defined "…as the strategic, transparent integration and achievement of an organization's social, systemic coordination of key inter-organizational business processes for improving the environmental, and economic goals in the long-term economic performance of the individual company and its supply chains" (Carter and Rogers, 2008, p. 368). This approach is supported by the triple bottom line idea: the intersection of economic, social and environmental performance. However, the literature of SSCM has especially grown with papers related to the environmental aspects (Darnall et al., 2008), while the study of the social issues or the holistic perspective of sustainability is limited (Pagel and Wu, 2009).

Thereby, diverse authors have recently begun to be interested in collecting the knowledge in the SSCM field with the aim to stand out the gaps and to identify future lines of research that allowing the development of the SSCM concept from a theoretical and practical point of view. The purpose of our research is to synthesize the contributions of these papers to highlight the common findings and proposals of future research directions and to list the fringe propositions.

2 Research methodology

A descriptive evaluation of the body of literature provides a general state of the art view of topics. Nevertheless, the interest of literature review papers in the SCM field has recently grown with a special concern in supporting the findings with a systematic methodology in order to maximize validity and reliability. Thereby, the systematic literature review differs from the descriptive review by employing rigorous and reproducible methods of evaluation (Denyer and Tranfield, 2009).

This paper is based on a SLR of literature review papers which in turn have applied this methodology to analyze the SCM and sustainability relationships. We have selected the 2000-2013 period because a preliminary descriptive evaluation of the literature shows that literature reviews on SSCM were introduced in the last decade for the first time Gold et al. (2010).For compiling the paper sample, the SLR is carried out by keywords searches conducted in academic databases EBSCO and Emerald Full text. Firstly, we have bounded our search in “literature review” papers type. Secondly, we have used the combination of keywords “supply chain management” AND “ecology*”, “green”, “(corporate) social responsibility” and “sustainab*” and “environment*” (see Miemczyk, J. et al., 2012; Gimenez and Tachizawa, 2012). A total of 10 papers have been found and then the abstracts have been carefully read in order to ensure the correct selection.

All the papers applied the same methodology, although the material collection in five papers is conducted in major academic databases (Science Direct, EBSCO, Emerald Full text, …) and, in the other five papers, in a selected number of journals. Afterwards, each number of papers identified according the search criteria, is classified following a coding scheme; the main topics of study, the methodology of research and the dimension of sustainability approach are examples of common categories defined in the coding schemes of these papers. Finally, in order to enhance research reliability, our structured keyword search was conducted by one of the researches and then checked by the second one, given that the use of multiple researchers helps to control for the biases (Tran field and Denyer, 2003).

3 Findings

The table 1 synthesizes the main contributions of each paper.

Table 1 Synthesis of systematic literature review papers of SSCM

Authors	Keywords	Objectives of the study	Findings and conclusions	Future research directions
Carter and Easton	27 keywords related to the economic,	To provide a SLR of the evolution of SSCM over with the	The field of SSCM has evolved from a perspective and	Sustainable Service SC. How bounded rationality and perceptions of

(2011) 80 papers	social and environmental dimensions of sustainability combined with SCM	goal of identifying trends, potential consensus in findings and approaches across studies, and gaps. To guide future research and improve the management of SSC initiatives	investigation of standalone research in social and environmental areas; through a CSR perspective; to the beginnings of the convergence of perspectives of sustainability as the TBL and the emergence of SSCM as a theoretical framework	opportunism within the context of SSCM impact the decision to source domestically or even locally, as opposed to internationally, and how SC governance structures are affected. The role of employees and innovative approaches to traditional analysis
Dey et al.(2011) Number of papers not specified	Sustainability, Logistics, Green, Transportation, SCM	To examine the current state of sustainability efforts within the field of SCM, more specifically SC logistics operations. To identify opportunities and provide recommendations for firms to follow sustainable operations	Short-term recommendations: start today and simple, top management must become committed, create a visual representation of your global SC, benchmarking each area of the global SC against other firms; Long-term recommendations: stay ahead of government regulations, set measurable carbon goals.	The logistics operations hold tremendous potential for a firm's quest towards sustainability. However, there is very little work done to understand the role of SC operations towards this end. The combination of monetary cost and environmental impact that logistics contributes to operations makes it a key area.
Abbasi and Nilsson (2012) 190 papers	Sustainab*, Environment*, green, combined with SC, logistic* and transport*	To explore the themes and challenges in making SC environmentally sustainable and to suggest propositions for further development of SCM theory and practice	The five major themes identified are: Concept of SSC; Management issues; Green activities and policies; Reverse Logistics/ Closed Loop SC; Transport fuel, energy and emissions. Five main categories of SCM challenges: Costs, Complexity, Operationalization, Uncertainties and Mindset and cultural changes.	1.The underlying financially driven logic of SC needs to be reassessed in research and practice. 2.Holistic models. 3.The difficulties of interpreting the concept of SSCM and the inertia of change must be made priority issues. 4.The mindset of people needs to be critical. 5.Organizations must establish new policy measures.

Table 1(continued)

Authors	Keywords	Objectives of the study	Findings and conclusions	Future research directions

Miemczyk et al. (2012) 73 papers	Supply, Purchasing, Procurement, Sourcing, Network combined with Green, Social, Environment*, Sustainab*, Responsib* and Stakeholder	To analyze existing research on sustainable purchasing and supply management at three levels of analysis (dyad, SC and network) with a focus on the definitions that are used. To understand how sustainable purchasing and supply are operationalized, identifying and categorizing the measures of the main purchasing processes. To develop a taxonomy of measures used in sustainable purchasing and supply at the three levels	There is a great deal of heterogeneity in the definitions and measures used. 50% of papers focused on an internal/functional or dyad level of analysis. The environmental research predominates. Categorization of measures identified: 69% of the measures are concerned with environmental issues. 81% of the measures concern the firm-dyad level of analysis. Some gaps (no measures that address the issues of make and buy and sustainability, few papers address purchasing processes such as supplier development)	Analysis of sourcing risk within wider networks. Development of measures to explore and test sustainability across SC. Influence of non-economic actors (i.e. NGO´s) stakeholders on purchasing and supply processes. Supplier development and involvement in sustainable new products development (NPD). Social sustainability
Gimenez and Tachizawa (2012) 41 papers	CSR, Sustainab*, Environment*, green, combined with supply, procurement, purchasing and logistics	To provide a SLR on the governance structures used to extend sustainability to suppliers. To answer two questions: What is the impact of these mechanisms or governance structure on sustainable performance? What are the enablers of these mechanisms?	Most papers focused on the environmental issues. Socially-oriented practices have been rarely studied and mainly under the umbrella of CSR practices. Governance mechanisms: both supplier assessment and collaboration have (+) impact on environmental and social performance, but relying only on assessment is not enough. Internal (I) and external (E) enablers of governance mechanisms identified. Most of the papers focused on I-enablers.	Further research is needed to assist managers in implementing both approaches. Further research should investigate the role of SC characteristics in the implementation of both approaches. Further research should investigate the relative effect of each of these enablers on the different approaches. Most of the enablers emerged from exploratory case studies. Further research should try to generalize these findings with bigger samples.

Table 1(continued)

Authors	Keywords	Objectives of the study	Findings and conclusions	Future research directions
Ashby et al., (2012) 134 papers	CSR, Green, Sustainab*, Environment*, Closed loop, Life cycle analysis, combined with SCM and SC	To investigate systematically the discipline of SCM within the context of sustainability	SSCM is a significant but evolving field evidenced by a current bias in the literature towards theory development and highly qualitative research methods. The environmental dimension is significantly better represented in the literature. The social dimension receives less emphasis than expected given SCM's focus on interaction, relationships and communication. These two dimensions are treated separately in the literature with limited insight on how to integrate them and current SCM and sustainability research provides limited practical outputs.	The literature review revealed a significant and persistent gap between the diffusion of sustainability discourse and its practical application. Developing of appropriate methods and tools to capture the evolving field of SSCM and move from the current dominance of case studies and surveys. The role of SC relationships in achieving sustainability. Life cycle analysis (LCA) and closed loop concepts could also provide a much more appropriate focus for environmental sustainability research as they apply a more connected and holistic view of supply chains.
Taticchi et al. (2013) 205 papers	Sustainab* combined with SC Performance AND Measurement OR Management OR Metrics OR Indicators	To carry out a SLR examining publications reporting the state of the art of SSC – PM (sustainable supply chains in the field of sustainable supply chain performance measurement (SSCPM))	There is no popular academic framework for SCPM and only few integrate the TBL approach. Little research has focused on measuring the social performance of SC; there is no evidence of sustainability improvements and technology investments; Research is spread over a variety of different disciplines	The call for a structured approach to SCPM. The call for a balanced TBL approach. The call for country and industry-specific studies. The call for establishing the scope of current knowledge.

Table 1(continued)

Authors	Keywords	Objectives of the study	Findings and conclusions	Future research directions
Morali and Searcy (2013)	Preliminary search term: SSCM and Sequential search terms: different combinations of 37 keywords	To explore the extent to which corporate sustainability principles are integrated into SCM in corporations	The integration of all three dimensions of sustainability into SC operations is relatively limited. Accountability on sustainability in the SC generally stops at the primary suppliers. There is less emphasis on measuring supplier performance than on measuring a company's own success. The standards to measure the sustainability are centered on three key themes: codes of conduct, product-/process-related certifications, and management systems and initiatives	Research is necessary in three key areas: to explore approaches to integrate all three pillars of sustainability into SCM; to develop performance measurement systems for SSCM, and to refine sustainability reporting practices with respect to SCM. Further, future research must go beyond studying these three areas separately and focus must move towards a more integrated approach. Secondly, new approaches are needed on linking knowledge to action for SSCM practices
Martínez-Jurado and Moyano-Fuentes (2013) 58 papers	Lean (11 keywords); SCM (17 keywords) and Sustainability (30 keywords)	To evaluate the state-of-the-art of research into the links between Lean Management, SCM and Sustainability with a view to: identifying the topic set studied and contributing a criterion for classifying the literature, and discussing the empirical evidence and orienting future research	A broad list of findings and contribution in two main topics of research and by line of research of each topic: Lean Management and Sustainability (LM and environmental sustainability; LM and economic sustainability; LM and social sustainability) Lean Supply Chain Management (LSCM and environmental sustainability; LSCM and economic sustainability)	A broad list of future research and implications for practitioners in two main topics of research and by line of research of each topic: Lean Management and Sustainability (LM and environmental sustainability; LM and economic sustainability; LM and social sustainability) Lean Supply Chain Management (LSCM and environmental sustainability; LSCM and economic sustainability)

Table 1(continued)

Authors	Keywords	Objectives of the study	Findings and conclusions	Future research directions
Winter and Knemeyer (2013) 456 papers	Not specified	To contribute to the knowledge on sustainability as it relates to SCM by using the triple bottom line approach and supply chain management elements	The existing literature is primarily focused on individual sustainability and SC dimensions rather than taking a more integrated approach. The findings suggest both the emergence of a group of themes within an individual dimension, such as green logistics within the environmental dimension as well as a set of themes that are consistent across dimensions	Use of quantitative methods to support research efforts. Applicability of a more multidisciplinary approach. Bringing additional disciplines together (e.g. strategic management, marketing, finance) to support a more holistic examination of SSCM. How SCM processes connect to the social dimension or combination of social and other dimensions of sustainability. Connection between managerial components and sustainability efforts to better understand how managerial practices can influence. Development and validation of appropriate metrics and scorecards in support of SSCM. Holistic approach towards SSCM research.

4 Conclusions and future research

The field of SSCM is ripe for theory development. Through our SLR, the current body of knowledge of the application of sustainable concept to SCM has been synthetized. The findings of the different papers provide opportunities for future research, coinciding in several proposals: exploring approaches to integrate all three pillars of sustainability into SCM; significant and persistent gap between the diffusion of sustainability discourse and its practical application; development and validation of appropriate metrics and scorecards in support of SSCM. We complemented these generic propositions with a broad list of specific future research directions and recommendations for academics and practitioners.

5 References

Abbasi M and Nilsson F (2012) Themes and challenges in making supply chains environmentally sustainable. Supply Chain Management: An International Journal, Vol. 17 No. 5, pp. 517-530

Ashby A, Leat M and Hudson-Smith M (2012) Making connections: a review of supply chain management and sustainability literature. Supply Chain Management: An International Journal, Vol. 17 No. 5, pp. 497-516

Carter CR and Easton PL (2011) Sustainable supply chain management: evolution and future directions. International Journal of Physical Distribution and Logistics Management, Vol. 41 No. 1, pp. 46-62

Carter CR and Rogers DS (2008) A framework of sustainable supply chain management: moving toward new theory. International Journal of Physical Distribution and Logistics Management, Vol. 38 No. 5, pp. 360-387

Darnall N, Jolley GJ and Handfield R (2008) Environmental Management Systems and Green Supply Chain Management: Complements for Sustainability?. Business Strategy and the Environment, Vol. 17, No.1, pp. 30-45

Denyer D and Tranfield (2009) Producing a systematic review. In D. Buchanan & A. Bryman (Eds.), The Sage Handbook of Organizational Research Methods. Sage Publications, London.

Dey A, LaGuardia P and Srinivasan M (2011) Building sustainability in logistics operations: a research agenda. Management Research Review, Vol. 34 No.11, pp. 1237-1259

Gimenez C and Tachizawa EM (2012) Extending sustainability to suppliers: a systematic literature review. Supply Chain Management: An International Journal, Vol. 17 No. 5, pp. 531-543

Gold S, Seuring S and Beske P (2010) Sustainable Supply Chain Management and Inter-Organizational Resources: A Literature Review. Corporate Social Responsibility and Environmental Management, Vol. 17, pp. 230-245

Martínez-Jurado PJ and Moyano-Fuentes J (2013) Lean management, supply chain management and sustainability: a literature review. Journal of Cleaner Production (in press), available on line, pp.1-17

Miemczyk J, Thomas E Johnsen TE and Macquet M (2012) Sustainable purchasing and supply management: a structured literature review of definitions and measures at the dyad, chain and network levels. Supply Chain Management: An International Journal, Vol. 17 No. 5, pp. 478-496

Morali O and Searcy C (2013) A review of sustainable supply chain management practices in Canada. Journal of Business Ethics, Vol. 117 No. 3, pp. 635-658

Pagell M, Wu Z and Wasserman ME (2010) Thinking differently about purchasing portfolios: an assessment of sustainable sourcing. Journal of Supply Chain Management, Vol. 46 No. 1, pp. 57-73

Taticchi P, Tonelli F and Pasqualino R (2013) Performance measurement of sustainable supply chains: A literature review and a research agenda. International Journal of Productivity and Performance Management, Vol. 62 No. 8, pp. 782-804

Winter M and Knemeyer AM (2013) Exploring the integration of sustainability and supply chain management. Current state and opportunities for future inquiry. International Journal of Physical Distribution and Logistics Management, Vol. 43 No. 1, pp. 18-38

145 Manufacturing competitiveness of production management: a case study

Neves J M S, Akabane G K, Peterossi H G, Pozo H

José Manoel Souza das Neves (✉ e-mail:jmneves.fatec@gmail.com)
Centro Paula Souza – Programa de Mestrado Profissional, São Paulo-Brazil

Getulio Kazue Akabane (✉ e-mail:getulio@akabane.adm.br)
Centro Paula Souza – Programa de Mestrado Profissional, São Paulo-Brazil

Helena G. Pererossi (✉ e-mail:helena@centropaulasouza.sp.gov)
Centro Paula Souza – Programa de Mestrado Profissional

Hamilton Pozo (✉ e-mail:hprbrazil@gmail.com)
Centro Paula Souza – Programa de Mestrado Profissional

Abstract: This work investigates the contributions of the MES – *Manufacturing Execution System* – for improving the competitive priorities of manufacturing. The theoretical framework was decisive to subsidize the research performance in a case study. It faced MES contributions in a manufacturing relating to improvement cost, quality, flexibility, conformity and reliability. Even the plant floor information quality improvements such as timely, standardized, reliable and precise. After ERP integration, MES filled out a gap, offering information to other functional areas of the organization. As research methods conducted from businesses department interviews showed the importance of decision make with process tracking in order to achieve competitive priority of the manufacturing.

Keywords: MES - Manufacturing Execution System; competitive priorities of manufacturing; organizational factors; tracking.

1 Literature Review

The MES system ensures a more efficient management because it allows decision making based on relevant, current and reliable information, allowing you to check what is happening in the manufacturing company. Figure 1 shows the desirable schematic view which comprises the integration, the MES, the various organizational levels, from plant floor to business management.

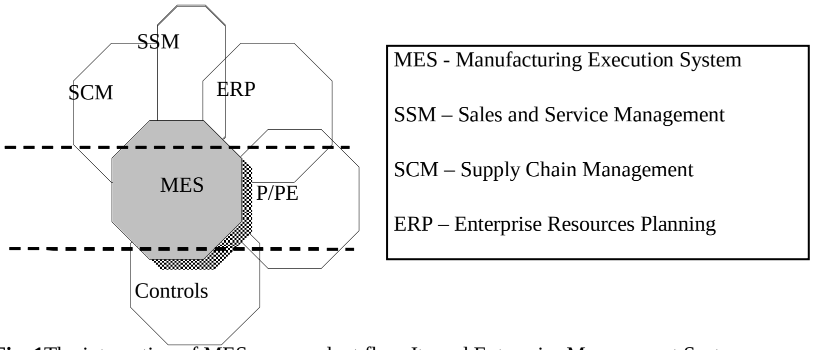


Fig. 1 The integration of MES among plant floor Its and Enterprise Management Systems

Reference: Snoiej (2006)

2 Manufacturing Execution System - MES and its role as an IT integrator

Figure 2 shows the structure of the company's strategies and the area of expertise of the various It’s used. The MES system fills this gap and integrates the IT plant floor to the company management, involving all functional areas.

Kall (1999) defines the MES, as a functional layer that integrates computerized ERP systems and controls the plant floor in order to manage the manufacturing planning production in a real and achievable manner, where a typical implementation of the MES fills the gap between the ERP system and the automated systems on the plant floor.

According to Blackstone Jr. and Cox III (2004), the MES is a system of information and communication for the production environment of a company. The MES has the purpose to monitor and to improve all aspects which influence the production process, in order to achieve high flexibility and low production costs. It has also important features such as production records, production reports, track history and details of the process of planning and scheduling.

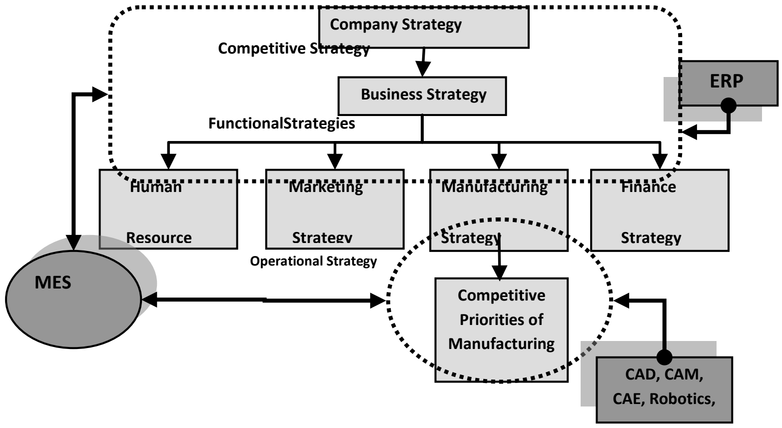


Fig. 2 – Integration of business management strategies with the priorities of manufacturing from theIT systemsand the MES - Adapted from Hayes e Wheelright , (1984)

The MES system is provided with an information center composed of 11 elements or functions (Figure 3), which are joined to other databases. These include the main functions of the MES (Hwang, 2006; Snoeij, 2006; Yu et al., 2009). The central idea is to measure in order to control. The performance indexes are used to compare the production lines within the same plant, company or with other known results. The functions shown in Figure 3 are integrated with sales and services (MSS), supply chain management (SCM), enterprise management system (ERP), Engineering (PPE), and controls, which can generate the means for production management (VINHAIS, 1998; HWANG, 2006), with fully computerized information, in a quick, safe and reliable way for the company.

Theodorou and Florou (2005) established the following to manufacture strategic priorities: cost (cheap materials, operating expenses, labor costs), quality (stability production quality, control in production line quality), flexibility (inventory level, lead time, flexibility and reliability in design, production, quality), and innovation (design, product promotion methods).

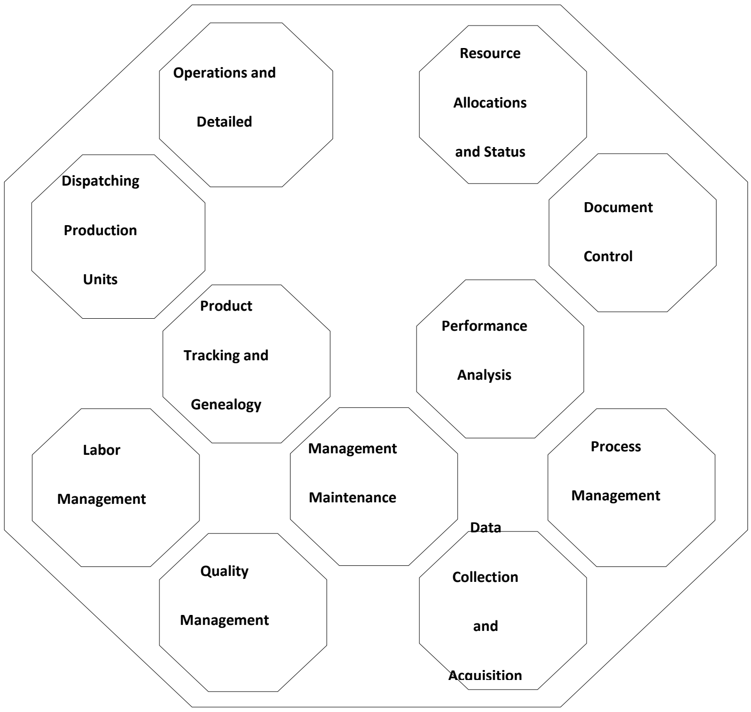


Fig 3 - Schematicof relationshipbetweenthe variousfunctions of MES Reference: Snoij (2006)

3 Methods and Objectives

This research was developed with the intention of contributing to the knowledge expansion about the process of implementing the MES used to link the IT to the ERP, and it improves the competitive dimensions of manufacturing process. It aimed also to analyze what organizational factors support this implementation from the case study in a global leader in rolled aluminum by revenue, production volume and market share.

Then the paper aims to answer the following questions: What is the contribution of the implementation of the MES information technology to improve the competitive priorities of manufacturing? How did the organizational factors contribute to the implementation of the MES? To what extent the MES contributes to the competitive priorities of manufacturing?

The single case study sample consisted of a multinational company, manufacturing, market leader in aluminum products.

The main way of collecting data was through semi-structured interviews, through research lines developed based on the theory of previous chapters. Additionally, visits were made and used technical possibilities of observation. Documents were selected to increase the reliability of the questions

4 Final Considerations

4.1 Contribution of the implementation of IT to improve the MES competitive priorities of manufacturing

Remelting serves the area of hot-rolling and it works in batches producing aluminum plates based on recipes that are determined from the needs of external customers.

There was a significant decrease in gas consumption as table 1 shows these improvements in the remelting area.

Regarding the benefits generated for the competitive priorities of the MES, there was also a significant difference in the three areas surveyed by having different production goals.

There was a significant decrease in gas consumption as table 1 shows these improvements in the remelting area.

Table 1 Improvement of competitive priorities in the remelting area

Priorities	Remelting	Remarks
Costs	a) Reduced consumption of natural gas. Around 5%. Natural gas is the second largest cost to the company. b) Rework reduction	The reduction was also due to the implementation of other quality tools with the MES that contributed to the reduction of gas.
Quality	a) Reduction of failures in the setup. b) Reduction of errors in the introduction into the furnace of the chemical composition of the plates	Only contribution of MES in order to implement double checking.
Delivery	There was no change.	
Flexibility	Increased the flexibility of changing a production line to another.	Only contribution of MES

Reliability	a) Registration data registration card are available online, with the possibility of tracking the entire process. b) more transparent information	Only contribution of MES
Compliance	Reduction of non-conforming signs.	The reduction was also due to the implementation of other quality tools with the MES.
Manufacturing integration with strategic business	Existing in the whole process. It is essential for business.	

Subsection in the hot-rolling mill by reducing the setup time from 10 to 15 seconds per plate, it increased the productivity and the flexibility of the area. The ability to track and control the production, in addition to the online availability of performance indicators (charts, productivity, use level) quickly led to a greater reliability. Table 2 shows the improvements with the implementation of the MES in a hot-rolling mill.

Table 2 Improvement of competitive priorities in the area of hot rolling

Priorities	Hot-rolling mill	Remarks
Costs	a) Better furnaces scheduling, gas consumption reduction. b) Elimination of discards in the wrong setup for the reverse rolling mill. c) Reducing the time of data appointment for operators (1.5 min/pointer/plate).	Improvements achieved only with the implementation of MES

Quality	a) Reduction of rejection in the reverse rolling mill. 1.7% to 0%rejection. b) Improving the quality of information on the plant floor.	
Delivery	There was no change.	
Flexibility	Reduced setup time from 10 to 15 second per card laminated.	
Reliability	Traceability and control of production, besides the online availability of the performance indicators (charts, productivity, level of use) more quickly.	
Compliance	Reduction of coils nonconforming.	
Manufacturing integration with strategic business	Existing in the whole process.	

After the implementation of the MES, it was reduced from 24.4 m³ per ton of coil production to 23.7 m³ in the first year and to 22.6 m³ in the second year. These numbers have generated a total reduction of 252,070 m³ of gas in the first year of implementation of MES, and of 690,120 m³ in the second year. This reduction generated savings of US$ 68,500 on the first year and of US$ 188,000 on the second year.

With the implementation of MES in the setup of scalping machine, the time was reduced from 6 to 5 hours. The reduction is due to the automatic appointment allowed by the MES. Before 2005, the appointment was manual.

Since the MES project, the hot-rolling mill began to receive data from the cards to be automatically laminated, performing the equipment setup and significantly reducing the possibility of errors. From the beginning of the month, there were no further rejections due to setup.

4.2 Conclusions

The system implementation was preceded by an IT strategic plan that began with the preliminary steps of planning, the goals we wanted to achieve and the implementation process. This plan included the participation of those responsible for the production areas, there a of IT, and of the company developing the system.

Traceability in this research's howed that it canbe a competitive advantage for the company because, through the MES, it can immediately identify the entire route of a given product, from raw materials coming from suppliers to the final product sent to the client. This ability o track the Web including the entire process can allow the client to know where your request is.

It was found that the organizational factors chosen were important to support the implementation of MES. In all process of implementing, the support of senior management was significant, both to secure funding the acquisition system (interfaces, hardware and training) and to obtain the returns on the investment in terms of performance improvements.

As per table 1 and table 2, MES implementation contributed significantly with competitive priorities regarding costs, quality, on time delivery, customer demand flexibility, and plant floor reliability and compliance.

For the successful implementation of the MES and to reduce the impacts on the people who are directly connected to the system, the formation of teams comprised by leaders and area operators who are responsible for the IT and the developer was fundamental. These teams were multiplying the areas where the MES was implemented, and created a network with goals to give positive results for the system implementation. The values were converted into shares and new theories that were seized as well as experiences, which meant that the company had a process of organizational learning in the implementation and in the use of MES.

Contributions to the business generated by his research are linked to the importance of the MES for the area's manufacturing business and its importance in integrating with the business and the organization.

The successful implementation of the MES occurred by building networks in multifunctional teams with members from the production areas and the IT.

In addition to generating competitive advantage, the MES spawned learning operators and heads of production areas and created a significant value to the company culture.

Generally, the MES consolidates the planning and mapping to the implementation of all production stages, processing applications connected with the control systems of production, optimizing production processes, democratizing information, integrating information, and viewing the production of the factory as a whole and in real time.

The process of implementation of the MES also allow edit creasing the knowledge of all those involved, improving their employability. The ability to work as a team since its development, implementation and use, have increased the level of satisfaction, transforming the negative anxiety of risk for its use, into a positive one, with the start of system operation know in that came to improve their performance.

5 References

Blackstone JR, J. H; Cox III, J. F. III, (2004) APICS Dictionary, 11 ed, Alexandria.

Hayes, R.H.; Wheelwright, S.C. (1984) Restoring our competitive edge: competing through manufacturing. New York: John Wiley.

Hwang, YD., (2006) The practices of integrating manufacturing execution system and six sigma methodology, International Journal if Advanced Manufacturing Technology, n. 30: pg. 761-768.

Kall, J.,(1999) Manufacturing Execution Systems: Leveraging Data for Competitive Advantage, Quality Digest, vol. 19(8), pg. 31-34, ago.

Shipton, H.; Fay, D., West, M.; PATTERSON, M.; BIRDI, K., (2005) Managing People to Promote Innovation, Creativity and Innovation Management, vol. 14, n. 2.

Snoeij, J., (2006) MES Product Survey 2006, LogicaCMG, MESCC – Manufacturing Execution System Competence Center, Arnhem.

Theodorou, P.; Florou, G., (2008) Manufacturing strategies and financial performance: the effect of advanced information technology: CAD/CAM systems, Omega, n. 36, p. 107 – 121.

Vinhais, J. A., (1998) Manufacturing execution systems: the one stop information source. Quality Digest, vol. 18(9), p. 39–40, set.

Yu, W.; Xiao-dong, X.; Cong-xin, L., Modeling Research on Manufacturing Execution System Based on Large-scale System Cybernetics, Journal of Shanghai Jiaotong University (Science), Shanghai Jiao Tong University Press, vol. 13(6), p.744-747, DOI: 10.1007/s12204-008-0744-x.

150 SCMI and its characteristics

Arantes F P, Leite M S A, Anjos JrO R

Fernanda P Arantes (✉ e-mail:nanda_arantes21@hotmail.com)
Production and SystemEngineeringDepartment. Federal University of Santa Catarina. RuaAracuã, 34, Florianópolis, SC, Brazil.

Maria Silene Alexandre Leite (✉e-mail: mariasileneleite@hotmail.com)
ProductionEngineeringDepartment. Federal University of Paraíba. Campus Universitário I, João Pessoa, PB, Brazil, CT.

Otoniel Rodrigues dos Anjos Junior (✉e-mail:pbdosanjos@hotmail.com)
EconomicsDepartment. Federal University of Paraíba. Campus Universitário I, João Pessoa, PB, Brazil, CCSA.

Abstract: Integration is constantly reported in the literature as essential feature of the SCM. However, it is as difficult to define it as operationalizes it, culminating in a lack of information about how to increase the level of integration between members. Thus, this research aims at identifying the features of integration, attesting to their relation to SCMI using multivariate statistical analysis. Factor analysis indicates that partnership, collaboration, information sharing and coordination are SCMI characteristics, with confidence as base aspect of them all. Thus, to advance understanding of how to increase the level of integration between supply chains members are necessary to better understand each of these characteristics.

Keywords: supply chain, integration, measuring.

1 Introduction

Integration is constantly reported in the literature as an essential feature of the Supply Chain Management (SCM) (Näslund and Hulthen, 2012; Pearcy and Giunipero, 2008; Richey Junior, et al., 2009). However, it is so difficult to define integration as operational zed it, culminating in a lack of information about how to increase the level of SCMI (Supply Chain Management Integration) (Näslund and Hulthen, 2012).

Having integrated supply chain means that all members work together to achieve a common goal: the ultimate customer satisfaction. For this, some features must be identified in the relationship between the members so that the flow of products, services, information and financial are effective along the chain, generating competitive advantage and increasing earnings.

However, there is no consensus in the literature about the each SCMI characteristics; thus every author proposes a different way of measuring integration, which is a reflection of the way so as to define (Basnet, 2013; Childerhouse and Towill, 2011; Danese, 2013).

Frohlich and Westbrook (2001) note the direction and degree of integration based on eight activities used by manufacturers to integrate upstream and downstream. Childerhouse and Towill (2011) and Childer house, et al. (2011) evaluate the integration through the value streams. He, et al. (2013) verify the impact of integration with suppliers and customers on the new product performance based on the trust theory. Danese (2013) demonstrates empirically that supplier integration practices positively affect the supply chain performance. Basnet (2013) developed an instrument to measure the supply chain internal integration.

SCMI is a very broad topic that involves a set of characteristics that need to be explored in depth so that we can increase the level of integration between the members. Rich and Hines (1997) study the integration with suppliers considering partnership, trust and information sharing. Danese (2013) assesses the integration based on the aspects of partnership and information sharing. Basnet (2013) focuses the research on the coordination, communication and emotional relationship.

In this context, this research aims at identifying the features of integration, attesting to their relation to SCMI using multivariate statistical analysis.

2 Literature Review

The SCMI has been seen as a way to develop a competitive advantage from the management of relationships. It enables cost reduction with the rationalization of processes and eliminating redundancies (Chen, Daugherty and Landry, 2009; Rosenzweig, Roth and Dean, 2003).

The customer is at the beginning and end of the SCM, there fore, the benefits of integration are translated into aspects valued by customers, such as product quality, reliability in delivery, process flexibility and cost leadership (Rosenzweig, Roth and Dean, 2003).

However, once the market has increasingly demanding customers and companies can no longer overcome by their own, the chain members should see each other as partners to achieve the integration, working together to establish strategic planning, demand forecasts and setting of targets (Kim and Lee, 2010).

Some features must be identified in relationship among members to achieve the SCMI, namely: confidence, information sharing, partnership, cooperation, collaboration and coordination.

Trust is a basic feature for SCMI because, when working together, the actions of one reflect on others (Chopra and Meindl, 2003; Jones, et al., 2010; Kwon and Suh, 2005; Laeequddin, et al., 2012; Mayer, Davis and Schoorman, 1995). The trust performance can be classified by the fulfillment of high performance promises (Jones, et al., 2010), the existence of procedures to perform the promised standards (Fawcett, Jones and Fawcett, 2012), the quality of interpersonal relationships (Cai, Jun and Yang, 2010).

Some steps to building a relationship based on trust include: considering the value of the relationship, establishing operational tasks and decision rights for each part, creating effective contracts and designing effective solutions to conflicts (Chopra and Meindl, 2003).

The needs and desires of consumers are constantly changing and companies need to adapt to this to stay competitive. The best way to do this is by establishing a close relationship between customers and suppliers through accurate flow of demand information, which will reduce the time spent in production planning, reduce inventory and make the company more responsive to customer needs (Chopra and Meindl, 2003; Flynn, Huo and Zhao, 2010).

Information sharing can happen at multiple levels, ranging from total absence to the full sharing of information, being an essential factor in the reduction of the bullwhip effect, which is the distortion of demand information as farther the member is from information in the chain (Sahin and Robinson, 2002).

Some key information shared include: performance measures (Lee and Whang, 1998; Li, et al., 2006), production information and order status (Lee and Whang, 1998; Sahin and Robinson, 2002), cost information (Li, et al., 2006; Sahin and Robinson, 2002), availability of production capacity, inventory levels and demand forecasts (Ding, Guo and Liu, 2011; Lee and Whang, 1998; Li, et al., 2006; Sahin and Robinson, 2002).

To increase efficiency in information sharing, the chain members can adopt compatible information systems, facilitating problem solving and strategic decisions making, collaboratively (Ha, Park and Cho, 2011).

The relationship between members of a supply chain partnership can be considered when the parties interact in both the short and long term, with common goals and shared benefits (Chen and Wu, 2010; Maloni and Benton, 1997; Ryu, So and Koo, 2009; Singleton and Cormican, 2013). Being essential to deal with the problems of the chain (Singleton and Cormican, 2013).

Partnership requires enterprises a structural change in the way we relate, encouraging mutual planning and problem solving together (Maloni and Benton, 1997); it requires that members have aperture to make adjustments in relationship (Chen and Wu, 2010; Motwani, Larson and Ahuja, 1998), share capacity, risks, losses and gains (Vieira, 2006), have availability and flexibility to adapt to changes (Chen and Wu, 2010), besides working with fewer suppliers to can develop a close relationship with each of its partners (Christopher, 2000; Christopher and Jüttner, 2000; Lambert and Cooper, 2000; Maheshwari, KUMAR and Kumar, 2006; Maloni and Benton, 1997).

Cooperation, coordination and collaboration are related to the integration of supply chains terms for which there is still no consensus on their definitions and how the relationship between them occurs. In some moments are presented as sequential (Ding, Guo and Liu, 2011; Pires, 2010; Spekman, Kamauff Junior and Myhr, 1998), in another as complementary (O'Brien, 1968) or no relationship, with very similar settings (Chopra and Meindl, 2003; Fawcett, Magnan and McCarter, 2008; Sahin and Robinson, 2002; Vieira, 2006).

Thus, it can be concluded that, as part of SCMI, cooperation and collaboration can be understood as the accomplishment of activities together to encourage greater gains for the chain as a whole, and coordination is necessary to organize such combined actions, ensuring the best result as possible.

3 Methodology

From the SCMI characteristics, a questionnaire was designed to assess the level of integration of the companies with the suppliers of their supply chain. This instrument consisted of 20 items, with response options: yes, no or not applicable.

As the research focus was to evaluate the integration with suppliers, each company consulted could complete a questionnaire for each supplier since the intensity of the relationships varies. Thus, 41 companies participated in the survey, resulting in 205 responses.

The questionnaires were concentrated in the city of João Pessoa, Paraíba State, Brazil, with 77% of responses collected in this municipality, 20% in nearby towns and 3%the remaining in other states. Most responses were obtained by interviews, 89%, and 1% of responses sent via email in case of more distant companies. The majority of the sample is concentrated in commerce, food, construction and manufacturing with 44%, 20%, 17% and 10% participation, respectively.

SCMI is not well defined in the literature, being important to carry out tests which show the relationship of the features proposed in the explanation of integration. In this sense, the multivariate statistics allows to cluster and reduces the data, relating the variables, even in the absence of a structured theoretical model (Bakke, Leite and Silva, 2008).

Factor analysis allows to relate the variables based on their correlations, forming groups of highly interrelated variables (Bakke, Leite and Silva, 2008). These groups represent dimensions that combined can explain the integration (Hair Junior, et al., 2009). Thus, the variables are combined in accordance with the latent feature of integration representing.

To test the data adequacy for factor analysis can be used the Keiser-Meyer-Olkin (KMO) criterion. The KMO varies from 0 to 1, with a coefficient in the range of 0.5 being considered very bad; it is ideal above 0.8 and above 0.9 would be excellent (Mingoti, 2005).

The Bartlett's test of sphericity tests the hypothesis that the variables are correlated (Mingoti, 2005). In this case, the significance should not exceed 0.05 (Bakke, Leite and Silva, 2008).

The reliability analysis of the construct preceding the factor analysis is used to verify data consistency. The most widely used model is the Cronbach's alpha, based on the mean correlation among the items. Its measurement varies between 0 and 1, with the range between 0.6 and 0.7 considered the lower limit of acceptability (Hair Junior, et al., 2009).

4 Results and Discussion

The set of 20 items was tested according to the aforementioned criteria. The first value to be observed was the Cronbach's alpha, which was equal to 0.82, indicating high reliability.

The Bartlett’s test of sphericity indicated significance equal to 0.000, rejecting the null hypothesis that the variables are uncorrelated. The KMO criterion was equal to 0.78, being very close to the ideal value. Thus, data indicate fit to a principal components factor analysis model.

The variance explained accumulated indicates that the group of variables in 5 factors explains 74% of the model, i.e. the set of variables used to evaluate the SCMI can be reduced to five variables as shown in Table 1.

The factors identified based on factor analysis indicate that the partnership, collaboration, information sharing and coordination are characteristics that partly explain the SCMI. The trust should also be included in this set, though not to appear as an isolated feature, since it consists of a prerequisite for the existence of the other.

This result allows us to move towards a consensus definition of SCMI, once it aggregates information to the existing definitions as presented by (Danese, 2013; Flynn, Huo and Zhao, 2010; Juttner, Christopher and Baker, 2007; Näslund and Hulthen, 2012;Richey Junior, et al., 2009;Thun, 2010), among others.

5 Conclusion

The SCMI is a theme that has been increasingly discussed in academia; however, many issues still need clarification, starting with its definition. Accordingly, this study sought to contribute to filling this gap by identifying some of the features that make the integration.

The use of factor analysis allowed clustering variables that measure SCMI in factors reducing these issues into subsets. Thus, one way to advance the understanding of how to increase the level of integration between supply chain members is to better understand each of these characteristics.

Thus, a detailed study of trust, partnership, collaboration, information sharing and coordination may be the next steps in research related to SCMI.

Table 1 Grouping of variables per factor

Factor	Variable	load
Factor 1 Partnership	Does this supplier meet the deadlines combined?	0.7621
	Does the amount received match what was requested?	0.7577
	Is there a standard procedure to replace damaged goods on delivery?	0.5982
	If your demand increases, is it able to meet you?	0.4661
	Do you have information on the suppliercosts?	0.8789
	Does this supplier have information on your costs?	0.6281
	Does have access to production information of the order?	0.6717
	Do you give preference to this supplier because of price?	0.5793
	Do you give preference to this supplier because of the quality?	0.7336
	Is this supplier tolerant to a delay of payment?	0.7531
	Would you share costs with this supplier to keep the partnership?	0.6551
Factor 2 Collaboration	Do good personal relationships help maintain this relationship?	0.7764
	Does he inform you if there is delay in sending the request?	0.8060
	Has he already included or would include a new product to meet your demand?	0.6987
	Does this relationship promote you some benefit that would not be achieved individually?	0.7026
	Does he guarantee a lower price?	0.8911
	Does he inform you in advance of a price increase?	0.7861
Factor 3 Information sharing	Do you use some formal system to share information? What?	0.5853
	Do you exchange information with him seeking to improve the product or process?	0.6232
Factor 5 Coordination	Is there a standard procedure to exchange the product in warranty?	0.7103

6 References

BAKKE, H. A., LEITE, A. S. M. & SILVA, L. B. (2008) Estatística multivariada: aplicação da análise fatorial na engenharia de produção. *Revista Gestão Industrial*, 4(4), pp.1-14.

BASNET, C. (2013) The measurement of internal supply chain integration. *Management Research Review*, 36(2), pp.153-172.

CAI, S. H., JUN, M. & YANG, Z. L. (2010) Implementing supply chain information integration in China: The role of institutional forces and trust. *Journal of Operations Management*, 28(3) May, pp.257-268.

CHEN, H., DAUGHERTY, P. J. & LANDRY, T. D. (2009) Supply chain process integration: a theoretical framework. *Journal of Business Logistics*, 30(2) 2009, pp.27-+.

CHEN, S.-P. & WU, W.-Y. (2010) A systematic procedure to evaluate an automobile manufacturer-distributor partnership. *European Journal of Operational Research*, 205(3) Sep 16, pp.687-698.

CHILDERHOUSE, P., et al. (2011) Supply chain integration: an international comparison of maturity. *Asia Pacific Journal of Marketing and Logistics*, 23(4), pp.531-552.

CHILDERHOUSE, P. & Towill, R. (2011) Arcs of supply chain integration. *International Journal of Production Research*, 49(24) 2011, pp.7441-7468.

CHOPRA, S. & MEINDL, P. (2003) *Gerenciamento da cadeia de suprimentos*. São Paulo, Prentice Hall.

CHRISTOPHER, M. (2000) The agile supply chain: Competing in volatile markets. *Industrial Marketing Management*, 29(1) Jan, pp.37-44.

CHRISTOPHER, M. & JÜTTNER, U. (2000) Developing strategic partnerships in the supply chain: a practitioner perspective. *European Journal of Purchasing & Supply Management*, 6, pp.117-127.

DANESE, P. (2013) Supplier integration and company performance: A configurational view. *Omega-International Journal of Management Science*, 41(6) Dec, pp.1029-1041.

DING, H. P., GUO, B. C. & LIU, Z. S. (2011) Information sharing and profit allotment based on supply chain cooperation. *International Journal of Production Economics*, 133(1) Sep, pp.70-79.

FAWCETT, S. E., JONES, S. L. & FAWCETT, A. M. (2012) Supply chain trust: The catalyst for collaborative innovation. *Business Horizons*, 55(2) Mar-Apr, pp.163-178.

FAWCETT, S. E., MAGNAN, G. M. & MCCARTER, M. W. (2008) A three-stage implementation model for supply chain collaboration. *Journal of Business Logistics*, 29(1) 2008, pp.93-112.

FLYNN, B. B., HUO, B. & ZHAO, X. (2010) The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management*, 28(1) Jan, pp.58-71.

FROHLICH, M. T. & WESTBROOK, R. (2001) Arcs of integration: an international study of supply chain strategies. *Journal of Operations Management*, 19(2) Feb, pp.185-200.

HA, B.-C., PARK, Y.-K. & CHO, S. (2011) Suppliers' affective trust and trust in competency in buyers Its effect on collaboration and logistics efficiency. *International Journal of Operations & Production Management*, 31(1-2) 2011, pp.56-77.

HAIR JUNIOR, J. F., et al. (2009) *Análise multivariada de dados*. 6 ed. Porto Alegre, Bookman.

HE, Y., et al. (2013) The impact of supplier integration on customer integration and new product performance: The mediating role of manufacturing flexibility under trust theory. *International Journal of Production Economics*,(0).

JONES, S. L., et al. (2010) Benchmarking trust signals in supply chain alliances: moving toward a robust measure of trust. *Benchmarking: An International Journal*, 17(5), pp.705 - 727.

JUTTNER, U., CHRISTOPHER, M. & BAKER, S. (2007) Demand chain management-integrating marketing and supply chain management. *Industrial Marketing Management*, 36(3) Apr, pp.377-392.

KIM, D. & LEE, R. P. (2010) Systems Collaboration and Strategic Collaboration: Their Impacts on Supply Chain Responsiveness and Market Performance. *Decision Sciences*, 41(4) Nov, pp.955-981.

KWON, I. W. G. & SUH, T. (2005) Trust commitment and relationships in supply chain management: a path analysis. *Supply Chain Management-an International Journal*, 10(1) 2005, pp.26-33.

LAEEQUDDIN, M., et al. (2012) Trust building in supply chain partners relationship: an integrated conceptual model. *Journal of Management Development*, 31(6), pp.550-564.

LAMBERT, D. M. & COOPER, M. C. (2000) Issues in supply chain management. *Industrial Marketing Management*, 29(1) Jan, pp.65-83.

LEE, H. L. & WHANG, S. (1998) *Information Sharing in a Supply Chain*. Research Paper No. 1549.Stanford, STANFORD UNIVERSITY.

LI, J. Q., et al. (2006) A strategic analysis of inter organizational information sharing. *Decision Support Systems*, 42(1) Oct, pp.251-266.

MAHESHWARI, B., KUMAR, V. & KUMAR, U. (2006) Optimizing success in supply chain partnerships. *Journal of Enterprise Information Management*, 19(3), pp.277-291.

MALONI, M. J. & BENTON, W. C. (1997) Supply chain partnerships: Opportunities for operations research. *European Journal of Operational Research*, 101(3) Sep 16, pp.419-429.

MAYER, R. C., DAVIS, J. H. & SCHOORMAN, F. D. (1995) An integrative model of organizational trust. *The Academy of Management Review*, 20(3), pp.709-734.

MINGOTI, S. A. (2005) *Análise de dados através de métodos de estatística multivariada: uma abordagem aplicada*. Belo Horizonte, UFMG.

MOTWANI, J., LARSON, L. & AHUJA, S. (1998) Managing a global supply chain partnership. *Logistics Information Management*, 11(6), pp.349-354.

NÄSLUND, D. & HULTHEN, H. (2012) Supply chain management integration: a critical analysis. *Benchmarking: an International Journal*, 19(4), pp.481-501.

O'BRIEN, G. (1968) The measurement of cooperation. *Organizational Behavior and Human Performance*, 3(4) //, pp.427-439.

PEARCY, D. H. & GIUNIPERO, L. C. (2008) Using e-procurement applications to achieve integration: what role does firm size play? *Supply Chain Management: An International Journal*, 13(1), pp.26-34.

PIRES, S. R. I. (2010) *Gestão da cadeia de suprimentos: conceitos, estratégias, práticas e casos*. 2. ed. ed. São Paulo, Atlas.

RICH, N. & HINES, P. (1997) Supply-chain management and time-based competition: the role of the supplier association. *International Journal of Physical Distribution & Logistics Management*, 27(3/4), pp.210 - 225.

RICHEY JUNIOR, R. G., et al. (2009) The moderating role of barriers on the relationship between drivers to supply chain integration and firm performance. *International Journal of Physical Distribution & Logistics Management*, 39(9-10) 2009, pp.826-840.

ROSENZWEIG, E. D., ROTH, A. V. & DEAN, J. W. (2003) The influence of an integration strategy on competitive capabilities and business performance: An exploratory study of consumer products manufacturers. *Journal of Operations Management*, 21(4) Jul, pp.437-456.

RYU, I., SO, S. & KOO, C. (2009) The role of partnership in supply chain performance. *Industrial Management & Data Systems*, 109(3-4), pp.496-514.

SAHIN, F. & ROBINSON, E. P. (2002) Flow coordination and information sharing in supply chains: Review, implications, and directions for future research. *Decision Sciences*, 33(4) Fal, pp.505-536.

SINGLETON, T. & CORMICAN, K. (2013) The influence of technology on the development of partnership relationships in the Irish construction industry. *International Journal of Computer Integrated Manufacturing*, 26(1) 2013, pp.19-28.

SPEKMAN, R. E., KAMAUFF JUNIOR, J. W. & MYHR, N. (1998) An empirical investigation into supply chain management: A perspective on partnerships. *International Journal of Physical Distribution & Logistics*, 28(8), pp.630-650.

THUN, J.-H. (2010) Angles of integration: an empirical analysis of the alignment of internet-based information technology and global supply chain integration. *Journal of Supply Chain Management*, 46(2) 2010, pp.30-44.

VIEIRA, J. G. V. (2006) *Avaliação do estado de colaboração logística entre indústria de bens de consumo e redes de varejo supermercadista*. São Paulo, Departamento de Engenharia de Produção. Escola Politécnica da Universidade de São Paulo.

151 The relationship among Order Picking, Logistics and Supply Chain Management: a reference model to configure an order picking system

Bozutti D F, Costa M A B

Daniel Fernando Bozutti, Msc. (✉ e-mail: dfbozuti@terra.com.br)
Professor at Universidade de Ribeirão Preto (UNAERP)
Av. Costábile Romano, 2.201 Ribeirania - Ribeirão Preto - Brasil SP
ZIP Code: 14096-900

Miguel Antonio Bueno da Costa, PhD. (✉e-mail: mbcosta@ufscar.br)
Professor at Universidade Federal de São Carlos (UFSCar)
Rodovia Washington Luís, km 235 - SP-310 - São Carlos - São Paulo - Brasil
ZIP Code 13565-905

Abstract: The order picking activity, one of the warehousing activities, is responsible for representative costs in the warehousing. These costs could reach up to 75% of the total warehousing costs (Coyle et al., 1996 apud Petersen and Aase, 2004). The model was developed based on the bibliographic research method, in order to keep the scientific approach of the study. The model was presented in process and activities and it was considered the Logistics and SCM (Supply Chain Management) premises of time, quality and cost. It was also presented a matrix in order to point out the main decisions to be taken in the model, considering four scenarios of SKU's quantity and variety. The main result of this research was the proposal of a method with a managerial approach never studied before.

Keywords: Picking, Logistics, Warehouse Management, Supply Chain Management.

1 Introduction

Order picking is the process of picking the products (Stock Keeping Units – SKUs) from the storage locations in order to fulfill the customer orders (Coyle et al., 1996 apud Petersen and Aase, 2004). Because of its highly cost intensive characteristic, becomes critical to Supply Chain Management and Logistics. Coyle et al (1996) apud Petersen and Aase (2004) estimated that the order picking process has a participation from 50% to 70% of all warehousing costs. Nowadays, this costs can be even higher, specially related to the increasing of the SKUs diversity and the increasing of different SKUs by each customer order (Bozutti and Costa, 2010).

This research had the objective to come up with a reference model to configure an order picking system. This objective is justified by the highly costs participation of this activity in the warehouses and by the absence of reference model with a managerial approach, as proposed by this research. Bozutti (2012) has conducted a research in order to identify the academic production of order picking. The result was an amount of one thousand and ninety-three papers (considering the most relevant papers) related to order picking. From this total amount, forty-six papers explored the order picking modeling, but the goal of such papers was mathematics, operational research and simulation modeling. The managerial approach, as proposed by this paper, was not found.

The methodology used to achieve the results presented was a literature research. Thereby, beginning from conceptual discussions and from papers information, it was developed the proposed model (conceptual model). It had a typical qualitative approach. The main principles of qualitative research are (Bryman, 1989 apud Martins, 2010): (i) subjective interpretation (the vision of the authors is considered during the model development) and (ii) nearness of the studied phenomenon (the core of this paper is order picking and the authors have experienced empirical and academic issues about such subject).

2 The relationship among Picking, Logistics and Supply Chain Management

Companies cannot be considered isolated in the market place (Lummus andVokurka, 1999). The Supply Chain Management (SCM) approach is a competitive model to companies (Pires, 2004) with the aim to link production, market, purchase, sales and distribution in order to satisfy the end customer (Bozutti,Costa and Ruggeri, 2010 andArnold and Chapman, 2004). The competition among brands and companies must be expanded to competition among Supply Chains (Lambert and Cooper, 2000).

Stock e Boyer (2009) mention the increasing of SCM publications took to the absence of a unique definition of SCM. This absence becomes more difficult the executive activities, because the benchmarking of metrics, processes, responsibility and human resources is more difficult to be performed. Such authors performed a literature review with one hundred and seventy-three papers and books about SCM and proposed the following definition:

"The management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that

facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction."(Stock and Boyer, 2009: 706)

This definition is in totally accordance with the purpose of this paper, in other words, Logistics is a part of SCM (Ballou, 2006) and can be considered as one of most visible parts of SCM (Pires, 2004).

Ballou (2010: 24) considers Logistics as Business Logistics. His definition to Business Logistics is:

"*Business Logistics is responsible for the products transportation and storage, in order to make easy the product flow, from the raw material acquisition to the end customer purchasing. It also takes in consideration the information flow that aids the product flow, with the purpose of deliver the right service level in an appropriate cost".*

Bowers ox and Closs (2001) also mention the Business Logistics includes all activities related to the product transportation and the information flow from, to and among all players of the supply chain. They consider the aim of Logistics is make products and services available in the place and time they are desired.

Logistics makes part of SCM and it is necessary to meet customer needs. As presented in the definitions, one of Logistics responsibilities is about the product flow. One of the Logistics' activities, responsible for the product flow, is the Physical Distribution Management.

The aim of the Physical Distribution Management is to manage all activities related to the production transportation (normally end items). Such activities are: (i) transportation, (ii) warehousing, (iii) stock control, (iv) handling, (v) order management, (vi) warehouse location definition and (vii) administrative issues (APICS, 2005).

As pointed, Warehousing Management is a responsibility of the Physical Distribution Management and order picking, being one of the activities performed and managed in warehouses, has a fundamental hole to meet the customer needs. It is responsible to pick the items in the storage locations and make combinations as established in the customer orders. Once customer orders have a high product variety, the order picking activity becomes more complex and more important in warehousing.

The order picking activity makes part and can be considered a Logistics process (Bozutti and Costa, 2010) and Logistics can be considered a SCM subsystem. Thus, any negative impact on order picking will have a negative impact on Logistics and a negative impact on SCM. In the same way, positive impact on order picking will result in positives impacts on Logistics and SCM. Positive or negative impacts on SCM and / or Logistics will solely affect the order picking if such impacts have direct relationship with the order picking itself.

3 Order Picking

Halsey (1998) mentions the Logistics professionals consider the order picking activity as one of the more important in the Physical Distribution. He complements his mention considering order picking as the responsible of the products link between vendors and customers.

The environmental complexity, which reflects in the order picking management and performance, can be described by (Manzini et al, 2007): (i) global changes and expanded markets; (ii) management of different products and such products with a lower life cycle; (iii) lower products quantity by each customer order; (iv) owner delivery lead times and (v) e-commerce growing.

Koster, Le-Duc and Roodbergen (2007) provides additional insights: (i) lower quantities in the production batches; (ii) direct delivery to the utilization site (to consumer in some cases); (iii) products customization; (iv) fulfillment of urgent customer orders; (v) small warehouses being supplied by distribution centers, increasing the order picking activity frequency in such distribution centers and (vi) postponement strategy as a way to have more responsiveness and agility to meet customer needs (Van Hoek, 2001 apud Koster;, Le-Duc and Roodbergen, 2007).

The trending of order picking complexity increasing as showed are in accordance with the Logistics and SCM complexities increasing. Such trending was predicable, as order picking makes part of Logistics and Logistics makes part of SCM, the trending of SCM influences Logistics and Logistics influences order picking.

Many definitions cab be found in the literature, but they can be summarized as follow:

Picking is an activity that makes part of Logistics (and Logistics make part of SCM) that is responsible to establish visiting rules in specifics storage locations located in a pre-defined warehouse layout in order fulfill the customer order, considering a service level that meet with customer expectation and the company profitability.

Bozutti and Costa (2010) mention five main activities that can be found in the warehouses. Such activities can be divided in three blocks: pre-picking (receive of products and warehousing), picking and post-picking (sorting & packing and shipping).There are three main flows: (i) product flow, (ii) information flow and (iii) return flow.

4 Reference model to configure an order picking system

A managerial order picking reference model must have and must present the link with macro approaches, that is, Logistics approach and SCM approach. The relationship among these three levels has a bi-univocal nature. So, each level receives inputs and provides outputs to the other levels. Such dynamic among these managerial levels must be considered in the decisions that can be taken using the model proposed.

To configure the order picking, it was considered three main macro processes: (i) to provide visibility of the company's supply chain; (ii) to define processes and activities in the warehouses and (iii) to configure the order picking system. The Figure 1 presents the details of the model

This research also provides insights about the model considering scenarios of quantity and variety of SKUs. Depending on the quantity and variety allocated to an order picking system, different decisions must be taken in order to get the best results of the proposed model. There are four main scenarios: (i) high quantity and low variety, (ii) high quantity and high variety, (iii) low quantity and high variety and (iv) low quantity and low variety.

For each scenario is necessary to assess the following issues of the order picking: (i) managerial issues (information systems and metrics), (ii) operational issues (picking policy, routing and zoning) and structural issues (product handling systems, storage systems, layout and automation).

For high quantity and low variety: (i) Information systems: integrated with ERP system andmust provide visibility of the products locations in the warehouse; (ii) Metrics: must consider visibility and punctuality; (iii) Picking policies: must consider visibility and punctuality, recommended to use zoning, batching and / or wave picking approaches;(iv) Routing: must allow agile scheduling (v) Zoning: applicable; (vi) Optimization / Heuristics: applicable; (vii) Product handling systems: motorized, because of the high quantity of products; (viii) Storage systems: integrated with the handling systems in order to obtain agility in the picking activity; (xix) Layout: must allow reductions in the cycle time; and (x) Automation: applicable.

For high quantity and high variety: (i) Information systems: integrated with ERP system and must have available advanced planning tools (in order to use optimization techniques or heuristics); (ii) Metrics: must consider visibility, punctuality and flexibility; (iii) Picking policies: must consider visibility, punctuality and flexibility; (iv) Routing: must allow punctuality and flexibility when scheduling; (v) Zoning: applicable and shall use the golden zone approach; (vi) Optimization / Heuristics: necessary; (vii) Product handling systems: motorized and automated; (viii) Storage systems: integrated with the handling systems and, depending on need, automated; (xix) Layout: must consider punctuality and flexibility; and (x) Automation: necessary.

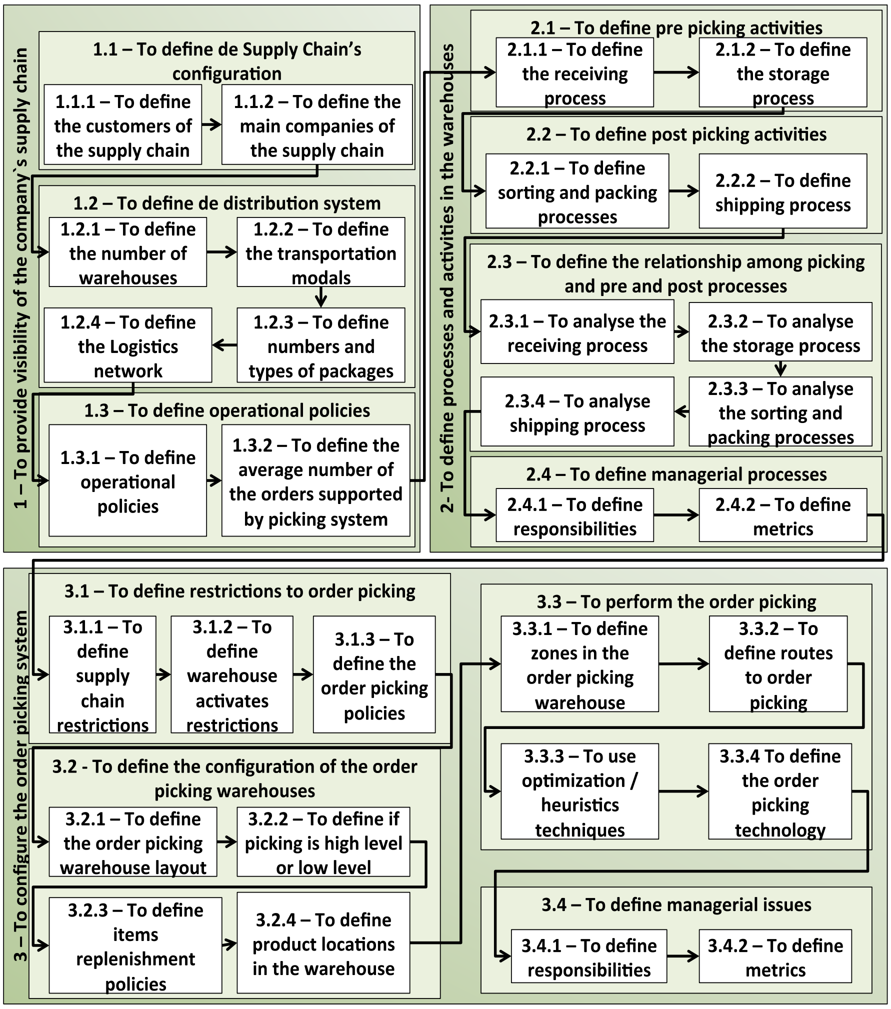


Fig. 1 The order picking reference model

For low quantity and high variety: (i) Information systems: integrated with the ERP system, must allow to work with a high variety of items; (ii) Metrics: must consider visibility and flexibility of the picking system; (iii) Picking policies: must consider flexibility – it is necessary to asses the need of zoning or batching utilization; (iv) Routing: must allow a flexible scheduling;(v) Zoning: applicable, after a need assessment; (vi) Optimization / Heuristics: applicable; (vii) Product handling systems: to asses the motorization need, but they must allow the work with different types of SKUs; (viii) Storage systems: must allow a high SKUs selectivity;
(xix) Layout: must consider flexibility; and (x) Automation: applicable.

For low quantity and low variety: (i) Information systems: it is not necessary the integration with the ERP system; (ii) Metrics: must understand the punctuality, agility and flexibility needs, showing the picking trending; (iii) Picking policies: simple procedures, but must achieve the warehouse requirements – batching is not necessary; (iv) Routing: it not necessary mathematical modeling, must be intuitive and must comply with the punctuality, agility and flexibility needs; (v) Zoning: not applicable; (vi) Optimization / Heuristics: not applicable; (vii) Product handling systems: manuals, not motorized; (viii) Storage systems: simple, without automation; (xix) Layout: must comply with the operational needs; and (x) Automation: not applicable.

5 Final Considerations

This study showed the relationship among order picking, Logistics and SCM and provides a reference model to configure an order picking system. The proposed model was divided in macro processes, processes and activities. The first step is to identify the supply chain e its physical distribution system. The second step is to define the warehouse activities. In the third step, all premises necessary to configure the order picking system are listed, always considering the approaches of the Logistics and SCM.

The main results of this study were: (i) presenting a managerial reference model to order picking systems, such approach has not been explored before; (ii) the premises of Logistics and SCM were considered to develop the model, in order to avoid conflicts among them; (iii) four scenarios of application were presented in order to obtain the better results of the model application; and (iv) the model developed considered the literature review contents, in order to guarantee the scientific research needs.

For future research can be conducted a practical basis in order to support and analyze the proposed model with further detail.

5 References

APICS, Versão digital do 11º dicionário, 2005.

Arnold, J.R.T. and Chapman, S.N. (2004) *Introduction to Materials Management*, 5thEdition, New Jersey: Pearson.

Ballou, R. H. (2006) 'The evolution and future of logistics and supply chain management', *Revista Produção*, vol. 16, n. 3.

Ballou, R. H. (2010) *Logística Empresarial: Transporte, Administração de Materiais e Distribuição Física*. Translating: Yoshizaki, H. T. Y., São Paulo: Atlas.

Bozutti, D. F. (2012) *Proposta de um modelo de referência para a configuração de um sistema de picking*. Dissertação de Mestrado do Programa de Pós Graduação em Engenharia de Produção, Universidade Federal de São Carlos.

Bozutti, D. F. and Costa, M. A. B. (2010) 'Visão Geral sobre o Picking',*XVII Simpósio de Engenharia de Produção (SIMPEP)*.

Bozutti, D. F., Costa, M. A. B. and Ruggeri, R. (2010)*Logística: Visão Global e Picking, Série Apontamentos*, São Carlos: EDUFSCAR.

Bowersox, D. J. and Closs, D. J. (2001)*Logística Empresarial: o processo de integração da cadeia de suprimento*. Translating: Equipe do Centro de Estudos em Logística, Neves, A. F., Fleury, P. F., Lavalle, C., São Paulo: Atlas.

Halsey, M. (1998) *Order Picking Systems*. . In: Tompkins, J. A., Smith, J. D., (org.), The Warehouse Management Handbook, 2nd Edition, United States of America: Edwards Brothers.

Koster, R., Le-Duc, T., Roodbergen, K.J. (2007) 'Design and control of warehouse order picking: a literature review',*European Journal of Operational Research*, vol. 182(2), pp. 481-501.

Lambert, D. M., Cooper, M. C. (2000)'Issues in Supply Chain Management', *Industrial Marketing Management*, vol. 29, pp. 65-83.

Lummus, R. R., Vokurka, R. J. (1999) 'Defining supply chain management: a historical perspective andpractical guidelines',*Industrial Management & Data Systems*, vol. 99(1), pp. 11-17.

Manzini, R., Gamberi, M., Persona, A. andRegattieri, A. (2007) 'Design of a class based storage picker to product order picking system'. *International Journal of Advanced Manufacturing Technology*, vol. 32, pp. 811-821.

Martins, R. A. *Abordagens Quantitativas e Qualitativas* (2010). In: Miguel, P.A.C. (org.), Metodologia de Pesquisa em Engenharia de Produção e Gestão de Operações, Rio de Janeiro: Elsevier.

Nakano, D. (2010) *Métodos de Pesquisa Adotados na Engenharia de Produção e Gestão de Operaçõe*s. In: Miguel, P.A.C. (org.), Metodologia de Pesquisa em Engenharia de Produção e Gestão de Operações, Rio de Janeiro: Elsevier.

Petersen, C. G., Aase G. (2004) 'A comparison of picking, storage, and routing policies in manual order picking', *International Journal Production Economics*, vol. 92, pp. 11-19.

Pires, S. R. I. (2004) *Gestão da Cadeia de Suprimentos: Conceitos, Estratégias, Práticas e Casos*, São Paulo: Editora Atlas.

Stock, J. R., Boyer, S. L. (2009) Developing a consensus definition of supply chain management: a qualitative study, *International Journal of Physical Distribution & Logistics Management*, vol. 39 (8), pp. 690-711.

162 A study on challenges and opportunities for energy business developments in the Smart City

Rodríguez-Molina J, Martínez-Núñez M, Pérez Aguiar W, de Diego R

Jesús Rodríguez-Molina (✉ e-mail: jesus.rodriguezm@upm.es)
Research Center on Software Technologies and Multimedia Systems for Sustainability (CITSEM) UPM, Valencia Road, Km 7, 28031 Madrid, Spain

Margarita Martínez-Núñez (✉ e-mail:mmartinez@euitt.upm.es)
Teaching unit of OrganizationalEngineering, Business Management and Statistics, UPM, Ctra Valencia, Km 7, 28031 Madrid, Spain

Waldo Pérez-Aguiar (✉ e-mail: waldo.perez@upm.es)
Teaching unit of OrganizationalEngineering, Business Management and Statistics, UPM, Ctra Valencia, Km 7, 28031 Madrid, Spain

Rubén de Diego (✉ e-mail: ruben.de.diego@upm.es)
Research Center on Software Technologies and Multimedia Systems for Sustainability (CITSEM) UPM, Valencia Road, Km 7, 28031 Madrid, Spain

Abstract: The services and applications that the Smart City offers are varied and remarkable: pollution control, energy consumption optimization, etc. These technological breakthroughs are likely to become widespread in the short term and improve the lifestyle of city inhabitants. However, the progress in business actors, from small and medium sized enterprises to established companies, does not seem to keep up with this evolution. There is a vacuum in the exploitation and service availability, along with a significant degree of immaturity on how a business regarding Information and Communication Technologies should use the opportunities that the Smart City offers. This paper studies energy businesses within the Smart City, and puts forward a proposal on how a business model can be made, offering value creation at the end where the user has turned into a "prosumer".

Keywords: Smart City, business model, energy, prosumer.

1 Introduction

Urban inhabitants surpassed rural ones for the first time in 2010, and they are predicted to become dominant during the next years, with 6 out of 10 people living in urban areas by 2030 and 7 out of 10 by 2050 (World Health

Organization, 2014). Thus, it becomes mandatory to conceive a strategy to maximize usage efficiency of natural resources, along with incorporating new ways of energy production. Among the many different initiatives that are under development, the Smart City is easily one of the most compelling. By augmenting conventional infrastructures with monitoring, sensing and actuating devices, it becomes a service provider by its own right, both for public and private entities. Therefore, it should come as no surprise that it has been defined as "*[...] quintessentially enabled by the use of technologies (especially ICT) to Improve competitiveness and ensure a more sustainable future by symbiotic linkage of networks of people, businesses, technologies, infrastructures, consumption, energy and spaces*" (European Directorate General for Internal Policies, 2014) or is claimed that "*a city may be called 'Smart' 'when investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance*" (Schaffers et al, 2011).

One of its most interesting facets is the possibility of adding hardware devices and software developments that manage energy production, distribution and consumption by means of Information and Communication Technologies, thus effectively reducing energy consumption and extending the durability of both the available power and resources, and permitting its usage in an environmentally friendlier manner. This feature, often referred to as the Smart Grid (described as "*the use of sensors, communications, computational ability and control in some form to enhance the overall functionality of the electric power delivery system*" Clark W. Gellings, 2009), also changes deeply the nature of the end user of the system: instead of having a regular consumer, they are able to harvest their own energy by using Distributed Energy Resources (DERs) and pour it onto the main power network, turning into an electricity producer/consumer (or rather, a "prosumer"). This shift towards a more context-aware energy usage offers a new scenario where new business models, focused on energy balance and dynamic resource availability, are prone to end up conforming new companies with an interest in renewable energies and responsible resource consumption. Offering some guidance for the development of these activities is the main objective of this paper. It is organized as follows: a study on outstanding Smart City initiatives and business models has been placed in section 2, while section 3 describes thoroughly the concept of prosumers and puts forward an example of a business models for them. From the knowledge that becomes inferred, conclusions are raised in Section 4. Finally, bibliographic references end up this paper.

2 Related Works

The amount of research projects, developments and proposals involving the Smart City has skyrocketed during the last few years. A report done by prominent research institutions (Smart cities – Ranking of European medium-sized cities, 2007) claimed that around seventy European cities can be defined as "Smart", because they implement to a significant extent several features that are considered as mandatory to regard a city as such. According to that report, the defined key characteristics are: *smart economy* (addition of Information and Communication Technologies that enhance the productivity of business, along with business association and new products and services conception), *smart people* (implies both qualification and e-skills for activities and jobs typical of a Smart City -renewable energies, pollution treatment, etc.-, as well as education and training availability for human beings), *smart governance* (civil, private, public and European Community organisms are linked together in order to guarantee efficient governance), *smart mobility* (systems dealing with mobility, logistics and transports must become safe, interconnected and sustainable enough to be integrated within the Smart City, as they will be responsible for the transportation of people and goods in an inexpensive, energy-efficient manner), *smart environment*(renewable energies exploitation as a way of turning urban planning into an environmental-friendlier area, extensive monitoring and evaluation of water resources, etc.) and *smart living*(ICT usage allows a more comfortable living, focused on quality housing, cultural facilities or a high level of health and safety).

There are multiple examples of European cities that can be defined as smart, or at least partially smart. To begin with, Amsterdam is pointed out as creating one of the most notorious implementations of the concept of the Smart City, named as *Amsterdam Smart City* platform or ASC (European Directorate General for Internal Policies, 2014).It could be described as a partnership involving research institutions, city authorities and businesses, as well as including the citizens from Amsterdam as active actors of Smart City initiatives, thus providing ground for the concept of end users taking action, and by proxy, transforming themselves into prosumers. It was reported that the platform was responsible for decreasing a 0.5 % the overall amount of carbon dioxide emissions. As modest as it may look like, it must be considered that the solutions were deployed to a small scale when compared to the whole city. Helsinki, too, is regarded as a city taking decisive steps to become smart(European Directorate General for Internal Policies, 2014), with diverse service implementations (mobile applications, digital services, open data services).The organization behind most of the initiatives related to the Smart City is Forum Virium, a non-profit, private entity that encourages partnership collaboration between the public and private sectors. Among the different projects for the Smart City there is an open data platform named Helsinki Region Info share, capable of regional information that can be used by adverse public, ranging from government institutes to businesses. Consequently, regular citizens are granted access to information that enables them to design their own applications, stimulating the growth of decentralized ICT activities using the Smart City as a framework.

Another remarkable example of how a Smart City is built can be found in the Spanish city of Malaga (Malaga Valley, 2014). In this case, there is a holistic approach that covers all the different challenges that a city must deal with in its daily routine: private and public transport (augmented reality to locate nearby bus stops, free Wi-Fi in the bus fleet, traffic management for troublesome access points), lighting infrastructure (LED-based rather than conventional light bulb-based components, dynamic light flow), water management (usage of Advanced Metering Infrastructure, real-time water control), renewable energy generation (wind micro turbine street lights) and even a digital wallet system (*Momo Pocket*) are currently under use. The ultimate goal of all these developments is their integration into a network made by smart services that will contribute to the sustainability of the city. As for the potential business activities, a classification has been put forward according to two different parameters: the degree of innovation in the technologies that are used and the size of the involved parties, as shown in Figure 1, where several businesses activities are displayed as examples. This paper focuses on the presume opportunities, as they are most likely to include a significant number of population with not particularly deep ICT knowledge that have the potential to become the cornerstone in the popularization of energy services encased within the Smart City.

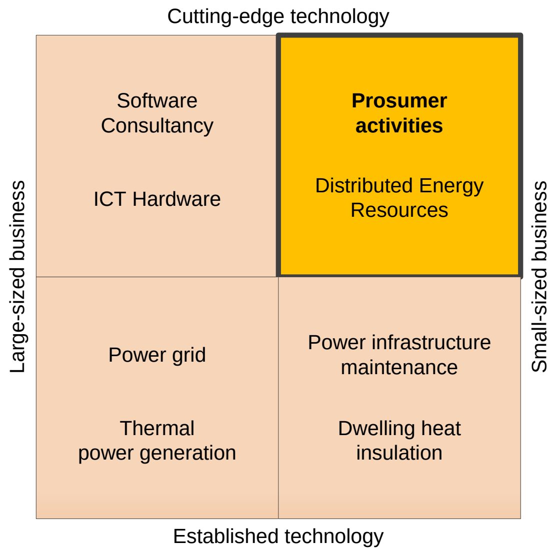


Fig. 1 Smart City businesses classification with examples.

There have been several attempts to create business that attract Research and Development initiatives and turn them into activities able not only to improve the overall quality of life within the Smart City, but also generate an economic activity. Some authors (Catherine E. A. Mulligan and Magnus Olsson, 2013) suggest that there is a somewhat ongoing controversy between two schools of thought -telecommunications and ICT- that impose their particular vision onto what a Smart City should be. The authors claim that many of the Smart City approaches are just mimicking earlier solutions that do not match the needs of this new environment, and propose a business model where the end user becomes the very center of all features and actions, such as privacy or data transfer. Although the authors bring light to an actor of critical importance, they usually regard the end user as a passive service consumer rather than as someone capable of generating a business by his/her own.

On the other hand, other researchers pour their efforts onto platforms reliant on business models for Smart Cities (Nils Walravens and Pieter Ballon, 2013) by starting from an established business model framework and inferring an additional set of parameters, shifting the scenario towards the Smart City in the end. It is stressed the high importance of the entity controlling the network and the system design, an aspect at the same level of considering if the system itself produces a significant value. Unlike the previous piece of work, the authors place city government at the center of their business model; as suitable as it may be, it drastically reduces the possibilities of end user intervention, let alone giving them the chance to offer something to the Smart City to trade with.

3 Prosumer as a concept and a proposal for a business model

As it has been previously mentioned, the Smart City is symbiotically linked to end users, as they use the services that the Smart City provides them with and, if given the chance, will enrich it by deploying their own facilities and self-made services. One of the clearest examples of this idea is the energy-related activities that take place in the Smart Grid, which can be regarded as the system of systems that enhances electricity management, as it has been highlighted before. Here, the role of a city inhabitant shifts from a regular consumer to an actor capable of providing their own power, as well as using the one that is offered to them as if they were any other power plant, albeit to a much smaller scale, thus becoming a “producer” and “consumer”at the same time, hence the term “prosumer”. This role change is depicted in Figure 2.

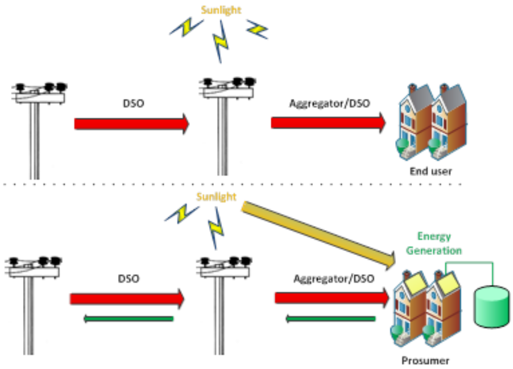


Fig. 2 Prosumer role change for energy generation and transfer.

Prosumers relate to other entities of the Smart City that play critical roles in energy distribution as the Distributed System Operator or DSO –responsible for distributing the higher voltage electricity to different local aggregators- and the Aggregator or Retailer–in charge of selling low voltage electricity that is transported to dwellings, facilities or stores-.Plus, there are other Smart City features where prosumers take part, like technology -a service or an application will be more or less likely to be tackled by a prosumer depending on the available technological solutions-,data information management -as information about energy usage in the Smart City is profuse, the prosumer may use it either to provide services with it or obtain a bonus- and business models -they will provide the chain value that will govern the information flow among the different parties that are implied in the delivery of the added value-.These interactions are depicted in Figure 3.

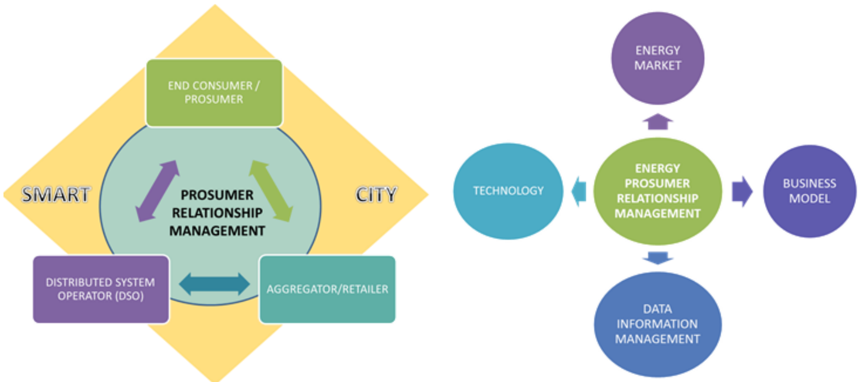


Fig. 3 Prosumer interactions with other actors.

There is a plethora of research projects that have an interest in creating renewed electricity infrastructures that will cope with the foreseeable conditions of the future, demanding an optimization of energy usage and prosumer participation. For example, the e-GOTHAM project aims to create a new aggregated energy demand model to provide the expectable benefits of the addition of renewable energies to the electricity production procedures (e-GOTHAM, 2014). In a scenario like this, an energy business model as the one that is presented in Figure 4becomes appealing: it contains prosumers and citizens as logical key partners, energy management activities (collection, storage and consumption) as the key activities and pre-existing facilities as key resources. What is more, it is expected that this model will offer an innovative value proposition based on trade with locally produced energy, along with relationships (advertisement actions), channels (power infrastructures) and customer segments, as any other business model would have. Finally, cost structure (power and facility maintenance) and revenue streams (fare discount and electricity sale revenues) have also been taken into account. Although it uses a traditional layout, the elements of the model have been conceived as natural components of the Smart City.

This example of prosumer energy production contains the most important characteristics that future prosumer businesses will have: on the one hand, the infrastructure costs and channels require a very limited investment, for almost all of the required equipment is already existing. On the other hand, the availability of more energy producers increases competence among power agents responsible for energy production, opening brand new possibilities for markets and investors.

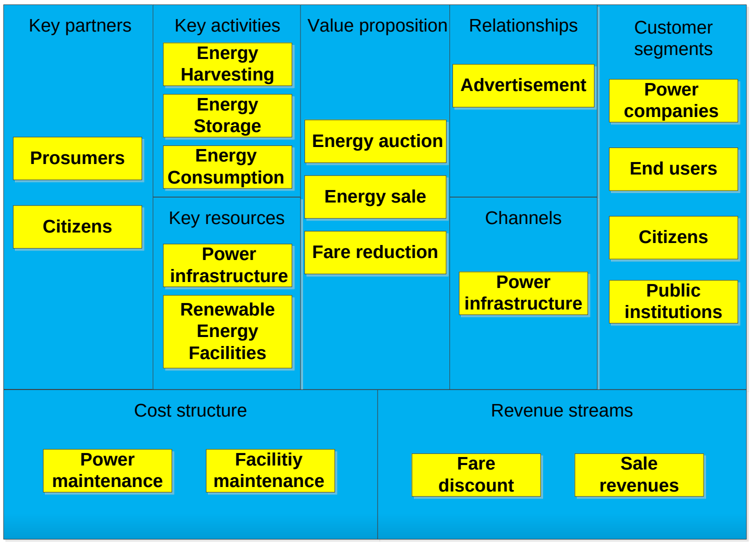


Fig. 4 Business model example for prosumer activities.

4 Conclusions

In this paper, an introduction of the main features of Smart Cities, their main technological aspects, and how they are interweaved when considering businesses models has been offered to settle the topic. Besides, a proposal to classify entrepreneurial activities has been put forward. Several initiatives in this area of expertise, both under a technological and a business perspective, have been described too so as to show how economic activities around the Smart City are lagging behind so far. Additionally, a business model has been suggested that not only has been conceived for the Smart City from scratch, but also expands the role of Smart City inhabitants as far as energy management is concerned, turning them from mere consumers to prosumers, active agents able to dynamically consume electricity from the power grid and generate it from renewable sources of energy.

5 References

Clark. W. Gellings (2009) The Smart Grid: Enabling Energy Efficiency and Demand Response, The Fairmont Press, 2009.

e-GOTHAM, program call ART Call 2011 295378. URL: http://www.artemis-ia.eu/project/index/view?project=39

European Directorate General for Internal Policies (2014). Policy Department A: Economic and Scientific Policy, Mapping Smart Cities in the EU.

Giffinger, Rudolf;Fertner, Christian;Kramar, Hans;Kalasek, Robert; Pichler-Milanović, Nataša; Meijers, Evert (2007) Smart cities – Ranking of European medium-sized cities.

MalagaValley (2014), URL: http://www.malagavalley.com/index.php/es/

Mulligan, Catherine E. A. and Olsson, Magnus (2013) Architectural implications of smart city business models: an evolutionary perspective. IEEE Communications Magazine, vol.51, no.6, pp.80,85, June 2013.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M. and Oliveira, A. (2011)Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation. Future Internet Assembly, LNCS 6656.

Walravens, N.; Ballon, P. (2013) Platform business models for smart cities: from control and value to governance and public value.IEEE Communications Magazine, IEEE , vol.51, no.6, pp.72,79, June 2013

World Health Organization (2014), Global Health Observatory, Urban Population Growth. URL: http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/.

168 Manufacture Optimisation With The Criation Of The Method Quality Execution Systems: Fusion Of The Systems Scada, E.R.P And M.E.S And Use Of Basic Quality Tools

Santos C, Brandão V

Carlos Jefferson de Melo Santos (✉ e-mail:carlos.jeferson@gmail.com)
Departamento de Engenharia Mecânica. Escola Politécnica Federal da Bahia. Universidade Federal da Bahia.RuaAristidesNovis, 02, Federação, Salvador.

Vanessa Brito Brandão (✉e-mail: vbbrandao@bol.com.br)
Departamento de EngenhariaMecânica. Escola Politécnica Federal da Bahia. Universidade Federal da Bahia. RuaAristidesNovis, 02, Federação, Salvador.

Abstract: Most manufacturing companies have systems that are able to assist in the decision taking in the whole strategic scale. The system operation is valid when there's direct action on the problem resolution. Efficient systems that reproduce a manufacturing operation structure productive indicators or integrate different areas of the productive sector that can develop process improvement when analysed in a whole, all together. Quality tools can assist decision taking from the resources generated through this information integration. This paper carries a proposal of creating a new methodology that absorbs the integration information of SCADA, MES and E.R.P systems, transforming the strategic decisions in production optimization through some basic quality tools.

Keywords: Quality tools, M.E.S., SCADA, E.R.P., Optimization.

1 Introduction

In the current market competitiveness, it is highly important that managers, supporters and operation make correct decisions. Often, these decisions have a great impact in a company's result, raising the level of importance in the composition of the data provided for these decisions. Kletti, Jurgen (2007) affirms that classic factories, where products are mainly valued for it components, have given way to modern service centres that face a new challenge of production: continually adapt to market demands. In manufacturing companies, whether discrete or continuous, the information about products in process, produced, or even issued to its costumers are required to obtain a variety of data and indicators. Productivity, rework of products, product variable costs, inventories (measured by the accuracy), compliance to the master production plan, loss in the process and product are some indicators that could be measured from the factory operation to the top managers, which will enable more assertiveness on the findings and definitions of strategies for continues improvement of the process, enhancing its production. The ERP (Enterprise Resource Planning), the M.E.S. (Manufacturing Execution Systems) and the SCADA system (Supervisory Control and Data Acquisition), when used together, will give to the company the perspective of what really happens in the operations and will allow greater alignment between strategic, tactical and operational levels, besides being able to expand these benefits to the entire supply chain (MARDEGAN, AZEVEDO and OLIVEIRA, 2002). However, despite a company have access to plenty of information in a short time due to the application of the lean manufacturing principles; the use of this content becomes irrelevant and unproductive if methods of solving problems are not addressed. Information will be generated for the improvement of processes and important decision-makings, however, without an effective driver for the continuous improvement of production. This article proposes a development for a method of decision-making, based on the fusion of three unidirectional systems (SCADA, MES and ERP) and the Quality Tools, drivers to the continuous improvement of productive systems and foment the efficiency of problems solving.

2 Justification

The available information are frequently constituted by data from diverse precision ratings: some are known for sure, other are estimated carefully and, finally, there are data which the accuracy is not good enough (MOREIRA, 1993). Even if there are loads of accurate and available data, with no guideline or direction of how to treat them, the amount of information would worth only as a database. These databases can be accessed in industries, service companies and consultancies inside programs or systems. Many areas need these data to develop its routines and apply improvements in its processes constantly. Whether it is MCP (Manufacturing Controlling and Planning) sector, by developing production master plan based on the database from the year before, aiming the material, machinery, workforce and supply management (RIBAS, BRAMBILLA, FERNANDES JR., 2010); the Quality sector, by verifying the historical series of a machine in order to proceed a PEC (Processes Statistic Control), with the three main ingredients: statistics techniques, problem solving techniques, leaderships/attitudes for improvement of productivity and quality, quality and systematic methods management (HRADESKY, 1989); the Maintenance sector, with its measures of reliability, that direct the best machine and the machine with the highest number of failures (FLOGLLIATO and RIBEIRO, 2009). There are operational management systems, process control and area integration, such as SCADA, M.E.S and ERP, respectively, that work as information integrator to get to know the problems and make people able to treat them.

The majority of the companies do only gather information and do not utilise the focused on the problems resolution. There is this deficiency in many enterprises, that limit the reasons analysis only with the PDCA cycles, generating actions that usually are premature and fundament less. The fabrication process can be visualised as a group of variation causes. These causes lead the changes in the various characteristics of product quality, what may give rise to defective products (WERKEMA, 1995). The start-up of analysis begins in the operations (Gemba for Kaizen) and need to achieve a dimension of continuous improvement. Elaborating this new method will bring a wider vision of what to treat and how to do it, and, leaving from the 5W2H sphere, of how to improve the process and/or product from accurate and given in real time data.

3 The Quality Tools

The quality of a product could be defined through variables, attributes, or a combination of both (MOREIRA, 1993). From this theory, it comes the requirement that a product or process fits in the requirements determined by the company. To reach these standards, the Quality Tools are used different moments. According to Carpinetti (2010), the Quality Tools are Stratification, Sheet Verification, Pareto Chart, Cause and Effect Diagram, Histogram, Diagram of Dispersion and Control Chart. The Quality Tools are used to collect, synthesize and analyse data (quantitative and qualitative), on the other hand, the basic techniques such as brainstorming, 5 Whys, affinity diagrams, 5S, 3Mu, 5W1H and 6M are used to help the members of the Circle of Quality of Control to think creatively (TOYOTA, 2008).

Quality tools should work as activities where the improvement follows the resolution of problems of products and processes. Also, it should not have only corrective actions from the analysis carried out by working groups, Kaisen, DFMEA (Design Failure Modes and Effects Analysis) or TPM (Total Productive Maintenance). It is hoped that the problems identified with this methodologies do not occur with the preventive actions that will be addressed and implemented. This reality becomes increasingly incipient, due to the inaccurate information, misleading analysis or even operational inefficiency. Without real information, the tools will not follow an objective way for the resolutions of problems and anomalies.

4 Unidirectional Collection And Distribution Of Data

The flow of information has a unique way, in which its distribution depends on the focus that the manufacture exerts on its products. The operations electronic data collection, that happens in the operations sector of a company, can be done through the utilisation of sensors (digital and analogic), which are monitored by software SCADA, and the data transferring is done by a Fieldbus network type by matching the sensors that can be linked to various machines in the operations or to the data collectors (MELLO, CREADO JR., OLIVEIRA, BREMER, 2010). This information is collected to the M.E.S System, that identifies all the data and transform them into management computerization, applicable to an Analyst, for example. From these data, ERA performs a control and an integration between what was generated by M.E.S and what the other manufacture associated areas can directly interfere in its processes and vice versa. This brings to the manufacture manager, for example, a wider view above the processes of each production line, of each sector, of each product. The “whole” is seen to important decision-makings. If this integration is not correctly performed (even with accurate data), the largest objective of a company might suffer retractions: expediting products with high costs, higher lead times and weak process management. It is needed a clear understanding of the tools in order to correct where there are gaps and implement the strategies to improve associated to Quality.

4.1 SCADA System

Silva and Salvador (2005) bring an actual concept of the SCADA System, in which the supervisory systems allow productive process or physical installation information to be monitored and tracked. Such information are collected through data acquiring equipment and, on the following, manipulated, analysed, stored and later, presented to the user. The information originating from various sensors and collectors that aim a higher precision in the capitation of data and insertions of these in the system. SCADA transforms these data in visual information, to instantaneous consults of what is happening in the operations. The collected data can be stored in a database, keeping available to other systems such as M.E.S and ERP (MARDEGAN, MARTINS, OLIVEIRA, 2003). Starting from these concepts, the manufacture has its information start up in SCADA, which characterizes the process in times, operation, quantities, batches number, etc. Such information is critical to the optimisation and customisation of products to be manufactured.

4.2 ERP

According to Cunha (1998), the ERP solution (Enterprise Resource Planning), represents an evolution of the MRP TI (Manufacturing Resource Planning) functionalities, incorporating important requirements of quality, maintenance, logistics, marketing, services and supplies. The MRP TI, on the other hand, means an evolution of MRP (Material Requirements Planning). Even if there is an integration between the areas (main purpose of ERP), the diffusion of these data becomes essential in the manufacture and later decision makings by managers. Freitas (2001) describes that, although ERP systems are excellent instruments in companies' operational activities support, these systems are weakened when its users need to take consolidated or strategic information of. Due to it, the difficult in directing the data and transforming them into decisions or improvements. The integration between the systems could be the first step to this strategic direction and better manufacture performance.

4.3 The M.E.S And Its Aplicability

According to Corrêa (1997), a M.E.S (Manufacturing Execution Systems) system collects and accumulates information of what was realised in the operations sector and feeds them back for the planning system. It has a direct interface with the SCADA system and may, as operational demands arise, possess the interface with the majority of the ERP systems available in the market. Its platform and layout describe the best visualisation of data when compared to the other two systems (SCADA and ERP), not taking off, however, the importance of these in decision making. The historical basis that M.E.S. provides through series graphs, real time mass balances, inputs and outputs of raw material, makes the system enriching in the processor-assisted manufacturing. For that, the sensors and data collectors precision should be in its correct set point, therefore wrong collections generate skewed and undesirable results.

5 Applications Of The Developed Method Quality Manufacturing Systems In A Manufacturing Industry

5.1 The traditional model of Systems integration

The current scheme of the fusion of these systems, and its integrations in the current literature, exists in pyramid shape, in which's base concentrates the SCADA system, with its collectors and process viewers. Followed by the M.E.S.System with its process control information and then by the ERP system, for the visualisation of bulk cargo balance, accounting, manufactures, stocks, etc., as it is shown below:

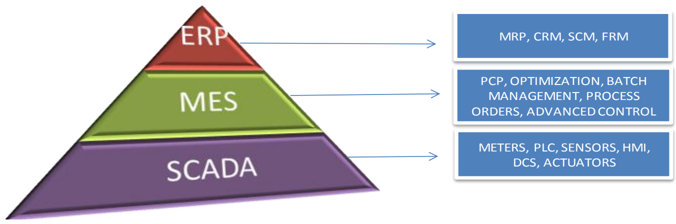


Fig. 1 Current integration of tools in order of process

This model reflects considerable advances, because there is uniformity and direction to where the information generates value. It also proposes which sector should have an information, which data must be integrated on the three systems and what are the main processes in which the top managers and the coordination level should be aware, to control and ensure that its process occur according to the Guidelines Management of the company. However, the provision of data is not enough for an effective decision-making. The manufacturing analysis should not be realized in parallel with the provision of data from the ERP, M.E.S and SCADA systems, but integrated to them, as to generate real data for the decision-making.

5.2. The proposed model: Quality Execution Systems

The efficiency of this process will be given by the application of basic management models Quality Tools, generating then the Quality Execution System method. For being a new decision making data management model, it should be pointed out and described its performance, mapping, layout and main results that can be acquired in applications in manufacture and in other service sectors such as banks. The model should have the format conforming to the pyramid shown down:

Fig. 2 Proposal of new model: Quality Execution Systems (Q.E.S.)

The main tools to be utilised in this new method will be described by Tague (2004), who describes the seven basic tools: Cause and effect diagram, Verification Sheet, Control Graphs, Histogram, Pareto Chat, Dispersion and Stratification Diagram.

5.3 Case Study: Increase of productivity of discrete manufacturing

Current situation: Productivity of 53%. Company's target: 85%
1st Step: Data collection – Done primarily by the SCADA system and directed to the M.E.S. Collected data of inventory and processes levels.
2nd Step: Reading of the data collected through M.E.S – Only bring some of the possible problems of not achieving the target of productivity. Also, combines the inventory management accomplished by the PCP, as a way of not missing row material and finished products.
3rd Step: Descriptions generated by the ERP system – Involves what M.E.S generated in the system and its integration with the others sectors, such as Quality, Loisics, Maintenance. This reading become essential due to the occurrences in Quality breaks corrected by the Maintenance and production driven by Logistics.
4th Step: The use of Quality Tools in obtaining the main causes for not reaching the required productivity. – Following the order of some tools, it is described the ones considered as the most important for this analysis:

- Through the M.E.S, time series were removed, and placed in control charts to verify which days, hours and operators executed the production with detours of raw material, lead time out of the pattern and occurrences in Quality (defective raw material and finished product out of the specification). It was also covered the operational tokens to track possible occurrences that can influence in the productivity indicator.
- After mapping, the Pareto Diagram was used to (80/20) deploy the possible causes in 80% of the occurrences and 20% of effort, which will not be studied.
- The occurrences described in the 80% were analyzed more succinctly with the cause and effect diagram, histogram, and dispersion and stratification diagram.

These analysis shows that the real problems that this productive sector suffered and will be critical information for operational decision making, analytical, coordination and managements.

The productivity results were increasing in the first months, but did not reach the target immediately. The continuing uses of tools, allied to the data generated by the integration of the three systems were the main factors for the solid achievement of this indicator. With the control of the main known causes, the foundation of the numbers did not came in e do not go down.

6 Conclusion

The elaboration of a new method is a consequence of not only the innovation needed and demanded by the market, but to the companies' real needs promoted by its employees, methods that bring results both satisfactory and consolidated. There is no ideal method, or a perfect one; however, there are methods that adapt to different types of production, manufacture, processes, etc. A same method could fit for two different companies, but could not fit for third company. The perspective of how to utilise is a sensible analysis and essential in obtaining improvements. The Quality Execution Systems for big processes in manufacture becomes an adequate process and equivalent in maintaining the results of these processes. Productivity growth, stocks and machinery maintainability are a few possible measurements to be treated by this new method. There is a big study to be realised with more details, to indeed proceed with great projects, which would make viable best results. The process and product customisation and optimisation would be achieved with more earnings and the enlargement of the company's competitiveness in the market.

7 References

MELLO, R., CREADO JR, D., DE OLIVEIRA, J., BREMER, C.: Performance Evaluation for Strategic Management Shop Floor, National Meeting of Postgraduate Administration, Joinville, Brazil, 2000.

FREITAS, Luciano. Metodologia para avaliação e implantação de uma camada de conhecimento baseada em prototipagem em empresas que possuam sistemas de ERP. Master's Dissertation in Graduate in Production Engineering. Federal University of Santa Catarina, 2001.

SILVA, A., SALVADOR, M.: O que são sistemas supervisórios? RT 025.04, 2004.

RIBAS, D., BRAMBILLA, F., FERNANDES JR., F.: Sistema de Programação Avançada da Produção com Capacidade Finita: O Caso da TRAFO Transformadores de Força do RS. Magazine INGEPRO – Inovação, Gestão e Produção, Vol. 02, N° 5, 2010.

MARDEGAN, R., AZEVEDO, R., OLIVEIRA, J.: Os benefícios da coleta automática de dados do chão-de-fábrica para o processo de negócio gestão da demanda. XXII National Meeting ofProductionEngineering, 2002.

CUNHA, Marco. Gestão Integrada De Processos De Negócio.Soluções integradas de sistemas corporativos atendem às necessidades de gestão dos processos de negócio?Dissertation in

Management.FundaçãoGetúlio Vargas School of BusinessAdministration São Paulo,Brazil, 1998.

MARDEGAN, R., MARTINS, V., DE OLIVEIRA. J. Estudo da integração entre sistemas scada, mes e erp em empresas de manufatura discreta que utilizam processos de usinagem. XXIII Meeting of Nat Eng Production, 2003.

KLETI JÜRGEN. Manufacturing Execution System (MES) – Verlarg Berlin Heidelberg: Springer, 2007.

HRADESKY, J. L. Aperfeiçoamento da Qualidade e da Produtividade. Guia prático para implementação do Controle Estatístico de Processo (CEP). São Paulo, Publishinghouse McGraw-Hill Ltda, 1989.

WERKEMA, M. C. C. Ferramentas Estatísticas Básicas para o Gerenciamento de Processos. v. 2. ChristianoOttoni Foundation. School of Engineering da UFMG. Belo Horizonte, MG. 1995.

TOYOTA Group; TQM Committee; QC Circle Subcommittee; QC Circle Leader´s Guidebook for Level Identification – How to get out of Zone D or C, Tokyo: JUSE Press Ltd., 2008.

TANGUE, Nancy R. (2004). "Seven Basic Quality Tools". The Quality Toolbox. Milwaukee, Wisconsin: American Society for Quality. Retrieved, 2010.

FOGLIATTO, F & RIBEIRO, J. Confiabilidade e Manutenção Industrial, Elsevier Editora LTDA , 2011.

MOREIRA, Daniel. Administração da produção e operações. São Paulo, Pioneira: 1993.

171 Studying the Performance of a Reverse Supply Chain with Product Returns using System Dynamics

Blanes V, Mula J, Campuzano-Bolarín F, Andrés B

Josefa Mula (✉e-mail: fmula@cigip.upv.es)
Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). EscuelaPolitécnica Superior de Alcoy, PlazaFerrándiz y Carbonell, 2, 03801 Alcoy, Alicante, Spain

Abstract: The purpose of this work is to analyze the impact of environmental policies on the long-term performance of a single-product supply chain. For this purpose, a system dynamics-based tool is presented that helps improve our understanding of how reverse supply chains with product returns perform. It also permits the analysis of possible problems and their solutions that this supply chain type faces, and provides a basis for future related research work.

Keywords: Supply chain; reverse logistics; product return; simulation; system dynamics.

1 Introduction

In the last few decades, researchers of various disciplines have shown more interest in the structure and performance of reverse supply chains in an ever-increasingly dynamic and changing setting, as well as growing concern about the natural environment. Consequently, the reverse supply chain concept, or “Closed Loop Supply Chain” (CLSC), has emerged, which goes beyond the conventional supply chain whose activity ends when the customer is satisfied with the product received. After considerable research, experts believed that after the customer abandons the used product, it could obtain a residual value, thus involving a new way of obtaining profit and, in short, a new form of business. This implies a change from a view centered on exclusive business that of a conventional supply chain, to one focused on environment-friendly business.

This article intends to determine the performance of CLSCs when faced with the environmental parameters posed by governments, such as laws that oblige them to collect products; awareness campaigns for consumers and the so-called “Green Image” effect which, in the long term, increases the product demand in those supply chains which manage products sustainably. For this purpose, a model based on the system dynamics methodology has been constructed, with which the performance of a CLSC, and the various reactions to changes in the aforementioned parameters, are simulated. Likewise, solutions are proposed to reduce or eliminate existing problems that emerge and are based on the new sustainability concept adopted by reverse supply chains in the product return context.

The rest of the paper has been arranged as follows. Section 2 summarizes the literature review. Section 3 describes the problem to be addressed. Section 4 shows the simulation and evaluation of the results. Finally, Sections 5 provides conclusions and further research.

2 Literature Review

The CLSC notion emerged from current industrial activities or practices to recover the value that used products still have in the market. These products may have been rejected because consumers have finished using them, they have reached their EOL (end of life), have become obsolete, or for technological improvement reasons, etc. These used products can be collected, while their parts, components, subassemblies or materials can be recovered and reprocessed to obtain new products (Fleischmann et al., 1997; Guide et al., 2000; Guide et al, 2003; Thomas &Bijulal, 2011).

The reverse supply chain, or close loop supply chain, includes all the product return processes from the end consumer, and the manufacturer intends to incorporate an additional added value into them by integrating these processes in all the supply chain activities (Guide et al., 2003).

Reverse supply chains include conventional supply chain activities and also additional reverse channel activities. Some of these activities may be: a) acquiring the product from the end consumer; b) reverse logistics to move products from the point-of-use to the point-of-availability; c) inspection, classifying and availability to determine the condition that the product is in, and the most economically appealing way to reuse it; d) reuse, repair, reprocessing, recycling or rejection; and e) re-marketing to create and use new secondary markets for reprocessed goods and to distribute them if necessary (Fleischmann et al., 1997; Guide et al., 2000; Guide et al, 2003; Hanafi et al. 2008).

3 Problem Description

The supply chain simulated in this work takes a closed loop structure; that is, it is a CLSC. The present simulation study is based on a combination of the research works by Srivastava (2008) and Vlachos et al. (2007). From the former research work, the supply chain outline to be simulated is adopted, while the development methodology and structure are taken from the work of Vlachos et al. (2007), along with the data for the simulation. The work of Vlachos et al. (2007) studies the long-term performance of a reverse supply chain with product reprocessing, and it also proposes a series of expansion policies for collection and reprocessing capacities. These expansion policies depend on the influence that the parameters which defend sustainability have, such as: consumers' environmental awareness, and the obligations and penalizations imposed by governments for collecting used products. Nonetheless, the main objective of the present study is to observe the performance of the reverse supply chain and understand the way it operates. Vlachos et al. (2007) developed a reverse supply chain with a single returned flow of used products, which are then reprocessed and form part of the manufacturer's inventory under "as good as new" conditions. The main difference in this reverse supply chain is that, in this case, there are three return flows or sustainable activities, based on Srivastava's outline (2008), to process the used product received from the consumer (Fig. 1).

This research centers on a "single-product" reverse supply chain, which includes the following operations or activities: supply, production, distribution, use, collection (and inspection), reuse, reprocessing, recycling and waste (rejection). Figure1 presents the case under consideration in this study. The "forward" supply chain includes two links, the manufacturer and the distributor. However the reverse channel takes on sustainable activities, reuse activities, reprocessing and recycling. Reuse and reprocessing return the product as an "as good as new" product through the necessary dismantling, adjusting and spare parts operations (Fleischmann et al., 1997). Indeed, the finished products are taken to the distributor and are then sold to cover demand. Product sales are transformed into used products which return to the system as a customer return or as an EOL return, and finally as uncontrolled waste.

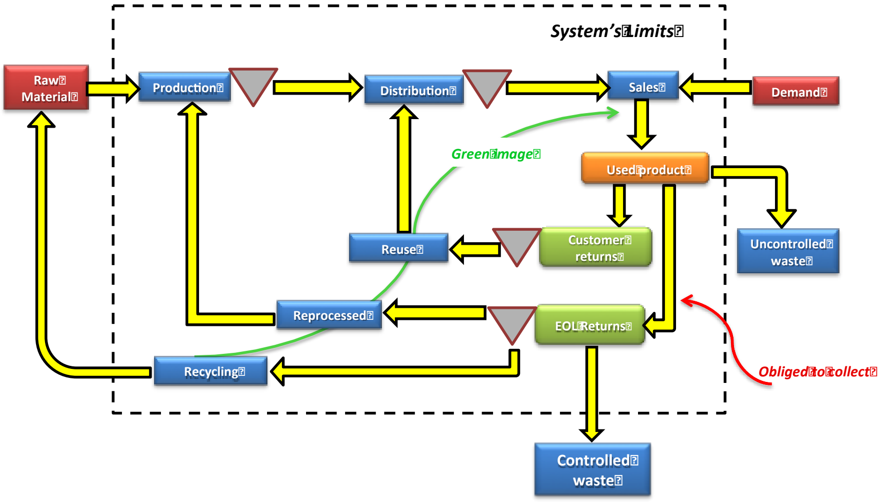


Fig. 1 The reverse supply chain under study.

4 Simulation

4.1 Simulation objectives

This simulation model aims to recreate a basic scenario where the aforementioned reverse supply chain acts, and to examine its performance when faced with possible variations that may occur with time. These variations are due, on the one hand, to the environmental policies imposed by governments, such as the obligation to collect used products and, on the other hand, to the "Green image" effect that brings about alterations in product demand (it increases given consumers' environmental awareness).If we bear this in mind, the adjustment, reprocessing, recycling and production collection capacities must be examined in order to evaluate their possible expansion to, thus, comply with corresponding legislation. Such legislation obliges companies to collect a given percentage, which is set according to their production capacity, in order to examine the possibility of reusing used products and to confer them a new use. Therefore the study objectives are to: a) examine the way the supply chain functions when faced with variations; b) quantify the costs associated with the key processes carried out; and c) quantify the total profit made by the supply chain.

4.2 Causal diagram

Figure 2 shows the causal diagram and interrelations among the variables comprising it. In the supply chain under study, *Total Demand* depends on the market and on the characteristics of this market, while the supply chain's own *Demand* depends on its promotion and its competition, which is given by its *Market Share*. Certain elasticity is assumed in the stationary demands owing to the supply chain's "*Green image*" effect. This "*Green image*" effect on product demand depends on market awareness, and consumers know which manufacturer supports and promotes product collection, recovery and reuse (Vlachos et al., 2007). One quantitative measure considered for the "*Green image*" effect is the *Reuse Ratio*, which is defined by the following equation:

$$ReuseRatio = \frac{Reusableproduct + Reprocessableproduct + Recyclingrate}{Sales} \quad (1)$$

In the Delphi study group, which includes supply chain managers from more than 500 companies belonging to Fortune 500, Hadfield et al. (2002) identified reprocessing/reuse activities as one of the 10 most important ones, and as one of the criteria that is most easily evaluated for the environmental strategy in supply chain management. This ratio directly affects demand.

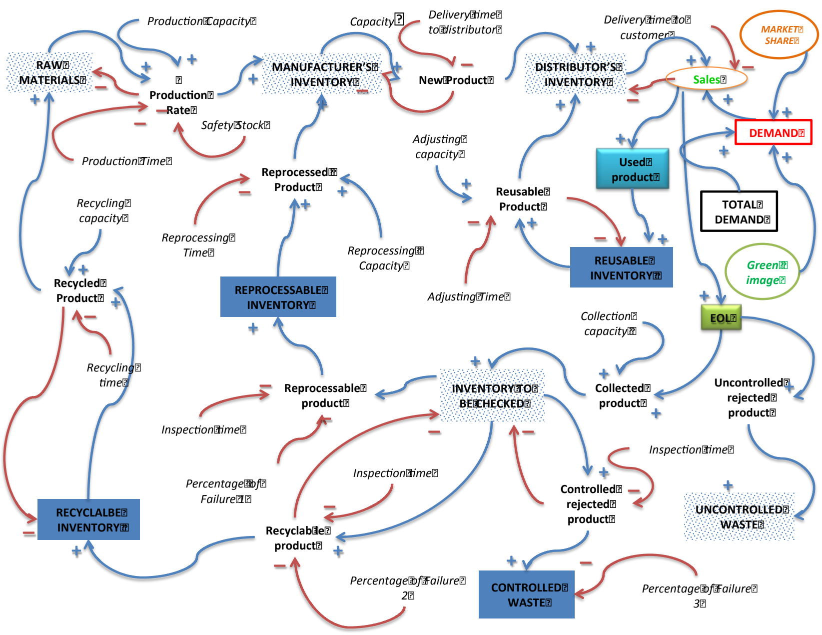


Fig. 2 Causal diagram of the supply chain under study.

4.3 Simulation Set up. Evaluation of the Results

The intention of the simulations done with the created model is to validate its usefulness as a strategic analysis tool.

First of all, a scenario (Scenario 1)was simulated, which has the following characteristics: the time horizon length used for the simulation is 300 weeks; the *Market Share* of the supply chain's *Demand* is the equivalent to 10%;and the adjustment capacity and the reprocessing capacity is set at 145 and 70 items/week, respectively. The *Production Costs* are established as being€100/item. All the storage costs are the equivalent to €0.4 per item and per week, except for the *Inventory and checking cost,* which is the equivalent to€2, the *Collection Cost* is €5/item, the *Adjustment cost* is €10/item, the *Reprocessing Cost* is €50/item and the *Recycling Cost* is €25/item. The *Retail Price* (RP) is €130/item.

After the initial simulation, all the inventory levels remained stable (manufacturer's inventory, distributor's inventory, used products inventories, reusable, reprocess able and EOL products),even after applying the "*Green Image*" effect from period 80,which increased initial demand by +3%. This increase in demand is the result of the good image that the company portrays to the consumer as it recovers used products. Although some stock out periods exist when demand increases, the profit made by the supply chain in this scenario comes to €2,900,000and the *Reuse Ratio is* 75.2%.

In order to study the performance of the supply chain's sales and inventories when faced with changes in the *Market Share,* a new scenario (Scenario 2) was simulated in which the value of this variable increased by 10% if compared with its initial value. This change led to increased demand, which the supply chain under the initial conditions was unable to respond to. So its inventory levels became unstable and this caused many stock out periods, which meant loss of sales. The *Reuse Ratio* lowered to53.2% if compared with Scenario 1. This value could be penalized if the reuse ratio went below the compulsory minimum value.

To correct the problems that arise from this increase in demand, increasing variables *Adjustment capacity and Reprocessing capacity* is advisable. Details of these changes can be found in Table 1.

Table 1 Values of the simulated scenarios.

Scenario 1	Scenario 2	Senario 3
Market_share= 0.1	Market_share = 0.2	Market_ share = 0.2
Adjustment capacity = 80 [items/week]	Adjustment capacity = 80 [items/week]	Adjustment capacity= 145 [items/week]
Reprocessing capacity = 50 [items/week]	Reprocessing capacity= 50 [items/week]	Reprocessing capacity= 70 [items/week]
		Cost of constructing the adjustment capacity = 1500 [€/item]
		Cost of constructing the

	reprocessing capacity = 3500 [€/item]

The results obtained after simulating Scenario 3 reveal stabilized inventories, which avoided the previously mentioned stock outs and, despite increasing the adjustment and reprocessing capacities, which implies a substantial investment for the reverse supply chain, the profit made in Scenario 3 (€5,143,000) exceeded that of Scenario 1. This was mainly due to the income from the product sales as sales loss was considerably cut. The *Reuse Ratio* rose to 75.6% in this last case.

5 Conclusions

This works describes the development of a simulation model based on system dynamics which has allowed the performance of a reverse supply chain with product return to be analyzed and known. For reverse supply chains, consumers' growing environment awareness means constant pressure, which is also favored by the environmental policies and legislation imposed by governments.

The developed model provides a detailed description of the simulated system by means of operations, such as flows and inventories, which take into account certain considerations in capacities, collection obligations and the "*Green image*" effect on product demand. With the methodology presented herein, different scenarios can be analyzed to, for example, simulate different "what if" policies and analyses in long-term horizons for reverse supply chains. The most important comparison variables include profit as a measure of the supply chain's performance in the various scenarios.

Future research lines are proposed: a battery of experiments with real data of supply chains from different sectors; defining a model which considers multiproduct extension; analyzing the performance of a supply chain with different probability distributions to the normal one or, for example, which are associated with empirical demand patterns.

6 Acknowledgment

This research has been funded by the Ministry of Science and Education of Spain project, entitled 'Operations Design and Management in Global Supply Chains (GLOBOP)' (Ref. DPI2012-38061-C02-01).

7 References

Fleischmann, M., Bloemhof-Ruwaard, J. M., Dekker, R., E. van der Laan, J. A. van Nunen, Wassenhove, L. N. V. (1997) "Quantitative models for reverse logistics: A review". European Journal of Operational Research, vol. 103, pp. 1-17.

Guide Jr., V.D.R., Jayaraman, V., Srivastava, R., Benton, W. C. (2000) Supply chain management for recoverable manufacturing system. Interfaces, vol. 30 (3), pp. 125–142.

Guide Jr., V.D.R., Harrison, T. P., Wassenhove, L. N. V. (2003) "The challenge of closed-loop supply chains". Interfaces, vol. 33 (6), pp. 3–6.

Hanafi, J., Kara, S., Kaebernick, H. (2008) "Reverse logistics strategies for end-of-life products".The International Journal of Logistics Management, vol. 19 (3), pp. 367-388.

Handfield R, Walton S, Sroufe R, Melnyk A. (2002) "Applying environmental criteria to supplier assessment: a study in the application of the analytical hierarchy process". European Journal of Operational Research, vol. 141 (1), pp. 70–87.

Kleijnen, J.P.C., (2005) "Supply chain simulation tools and techniques: a survey". International Journal of Simulation and Process Modelling, vol. 1 (1-2) pp. 82-89.

Srivastava, S.K., (2008) "Network design for reverse logistics". Omega. The International Journal of Management Science, vol. 36 (4), pp. 535-48.

Thomas, A. V., Bijulal, D. (2011) "Closed-Loop Supply Chains: the Green Practices in Supply Chains". National Technological Congress, Kerala. College of Engineering Trivandrum, January, pp. 28-29.

Vlachos, D., Georgiadis, P., Iakovou, E. (2007) "A system dynamics model for dynamic capacity planning of remanufacturing in closed-loop supply chains". Computers Operations Research, vol. 34, pp. 367-394.

173 Open Innovation in the Automotive Industry: What can carmakers' annual reports tell us?

Ramírez-Portilla A, Brown T, and Cagno E

Andrés Ramírez Portilla (✉ e-mail: andres.ramirez-portilla@indek.kth.se)
Department of Industrial Economics and Management. School of Industrial Engineering and Management. KTH Royal Institute of Technology. Lindstedtsvägen 30, 10044, Stockholm.

Abstract: Recent research shows the adoption of open and collaborative innovation in the car industry suggesting these practices could be applied in other mature industries. However, researchers have studied the car industry mostly through case studies showing the relevance of innovation practices mainly from their viewpoint and less from the firm's perception. Thus, the purpose of this study is twofold: (1) to confirm the application and the weight that carmakers give to Open Innovation concepts and, (2) to extend the methods and data sources used to study Open Innovation. Based on a conceptual content analysis of the annual reports from 2005 to 2012 from ten large carmakers, this cross-sectional study shows that all the selected firms have included assertions closely related to openness and collaboration in innovation. Concepts related to inbound Open Innovation appear in greater extent than outbound concepts, but there is no clear evidence of the aggregated value of both groups of concepts on firm performance. The results of this research support the idea that in last years open and collaborative innovation in carmakers has genuinely increased in practice and not only on the researchers attention.

Keywords: open innovation; automotive industry; large carmakers; content analysis; annual reports.

1 Introduction

The adoption of Open Innovation (OI) is one of the hottest topics in innovation management. Clear evidence in academic literature shows the number of citations of Chesbrough's seminal book (2003) increasing from 1,800 in July 2010, to 8,000in May 2014. This astounding citation trend could be explained by the wide applicability of the Open Innovation model in different firms and contexts(Schroll and Mild, 2011). In practice, this is also evident with the increase of open and collaborative innovation practices adopted during the last years, not only by high-tech sectors, but also by manufacturing firms(Grundström et al., 2013; Laursen and Salter, 2006)as well as firms in mature industries with expensive innovation development costs(Armellini et al., 2012; Chiaroni et al., 2010, 2011).

Research verifying the external validity of Open Innovation in different contexts has provided evidence to confirm OI as a valuable notion to manage innovation(Huizingh, 2011). In part, this has been possible due to a research agenda on testing OI concepts in industries beyond high-tech sectors(Chesbrough and Crowther, 2006). The automotive industry is one of them because even though the innovation process has been traditionally restricted to the boundaries of the firms, Open Innovation seems to be a latent alternative (Ili et al., 2010).

Nevertheless, despite the valuable research of OI in the automotive industry, most findings have been drawn from case studies, which prevent understanding the real perception that automotive firms have towards Open Innovation practices. This drawback could result in an escalating narrative fallacy and a distortion bias(Taleb, 2010)of the relevant innovation practices for automotive firms. Addressing this problem is noteworthy, as researchers need to be critical on the methods used to study Open Innovation(Schroll and Mild, 2011)to better differentiate between what they want to see and what is really there. Likewise, firms invest resources mainly in innovation practices that perceive as important; therefore, a wider adoption of Open Innovation across the whole industry will be possible only if OI practices are considered as strategic (de Freitas Dewes et al., 2010).

This paper explores Annual Reports (AR) from 10 large carmakers (2005 to 2012) as data sources to study OI practices. As previous research has revealed the validity of AR assertions on innovativeness(Michalisin, 2001), analyzing OI assertions could be an objective way to evaluate the weight that firms in the automotive industry truly assign to OI. Thus, the purpose of this study is twofold: (1) to confirm the importance that carmakers give to Open Innovation concepts and, (2) to extend the research methods used to study these concepts in mature industries.

The paper is organized in the following way. Section 2 provides a brief overview of Open Innovation research in the automotive industry and the constructs used in the analysis. Section 3 explains the methodology and sample selection criteria. Section 4 discusses the results with theoretical and practical implications. Finally, section 5 provides the most relevant take away messages and conclusions.

2 Open Innovation Research in the Automotive Industry

Open Innovation is frequently defined as ‘the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and to expand the markets for external use of innovation, respectively' (Chesbrough et al. 2006, p. 1). The first process has been labeled as inbound OI and the second outbound OI, both modes operational zed by specific practices. The inbound mode consists of the practices to explore and leverage external technologies and discoveries while the outbound mode involves the practice of developing external relationships to commercialized proprietary technologies (Bianchi et al., 2011). The variety of inbound and outbound practices can be broad as OI can encompass several phenomena such as crowd sourcing, community-based innovation, and mass customization (Schroll and Mild, 2011). Thus, a particularity of OI is the possibility to integrate it with other innovation management concepts and practices (Huizingh, 2011).

Automotive OEMs have heavily involved their suppliers in new product development since the 80s. Still, researchers studied these partnerships focusing mainly on how one party achieved imbalanced benefits (Ge and Fujimoto, 2006). Since the term of OI was coined (Chesbrough, 2003), researchers have started to study gradually the car industry under its assumptions. Results are contrasting because while some state R&D inside large carmakers seem to move towards an OI model (Ili et al., 2010), others claim OI is not viable since supplier involvement is still a practice controlled by strict guidelines from OEMs (Dodourova and Bevis, 2012).

Even if OI has not been diffused in the whole car industry, it is undeniable the increasing literature on this topic. Relevant examples includeIli et al.(2010)study in the German car industry or Karlsson and Sköld (2013) study on vertical and horizontal OI in global automotive groups, both remarking the potential of OI to support better R&D productivity. Dodourova and Bevis (2012) exploration on knowledge flows determines that OEMs are most likely to use OI practices than Tier-1 suppliers and SMEs. Lazzarotti et al. (2013) study on different levels in the automotive value chain confirms that OI practices enhance innovation performance. Similarly, Di Minin et al. (2010) study on Italian carmaker Fiat shows the effectiveness of adopting a strong OI strategy to increase overall performance; yet, others shown that only some OI practices influence firm performance (Mazzola et al., 2012). Based on the above, some of the most relevant OI practices used or with potential to be used by OEMs are presented in table 1.

Table 1 Open Innovation practices used or with potential to be used in the automotive industry.

Modes	Ili et al., 2010	Karlsson and Sköld, 2013	Mazzola et al., 2012
In-bound	Development request, reverse engineering, trend and technology scouting, learning journeys, common research laboratory, online portal for ideas, market places, competitions, venture capital	Announcing possibilities, systems for assessing offerings, open to initiatives, partnering and cooperation with firms	Supplier, university and government collaborations, national public funding, in-licensing acquisition
Out-	Reciprocal license agreements,	Continuous scanning of	Out-licensing, divest,

bound	licensing, alliance, joint venture, patent sale, business unit sale, external training, grant-back license, consulting, personnel exchange	small high-techs and start-ups, open up for bids from all potential suppliers, joint and new ventures initiatives	external technology commercialization, co-patent, manufacturing and R&D alliance

3 Research Approach

Annual reports (ARs),considered as grey literature, have been used for years as valid sources of primary data for management and innovation studies(Michalisin, 2001). ARs communicate key information to the firm's shareholders, its market and other stakeholders; consequently, by analyzing ARs content it is possible to study the firms' corporate strategy (Bowman, 1984). In addition, previous studies have shown the value of analyzing ARs to monitor the evolution of managerial ideology in car OEMs (Tinker and Neimark, 1987) or to explore the strategic relevance of R&D activities (Mangematin and Nesta, 1999). Content Analysis Method (CAM) was chosen as it can also be used to investigate cultural patterns, reveal the focus of attention, and describe trends in communication (Weber, 1990). In this study, ARs were preferred over the 'Form 10K' as most sampled firms do not issue this report. The car OEMs were chosen based on the criteria to be included either on the lists of Reuters "Top 100 Global Innovators", Forbes 'Top car makers', high growth potential carmakers from 'BRIC' countries, or in academic literature as firms practicing Open Innovation (see Table 2). Carmakers such as Honda, VW and GM although included in the aforementioned lists, were not used, as some of their ARs were not public. The conceptual CAM included the steps of collecting, coding and statistical processing the ARs to later interpret the results (Weber, 1990), and it was done with the software QDA Miner. To not bias the results, the data were analyzed by the researchers and verified by an external coder.

Table 2 List of automotive OEMs used for this study including their selection criterion.

Name	Country	Region	Criteria	Name	Country	Region	Criteria
Ford	USA	NA	Reuters' list	**Hyundai**	Korea	AS	Forbes' list
Toyota	Japan	AS	Reuters' list	**DFM**	China	AS	OEM - BRIC
Renault	France	EU	Reuters' list	**Tata**	India	AS	OEM - BRIC
Scania	Sweden	EU	Reuters' list	**BMW**	BMW	EU	Academic Lit.
Daimler	Germany	EU	Forbes' list	**Fiat**	Italy	EU	Academic Lit.

4 Results and Discussion

The overall results show that all of the selected OEMs have included assertions of concepts related to Open Innovation in their annual reports with an increasing trend over the last years (Fig. 1). Even though some carmakers exhibited a greater number of assertions than others during specific years (e.g. in 2011 lowest value was 4 and highest was 35), a clear ranking of OEMs adopting Open Innovation practices could not be established. Similarly, albeit a lack of remarkable difference between the averages results if analyzed by regions, a subtle trend was the earlier existence of OI indicators in European OEMs. Another major finding was the clear and greater presence of assertions related to concepts of the Inbound mode over the Outbound mode. Moreover, when comparing the results of these two modes with yearly revenues (Fig. 2) a bigger number of Outbound practices do not seem to have a greater effect on performance.

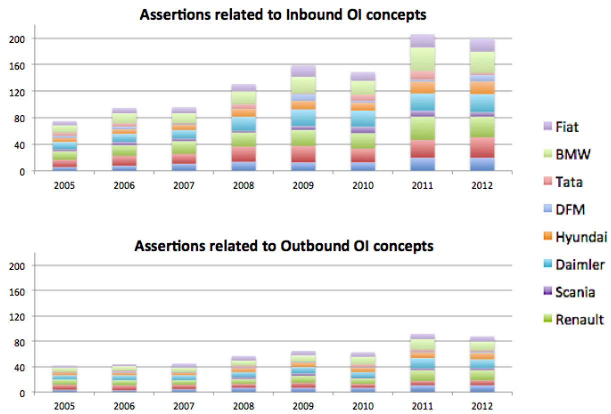


Fig. 1 Assertions of inbound and outbound open innovation practices in annual reports.

A surprising finding to arise from this study was that carmakers such as Fiat or BMW, which have been portrayed in literature and in practice as applying Open Innovation, did not show a higher rate of OIrelated assertions in comparison to other OEMs. On one hand, these firms might not consider OI as a strategic initiative that needs to be stressed in annual reports; but on the other, these firms could have embraced OI practices as part of their regular strategy and thus, they do not communicate it in ARs. We believe in the later as previous studies(Gassmann et al., 2010; Ili et al., 2010; Lazzarotti et al., 2013; Di Minin et al., 2010) have provided positive and specific evidence of these firms adopting OI.Taken together, the results suggest that even though OEMs do not always explicitly communicate it, they have adopted Open Innovation ideas during the last years, even during the automotive industry crisis of 2008-10. In general, these findings enhance our understanding of the relevance that firms in mature industries allocate to Open Innovation (Chiaroni et al., 2010) and suggests that a higher rate of outbound activities does not clearly influence an improvement on measures of firm performance (Mazzola et al., 2012), such as higher revenues in car OEMs.

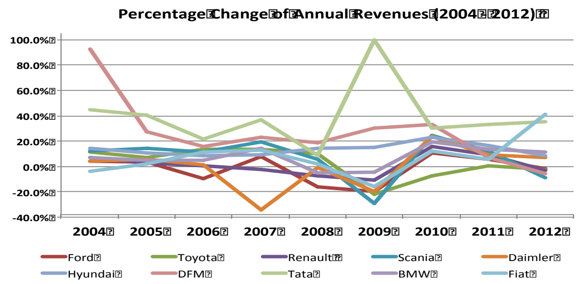


Fig. 2 Percentage change of total annual revenues from the 10 carmakers selected.

Finally, the findings of this study have a number of important implications for practice and policy. The automotive industry has been considered as a barometer of technological development and other indicators of global economy; therefore, this study suggest that it could also be considered as an indicator of the diffusion of the adoption of OI practices in asset-intensive, mature industries(Chiaroni et al., 2010). Concepts related to OI in Annual Reports could be a proxy of the degree of openness of a firm. Even though large carmakers include several concepts related to innovation in their ARs, a suggestion is to communicate explicitly Open Innovation initiatives. These actions can support the development of the firm's strategic innovation communication(Trautmann and Enkel, 2014) that could have a positive impact in shareholders, potential partners and the market. Moreover, results of this study show that Open Innovation could influence in some degree key performance indicators such as OEMs revenues, which in turn increase their overall performance. This may suggest that in order to increase the industrial performance of the automotive industry, firms belonging to and collaborating in this industry should adopt OI. However, a note of caution to OEMs here is appropriate: open and collaborative innovation can take several forms and some of them may affect the industry negatively if not embraced by carmakers on time. Car-sharing communities are an example of open collaborative initiatives that can impact the sales of cars directly and the profitability of OEMs. With this phenomenon in mind, Daimler and BMW have already launched their own car-sharing initiatives, and we foresee other carmakers will join them soon on similar practices.

5 Conclusions and final remarks

The purpose of this paper was to evaluate the increasing relevance of open innovation practices in the automotive industry by examining annual reports from OEMs. We analyzed the annual reports from years 2005 to 2012 of ten large OEMs using a conceptual content analysis method. The current study adds to a growing body of literature on the phenomenon of the adoption of open innovation in mature industries with expensive innovation development costs. Likewise, as previous studies, this paper confirms the increasing potential of studying open innovation in the automotive industry (Ili et al., 2010; Lazzarotti et al., 2013). Some limitations need to be noted. The study was limited to the analysis of text and it disregarded the innovation context of some images as theresearch scope did not covera relational content analysis or a semi-objective textual analysis(Beattie et al., 2004). Nevertheless, we believe using such research approaches would yield analogous results. Similarly, although the current study is based on a small sample of firms, it serves the purpose of being used as a base for future studies that investigate the role and effects of Open Innovation practices in similar industries. Further research that extends the ideas proposed in this paper can focus on studying the isolated and aggregated effects, of inbound and outbound modes in different types of performance measures. For instance, the overall effect on performance could be studied by considering the environmental and industrial dimensions. It would be interesting to explore the relevance of open and collaborative innovation in other types of firms in the automotive industry. Future studies should focus in other actors interacting in the car industry like universities, small suppliers, or smaller carmakers. More broadly, research is needed to determine the validity and utility of open and collaborative innovation in low-tech firms from mature industries and investigate how they can successfully adopt these practices.

6 References

Armellini, F., Kaminski, P.C. and Beaudry, C. (2012), “Integrating open innovation to new product development - the case of the Brazilian aerospace industry”, *International Journal of Technological Learning, Innovation and Development*, Vol. 5 No. 4, pp. 367 – 384.

Beattie, V., McInnes, B. and Fearnley, S. (2004), “A methodology for analysing and evaluating narratives in annual reports: a comprehensive descriptive profile and metrics for disclosure quality attributes”, *Accounting Forum*, Vol. 28 No. 3, pp. 205–236.

Bianchi, M., Cavaliere, A., Chiaroni, D., Frattini, F. and Chiesa, V. (2011), “Organisational modes for Open Innovation in the bio-pharmaceutical industry: An exploratory analysis”, *Technovation*, Elsevier, Vol. 31 No. 1, pp. 22–33.

Bowman, E.H. (1984), “Content Analysis of Annual Reports for Corporate Strategy and Risk”, *Interfaces*, Vol. 14 No. 1, pp. 61–71.

Chesbrough, H. (2003), *Open innovation: The new imperative for creating and profiting from technology*, Harvard Business Press, Boston.

Chesbrough, H. and Crowther, A. (2006), "Beyond high tech: early adopters of open innovation in other industries.", *R&D Management*, Vol. 36 No. 3, pp. 229–236.

Chesbrough, H., Vanhaverbeke, W. and West, J. (2006), *Open Innovation: Researching a New Paradigm*, Oxford University Press, Oxford, p. 372.

Chiaroni, D., Chiesa, V. and Frattini, F. (2010), "Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries", *R&D Management*, Vol. 40 No. 3, pp. 222–245.

Chiaroni, D., Chiesa, V. and Frattini, F. (2011), "The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm", *Technovation*, Elsevier, Vol. 31 No. 1, pp. 34–43.

Dodourova, M. and Bevis, K. (2012), *Comprehensive analysis of Open Innovation practices in the European car industry*, Hertfordshire, UK, pp. 1–14.

De Freitas Dewes, M., Lelis Gonçalez, O., Pássaro, A. and Domingos Padula, A. (2010), "Open innovation as an alternative for strategic development in the aerospace industry in Brazil", *Journal of Aerospace Technology and Management*, Vol. 2 No. 3, pp. 349–360.

Gassmann, O., Zeschky, M., Wolff, T. and Stahl, M. (2010), "Crossing the Industry-Line: Breakthrough Innovation through Cross-Industry Alliances with 'Non-Suppliers'", *Long Range Planning*, Elsevier Ltd, Vol. 43 No. 5-6, pp. 639–654.

Ge, D. and Fujimoto, T. (2006), "Suppliers ' Involvement in New Product Development in the Japanese Auto Industry – A Case Study from a Product Architecture Perspective", *Management of Technology and Innovation in Japan*, Springer, pp. 235–248.

Grundström, C., Sjöström, R. and Rönnbäck, A.Ö. (2013), "Manufacturing SMEs and Open Innovation – findings from Sweden", *The 6th ISPIM Innovation Symposium*, Melbourne, Australia, pp. 1–18.

Huizingh, E. (2011), "Open innovation: State of the art and future perspectives", *Technovation*, Elsevier, Vol. 31 No. 1, pp. 2–9.

Ili, S., Albers, A. and Miller, S. (2010), "Open innovation in the automotive industry", *R&D Management*, Vol. 40 No. 3, pp. 246–255.

Karlsson, C. and Sköld, M. (2013), "Forms of innovation openness in global automotive groups", *International Journal of Automotive Technology and Management*, Vol. 13 No. 1, pp. 1–17.

Laursen, K. and Salter, A. (2006), "Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms", *Strategic management Journal*, Vol. 27 No. 2, pp. 131–150.

Lazzarotti, V., Manzini, R., Pellegrini, L. and Pizzurno, E. (2013), "Open Innovation in the automotive industry: Why and How? Evidence from a multiple case study", *International Journal of Technology Intelligence and Planning*, Vol. 9 No. 1, pp. 37–56.

Mangematin, V. and Nesta, L. (1999), "What kind of knowledge can a firm absorb?", *International Journal of Technology Management*, Vol. 18 No. 3/4, p. 149.

Mazzola, E., Bruccoleri, M. and Perrone, G. (2012), "The effect of inbound, outbound and coupled innovation on performance", *International Journal of Innovation Management*, Vol. 16 No. 6, p. 27.

Michalisin, M.D. (2001), "Validity of annual report assertions about innovativeness: an empirical investigation", *Journal of Business Research*, Vol. 53 No. 3, pp. 151–161.

Di Minin, A., Frattini, F. and Piccaluga, A. (2010), "Fiat: Open Innovation in a Downturn (1993-2003)", *California Management Review*, Vol. 52 No. 3, pp. 132–159.

Schroll, A. and Mild, A. (2011), "Open innovation modes and the role of internal R&D: An empirical study on open innovation adoption in Europe", *European Journal of Innovation Management*, Vol. 14 No. 4, pp. 475–495.

Taleb, N.N. (2010), *The Black Swan: The Impact of the Highly Improbable Fragility*, Random House LLC, p. 400.

Tinker, T. and Neimark, M. (1987), "The role of annual reports in gender and class contradictions at General Motors", *Accounting, Organizations and Society*, Vol. 12 No. I, pp. 71–88.

Trautmann, K. and Enkel, E. (2014), "Success Factors For Strategic Communication Of Corporate Innovativeness For Financial Analysts", *International Journal of Innovation Management*, Imperial College Press, Vol. in press.

Weber, R. (1990), *Basis Content Analysis*, Sage Publications, Thousand Oaks, CA, 2nded., p. 97.

177 E-BPM: La Eficiencia Competitiva en la Educación Superior

E-BPM: Competitive Efficiency in Higher Education

Pardo JE, Mejías AM

Juan E. Pardo (✉e-mail:jpardo@uvigo.es)
Grupo de Investigación OSIG. Departamento de Organización de Empresas y Marketing.
Escuela de Ingeniería Industrial. c/Maxwell s/n, 36310Vigo.

Ana M. Mejías (✉e-mail: mejias@uvigo.es)

Abstract: This paper reflects the main aspects of the project that is being developed in order to analyze and promote the use of BPM technology in the processes related to teaching in a University Center or a Higher Education Institution. Through this technology it is intended to perform a process reengineering management related to computer classrooms used in the deployment of the educational activities of more practical or applied. The objective is to achieve increase their efficiency and improve the perception of those involved, whether they should develop these processes as those that are the recipients of the services offered through hem.

Resumen: En esta ponencia se recogen los principales aspectos del proyecto que se está desarrollando con el objeto de analizar y fomentar el uso de la tecnología BPM en la gestión de los procesos relacionados con la actividad docente a la que tiene que hacer frente un Centro Universitario o Institución de Educación Superior (IES). A través de esta tecnología se pretende realizar una reingeniería del proceso de gestión relacionado con aulas informáticas utilizadas en el despliegue de las actividades formativas de carácter más práctico o aplicado. El objetivo es conseguir incrementar su eficiencia y mejorar la percepción de los agentes implicados, tanto los que deben desarrollar estos procesos como aquellos otros que son los receptores de los servicios que se ofrecen a través de los mismos.

Keywords: BPMS, Competitive efficiency, Process Reengineering, Higher Education Institution.

Palabras clave: BPMS, Eficiencia competitiva, Reingeniería de procesos, IES (Institución de Educación Superior).

1 Introducción

No cabe duda que la realidad que caracteriza a las Instituciones de Educación Superior (IES) de nuestro entorno económico ha cambiado notablemente en las últimas décadas. Durante los años sesenta y setenta de produce en Europa una transición en la que se pasa de sistemas universitarios de minorías a sistemas universitarios de masas. Las políticas gubernamentales se centraron en ese momento, entre otros, en el objetivo de equidad y de igualdad de oportunidades para el acceso a la educación superior. Durante los años setenta, la recesión económica en la que se sumergieron la mayoría de los países desarrollados, junto al incremento del gasto público en las universidades, como consecuencia de la expansión producida, dirigieron un período de austeridad para la educación superior, empezando a extenderse una corriente de opinión generalizada que, cuestionando los resultados de la educación superior, propugnaba la reducción del gasto público en ella. En los años ochenta y noventa las nuevas demandas surgidas de las economías industrializadas avanzadas se han centrado, en buena parte, en aspectos concernientes a la eficiencia, a la calidad y a los servicios públicos relevantes, con énfasis particular en la importancia de la contribución de la Universidad al desarrollo tecnológico y económico. Desde los poderes públicos se comienza a dar mayor autonomía a la Universidad, a través de la desregulación de los sistemas universitarios, a la vez que se les exige la búsqueda de objetivos tales como la eficiencia y la calidad. En la actualidad, la crisis económica y social cuestiona nuevamente el modelo educativo en todos los niveles, demandado un uso más eficiente de los recursos.

Por esta razón, en los últimos años la Educación Superior o Universitaria, principalmente en los centros públicos, está dirigiendo su atención de forma creciente a la evaluación de la eficiencia interna de sus actividades y de sus procesos para intentar obtener una enseñanza de calidad, competitiva y, a la vez, sostenible.

Además de todo lo dicho anteriormente, nos encontramos ante el proceso de creación del “Espacio Europeo de Educación Superior”(Declaración de Bolonia, 1999), que supone un fuerte incremento de la competencia entre instituciones universitarias y la búsqueda de situaciones caracterizadas por la eficiencia y la calidad de los servicios ofrecidos, derivado del entorno competitivo. Paralelamente, estamos ante un escenario de cambio de la legislación universitaria española, que introduce un órgano de evaluación de los resultados universitarios, la Agencia Nacional de Evaluación y Acreditación (ANECA), que ha supuesto que los procesos de evaluación estén de plena actualidad.

2 La eficiencia en el ámbito educativo superior

La eficiencia constituye uno de los objetivos teóricos y de contrastación empírica de los Sectores Públicos modernos. En el caso del Sector Público español, la Constitución de 1978 señala en su art. 31.2 que: "El gasto público realizará una asignación equitativa de los recursos públicos y su programación y ejecución responderán a los criterios de eficiencia y economía".

Dentro de la relación eficiencia y economía en el ámbito de la educación, al hablar de eficiencia nos podemos referir, de forma general, a dos campos distintos:

Eficiencia externa, que trata de maximizar el beneficio que la educación reporta a la sociedad (Effectiveness).

Eficiencia interna, que trata de producir el output al menor coste posible (Efficiency).

A la hora de analizar la eficiencia interna en el sector de la educación, hay que tener en cuenta tanto los ‘inputs’ como los ‘outputs’ para evitar caer en dos planteamientos erróneos que, con frecuencia, suelen estar presentes en muchos foros. El primero es juzgar la eficiencia sólo en relación a los costes o recursos obviando el ‘producto’ obtenido. Evidentemente, la cuestión de qué es más eficiente sólo puede ser respondida si sabemos algo acerca de los resultados. El segundo, común entre los defensores de la educación superior, es juzgar la eficiencia sólo en relación con los resultados. Se supone que la mejora de los resultados es lo deseable al margen de lo que ocurra con los costes o los recursos consumidos. Ambos enfoques fallan al no reconocer que la eficiencia es una relación entre dos variables, costes y resultados. Es evidente que los resultados de la educación, la sanidad,…no pueden medirse de igual manera que en otros sectores, pero tampoco puede obviarse la necesidad de hacer un uso eficiente de los recursos para que el sistema pueda ser sostenible (lo que en términos de la empresa privada se denominaría viable)

Dentro de la eficiencia interna, uno de los inputs lo constituyen los ‘medios educacionales’ entendidos éstos como los recursos utilizados por el docente para facilitar el proceso de aprendizaje del alumno. En nuestros días es habitual hablar de la tecnología educativa, entendiendo ésta como el diseño y desarrollo e implementación de técnicas y materiales basados en los nuevos medios tecnológicos (Tecnologías de la Información y las Comunicaciones – TIC) para promover la eficacia y la eficiencia de la enseñanza y contribuir a resolver los problemas educativos. Es evidente que todos estos medios deben ser gestionados de una manera eficiente para conseguir los resultados buscados de lo contrario nos encontraríamos con una situación en la que el coste de estos recursos no está en relación directa con los resultados del aprendizaje.

Por otra parte, la eficiencia actúa en el ámbito interno de las organizaciones considerando que ahí es donde se puede trabajar para reducir los gastos. Pero qué pasa en un entorno turbulento donde hay que estar al tanto de lo que está pasando "afuera" de la organización, para ajustar las estrategias y acciones de manera que se pueda aprovechar las oportunidades o neutralizar las amenazas que se presenten.

Ello nos lleva a reflexionar y e pensar en una eficiencia competitiva, es decir, en una eficiencia que no solamente haga un uso racional de los recursos sino que además garantice la supervivencia y el éxito de la organización dándole a la sociedad los beneficios que ésta necesita. Es necesario llevar a cabo una re-ingeniería de los procesos y eliminar todo aquello que no aporta valor.

2.1 Consideraciones sobre la eficiencia en el ámbito educativo superior

El creciente interés por la mejora de la gestión de los recursos públicos ante las fuertes presiones financieras sufridas por los gobiernos de todos los países desarrollados como consecuencia de la crisis económica, han promovido un cambio de planteamiento en la gestión de las IES. En este sentido es cada vez más frecuente hablar de la necesidad de una orientación hacia los procesos y de la utilización de herramientas orientadas hacia su gestión como, por ejemplo, los BPMS.

Los sistemas BPM (Business Process Management), también conocidos como 'Sistemas para la Gestión por Procesos' o Workflow, constituyen un enfoque moderno de la tecnología de software empresarial para abordar la automatización y optimización del funcionamiento de las organizaciones de toda índole ante la necesidad de dotarse de una eficacia que permita sobrevivir, prosperar y dar el adecuado servicio en un contexto de intensa competencia y constantes cambios.

La finalidad de un BPM es descomponer la actividad global de una empresa u organización en un conjunto de 'Procesos', entidades de funcionamiento relativamente independiente, aunque conectadas con las demás, que pueden ser analizadas con detalle y cuyas acciones repetitivas puedan ser automatizadas, tanto en lo concerniente a los sistemas como a las personas que intervienen, para optimizar tiempos, oportunidades y costes, sin perder la capacidad de adaptación constante y rápida a los cambios y conservando la coexistencia de métodos seguros con la necesaria flexibilidad para facilitar la intervención activa y fundamental de las personas en los procesos.

En el ámbito de un centro universitario los procesos de negocio son los llamados procesos burocráticos, los trámites públicos y las actividades internas precisas para prestar el servicio a los alumnos, colaboradores, clientes y resto de ciudadanos. Bajo la visión de BPM se debe ver al conjunto de "clientes" como un consumidor de servicios, cada vez más exigente, que considera que el servicio público debe ser ágil, que debe responder al tipo de servicio que solicita. Es por ello que cada centro deberá tomar una orientación como un proveedor de servicios, con unos recursos, que al igual que muchos otros sistemas, son cada vez más escasos, por lo que tendrán que ser optimizados para poder hacer más con menos y donde los procesos administrativos y trámites burocráticos, tanto internos como externos, son vistos como un proceso de negocio, el cual deberemos ser capaces de modelar, gestionar, simular, mejorar en su comportamiento y eficiencia, controlar y monitorizar.

3 Aplicación de la tecnología BPM en una IES

El objetivo de esta ponencia es abordar los beneficios de la aplicación la tecnología BPMS en los procesos relacionados con la actividad docente de un centro universitario. La realidad de los centros educativos, en particular los de enseñanza universitaria, se caracterizan por una gran diversidad de procesos, algunos con una enorme complejidad, y por una falta generalizada de recursos para acometer dichos procesos de una forma satisfactoria. No es de extrañar que, ante este escenario, algunas instituciones universitarias vean en las herramientas BPMS un gran potencial para mejorar la eficiencia de sus procesos y se hayan marcado una estrategia orientada hacia el uso de estas herramientas. Otro aspecto, sin duda de gran interés, es la necesidad de visualizar los procesos de una manera clara para llegar a comprender el alcance de los mismos. Existe una percepción generalizada de que las tareas que se llevan a cabo dentro de las instituciones educativas no están bien definidas y que consumen una cantidad enorme de recursos, con unos resultados y un nivel de eficiencia muy bajos, sin entrar en el bajo nivel de satisfacción que generalmente manifiestan los usuarios de estos servicios. Otro de los paradigmas que nos encontramos en nuestros días es, ante una sociedad inmersa en un proceso de socialización debido al gran auge de las redes sociales, que muchos de los agentes que intervienen en un mismo proceso apenas interactúan entre ellos. Se observa que existe una ausencia generalizada de intercambio de conocimientos. Es evidente que sin esta condición es muy difícil llegar a establecer procesos eficientes que aprovechen todo el potencial que los agentes que intervienen tienen a través de sus experiencia.

Para alcanzar este objetivo es necesario entender el alcance de la orientación hacia los procesos de negocio y los beneficios que ésta pueden suponer para la institución. También es clave tener presente que la tecnología, en particular la tecnología BPM, no va a resolver nuestros problemas por sí misma. En necesario disponer de un buen planteamiento metodológico y seleccionar adecuadamente los procesos por los que se debe iniciar un proyecto de esta naturaleza. Por ello, dada la enorme cantidad y diversidad de procesos a los que se ve sometida la actividad docente propia de un centro universitario (configuración del plan de horarios, calendario de exámenes, organización de grupos, gestión de recursos tales como laboratorios y aulas informáticas,…), es necesario elegir, en una primera fase, aquellos procesos que permitan entender claramente las ventajas de este enfoque y la utilidad de la tecnología BPMS, para luego extenderlo con éxito al resto de los procesos de la organización. Por otra parte, en las IES existen procesos de carácter centralizado, es decir, que son comunes a todas las IES que integran la Institución Superior a la que pertenecen, la Universidad. Estos procesos vienen ya definidos y la IES apenas tiene capacidad de influencia sobre los mismos, más allá de las sugerencias y/o peticiones que se formulan para un mejor funcionamiento de la Institución a través de los cauces establecidos. Dentro de estos procesos está, a modo de ejemplo, el de matriculación del alumnado. En una segunda categoría estarían los procesos descentralizados, aquellos que son definidos y gestionados por la IES. Dentro de éstos, podemos encontrar la asignación de los recursos y/o espacios docentes a utilizar en el despliegue de las actividades formativas específicas del centro.

En este trabajo se ha optado por un proceso descentralizado que depende de la IES y, por tanto, la IES tiene capacidad para su diseño, formulación y ejecución. Por otra parte, también creemos que para que el enfoque BPM vaya calando en toda la Institución, es mejor realizar el arranque desde 'abajo hacia arriba'. La dinámica de estas instituciones tiende a crear una percepción de que si el proceso se inicia aguas abajo no cuenta con el sentir ni con las necesidades reales de los usuarios finales. La ventaja de iniciarse desde una IES es que éstas están en mayor contacto con la realidad de los procesos y si éstos son abordados por la propia IES tienen un mayor impacto. Ello no quiere decir que la Institución superior quede al margen, ni mucho menos, sino que desempeñe un papel de catalizador y que proporcione a las IES todo el soporte necesario para la aplicación de este enfoque y el uso de herramientas adecuadas que encajen con los requerimientos de la Institución desde una perspectiva global.

El proceso seleccionado se centra en la gestión de las aulas informáticas que se emplean en la IES en el desarrollo de la docencia con un carácter más práctico y/o aplicado. En la actualidad, la IES cuenta con un total de 20 aulas informáticas dotadas con más de 600 equipos, servidores, etc. Los usuarios de estas instalaciones son, entre alumnos de grados, másteres y profesores, más de 4000, lo que exige una gran eficiencia y agilidad para atender a todas las necesidades que se puedan plantear y que son, básicamente, por un lado garantizar que los programas que van a ser utilizados en las aulas están correctamente instalados y listos para su uso en las fechas programadas. Por otro lado, dada la gran cantidad de equipos y de usuarios, es necesario asegurar el buen funcionamiento de los equipos para que el nivel de servicio (puestos disponibles) y que la fiabilidad de los mismos (buen estado) sea acorde a las exigencias de la IES.

4 Metodología del trabajo

Para llevar a cabo la aplicación de la tecnología BPMS al proceso de gestión de las aulas informáticas de un centro universitario, cuyas características han sido descritas en epígrafes anteriores, es necesario contar con un planteamiento metodológico adecuado. Para este trabajo se han seguido, teniendo en cuentas las recomendaciones de los expertos en este campo (Jeston and Nelis, 2008), las etapas que se recogen en los siguientes apartados:

- Análisis detallado del proceso a desarrollar.
- Construcción del Diagrama de Procesos basándose en la notación estándar (BPMN).
- Datos del Proceso. Debe identificarse de una manera clara y precisa toda la información que afecta al proceso estudiado.
- Identificación y creación de formas.
- Establecimiento de las Reglas de Negocio que afectan al proceso.
- Asignación de recursos (qué se va a hacer, quién, cuándo y cómo lo va a desarrollar).
- Posible Interconexión con otros sistemas (SOA).
- Verificación del proceso. Validación del modelo en un ambiente de prueba.
- Puesta a punto del proceso.
- Realizar el paso de la etapa de producción.
- Aplicación Web de Implementación.
- Establecimiento de Indicadores de Gestión del Proceso.

No obstante, desde un punto de vista más general y conceptual, la metodología tiene que obedecer a unas directrices generales que hemos denominado bajo las siglas "AN-VERSA". Estas siglas se corresponden con una serie de aspectos que son básicos que se contemplen. En primer lugar está el conocimiento de nuestro negocio (Análisis del Negocio), que somos y cuál es la misión según el planteamiento estratégico adoptado por la Institución. Tras este análisis, lo siguientes es analizar los procesos y determinar aquellos que están alineados con la estrategia, los que realmente aportan Valor, eliminando todos aquellos que no aporten ningún tipo de valor al desempeño de la Institución. Tras la valorización tendríamos que diseñar los procesos de forma que sean Eficientes. Para alcanzar esto consideramos que es necesario seguir tres etapas: Racionalizar, Sistematizar y Automatizar. La racionalización consiste en el desarrollo de procesos 'sencillos' que utilicen los recursos adecuados. Sólo cuando hayamos alcanzado esto estaremos en disposición de iniciar la siguiente fase, la de Sistematización. Es decir, estudiar los procedimientos que se deben seguir para que el proceso se haga de una manera ágil (lo que equivaldría al establecimiento de los métodos de trabajo a seguir en las distintas tareas del proceso, de forma análoga a los que se haría con un proceso productivo). Por último, faltaría la Automatización, es decir, tener la capacidad de realizar los mismos procesos de una manera repetitiva utilizando siempre los mismos criterios y métodos de trabajado. Obviamente, toda esta metodología debe estar embebida en un proceso de mejora continua en la que se vayan introduciendo aquellos aspectos que, con la experiencia, el paso del tiempo, el desarrollo tecnológico,… son susceptibles de incrementar la eficiencia de nuestros procesos e incluso llevando a cabo la eliminación de aquellas otras cuestiones que ya no aportan valor.

5 Resultados y conclusiones

A pesar de que el trabajo todavía se encuentra en fase de desarrollo y, por tanto, debemos ser prudentes, los resultados obtenidos hasta el momento permiten poner de manifiesto una serie de aspectos que consideramos muy interesantes.

Todavía existe un gran desconocimiento de este tipo de herramientas en los entornos de las instituciones universitarias donde, paradójicamente, el volumen de procesos que se desarrollan es muy elevado. Además, con el nuevo marco al que se ven sometidos los centros universitarios por los procesos de acreditación, verificación,... hacen necesario el desarrollo de un enfoque orientado hacia los procesos.

Tras la construcción de un primer prototipo de modelo se ha podido comprobar cómo los usuarios entienden mejor las tareas que hacen y el sentido de las mismas, tienen una visión del proceso y el alcance del mismo. Quizás la mayor aportación de este trabajo es que ha puesto la primera semilla para crear una cultura de trabajo orientada hacia los procesos y se ha despertado la sensibilización hacia estos temas. Fruto de este proyecto de han derivado una serie de actividades formativas que se han iniciado a lo largo del curso 2012-2013 y que está previsto potenciar en el futuro con el objeto de dar a conocer estas herramientas y la importancia de la orientación hacia la gestión de los procesos de negocio.

3 Referencias

Fingar H, Smith H (2003) Business Process Management. The Third Wave. Meghan-Kiffer Press

Freund J, Rücker B, Hitpass B (2011) BPMN 2.0. Manual de Referencia y Guía Práctica. BPM Center. Edición Hispana.

Jeston J, Nelis J (2008) Business Process Management. Practical Guidelines to Successful Implementacions, 2th Edition, Elsevier.

Kaplan, Robert S; Norton, D. P. (1992). "The Balanced Scorecard - Measures That Drive Performance". Harvard Business Review (January–February): 71–79.

Kirchmer M., (2008) High Performance Through Process Excellence. Springer Verlag.

Scheer A. W. (1994) Business Process Engineering – Reference Models for Industrial Enterprises. Springer Verlag, Berlin.
Scheer A. W. (1998) Business Process Modeling. Springer Verlag, Berlin.

185 Information enclosing knowledge networks. A study of social relations

Sáiz-Bárcena L, Díez-Pérez JI, Manzanedo del Campo MA, Del Olmo Martínez R

Sáiz-Bárcena L (✉ e-mail: lsaiz@ubu.es)
Dpto. de Ingeniería Civil. Escuela Politécnica Superior. Universidad de Burgos. Av/ Cantabria S/N, 09006Burgos.

Díez-Pérez JI (✉e-mail: ignacorreo@hotmail.com)
Ph. Student. Dpto. de Ingeniería Civil. Escuela Politécnica Superior. Universidad de Burgos. Av/ Cantabria S/N, 09006Burgos.

Manzanedo del Campo MA (✉ e-mail: mmanz@ubu.es)
Dpto. de Ingeniería Civil. Escuela Politécnica Superior. Universidad de Burgos. C/ Villadiego S/N, 09001Burgos.

Del Olmo Martínez R (✉ e-mail: rdelolmo@ubu.es)
Dpto. de Ingeniería Civil. Escuela Politécnica Superior. Universidad de Burgos. C/ Villadiego S/N, 09001Burgos.

Abstract: We design and test a multiagent-based knowledge-exchange network, the results of which will guide corporate decision-making in this field. Its novelty resides in the application of multi agents to the field of knowledge management. We selected this methodology because it is valid for the purpose of the study, because it generates realistic and practical conclusions and, moreover, because it serves to negotiate the difficulties that these aspects of a qualitative and social nature can in reality imply for the firm. We designed the knowledge network through simulation with multi agents, studying some of their most important parameters. In doing so, we arrived at a set of conclusions, prominent among which are that by using the network, we may easily identify experts, and people that either share or conceal knowledge. The network also helps us locate people with leadership capabilities and those that remain isolated, as well as the formation of subgroups that segregate themselves from the original network and that can set up their own independent relational structures, unsupportive of knowledge exchange.

Keywords: Knowledge sharing, knowledge network, multi-agent, simulation.

1 Introduction

Management of the firm based on the knowledge of its workers, together with the organizational culture and the influence of social relations between people carrying out different tasks, have a significant effect on knowledge-exchange within the firm (Gutiérrez and Flores 2011), (Sáiz-Bárcena et al. 2013), (Sáiz-Bárcena et al. 2014). Such a large-scale flow of social relations and the stream of exchanges that it stimulates have given rise to popular social networks, on which basis knowledge networks have emerged, over recent years (Shin and Park, 2010). Their study and analysis in the firm can assist in diagnosing the strengths and weaknesses of knowledge and locating people that transmit and receive knowledge, the leaders at mastering and sharing knowledge (Pedraja-Rejas and Rodríguez-Ponce 2008a), (Pedraja-Rejas and Rodríguez-Ponce 2008b), (Mládková 2012), and the obstacles that make exchange difficult. The objective of this article is to design and to test a multiagent-based knowledge-exchange network, to arrive at results that can guide decisions and actions on knowledge exchange in a business setting. Its novelty resides in the application of multi agents to the field of knowledge management. We selected this methodology as valid for the purpose of the study, because it obtains realistic and practical conclusions and, moreover, because it serves to negotiate the difficulties that these aspects of a qualitative and social nature imply for the firm in reality.

To do so, in the first section, we analyze the design of the knowledge network through simulation with multi agents. In the following section, we study and interpret some of the most important network parameters, such as input degree and output degree and modularity. By doing so, we arrive at a set of conclusions, among the most relevant of which is that the network greatly facilitates the location of knowledge experts, people that share knowledge and those that conceal it. The network also helps us locate people with leadership capabilities and those that remain isolated, as well as the formation of subgroups that segregate themselves from the original network and that can set up their own independent relational structures, unsupportive of knowledge exchange.

2 The design of a knowledge network through simulation

The method applied is a simulation with multi-agents. It is a program which uses Net logo software. The agents move randomly in all directions. The program takes control of various parameters: such as to fix the distance of movement, number of agents, predisposition to social relationships, display the directional links or ties established between agents.

The control of these parameters may modify the density of the network due to the number of links. This simulation has been done with 34 agents. After 200 cycles of time, the agents convert into nodes. The nodes simulate people, and the links simulate social relationship between agents to exchange and share knowledge. The network obtained can be visualized by Gephi. The links can be directed or undirected, depending on what and how you want to analyze and to study the network. If you want to analyze the relations, you have to study the undirected links, but in this article directed networks are used because it is interesting to study the direction of the exchange of knowledge, for locating the people who share and receive the most.

There are two sorts of simulation, using two different sorts of software. The first simulation uses multi-agents, for the creation of the network with nodes and links. In the second, the network is assimilated to the network of a company where there are relations sharing knowledge, and the network is studied to reach very interesting conclusions. The network of a company can be more or less dense due to the relations between employees, and it can detect social problems, segregation, isolation, or be used to find people who have the most and the fewest links, because they have exchanged or shared knowledge. With the network, you can locate key employees, who can prevent other workers from running the risk of being isolated.

From a sociological perspective, when the nodes of a network represent people (or organizations) and the links between them their relations, we can refer to it as a social network (Barber et al. 2011), (Arcila and Said-Hung 2012). Such a structure, for the purposes of this study, helps to design and to generate the knowledge map of the firm through the use of specific software (Cobo et al. 2012), (Irani et al. 2009), improving corporate performance (Lee et al. 2011). One application of information technology to knowledge networks is that it facilitates and contributes to knowledge exchange in the firm or between firms (Martin-Rios 2012). So, by identifying the network and by analyzing the links, we can almost immediately locate the people that exchange, contribute and conceal knowledge and the extent to which they do so.

The networks present different configurations, which may depend on the links that are defined by the exchange of knowledge or the established social relations, among others. Their representation is in the form of nodes and relations or links (Watthananon and Mingkhwan 2012), (McLinden 2013). They are therefore tools that mean we can detect and study social relations arising from the exchange of knowledge, either because of the software they employ or because they are linked with certain information technologies that facilitate knowledge processes (Vaccaro et al. 2010).

Multiagent-based network simulation serves to study social and engineering situations (Terán et al. 2010), (Izquierdo et al. 2008) in a business setting. Net logo 5.0 software is appropriate, in our case, for the simulation of these social relations, in order to depict the network. After its study, we can arrive at practical conclusions, by using Gephi software (Fig. 1) (Wu 2001), (Wang et al. 2009), (Caballero et al. 2011), (Rodríguez et al. 2011), and obtain data for subsequent statistical studies (Thiele et al. 2012).

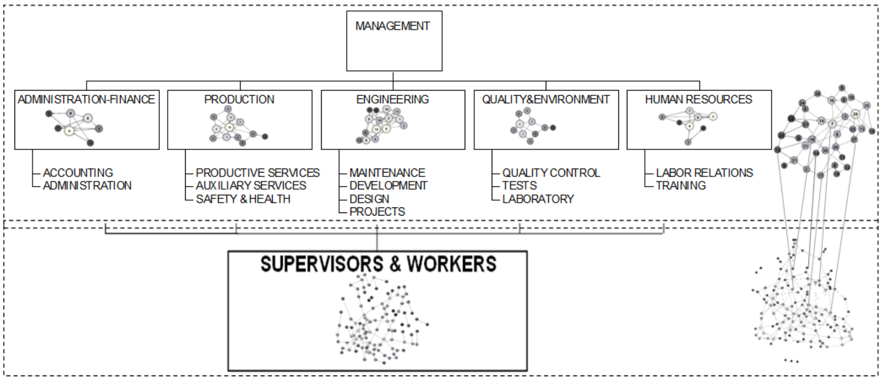


Fig. 2 Netlogo simulation of the network visually represented with Gephi software.

3 Relevant parameters and study of the network

The analysis of network parameters is very important (Yu et al. 2013), (McLinden 2013), given that they represent all the information on the nodes, the links or the relations, the dysfunctions, and if applicable, the need for other nodes and actors (Shin and Park 2010) and even the power of the relevant nodes (Simpson et al. 2011). In our case, a knowledge network with many links is conducive to exchange between people, although it can also lead to the creation of subgroups, which diminish social cohesion in the firm (Janhonen and Johanson 2011).

3.1 Input degree and output degree

Input degree represents the nodes that receive more knowledge and shows those agents that other members of the group have supported and taught. So, workers that have established more relations for learning purposes may be located (Fig. 2).

The output degree of the nodes shows the actors that contribute most knowledge to the group (Fig. 2). The case may arise in which the person who shares most knowledge is not the authentic expert; in consequence, we should analyze whether the expert acts as a transmitter of knowledge, as the one that exchanges most knowledge, or whether the expert shares it, on the majority of occasions, with the same person. That particular circumstance is important, as it would indicate that the knowledge was transmitted hierarchically, from the expert to a subordinate and then onto others. The firm should therefore investigate the location of the expert and the resultant links, because the expert may be protecting and concealing knowledge, with the devastating consequences that such an action would entail for the network.

On a positive side, the output degree of the network also serves to show new experts or leaders, the identification of whom would otherwise be more difficult.

Network degree represents, at the same time, the aforementioned parameters – output and input degree. These are nodes of great importance for the firm, as they are agents and people that show many relations and deploy very high levels of knowledge exchange activity. These people demonstrate leadership skills within the social group or subgroup, with high influence over other group members, favoring and provoking the exchange of knowledge between them all (Pedraja-Rejas et al. 2006).

3.2 Network modularity and group formation

The study of modularity serves to analyze the groups that form in the firm when its members exchange knowledge. These groups can imply a problem for the diffusion and exchange of knowledge, because subgroups and small factions can form that limit knowledge exchange (Fig. 2).

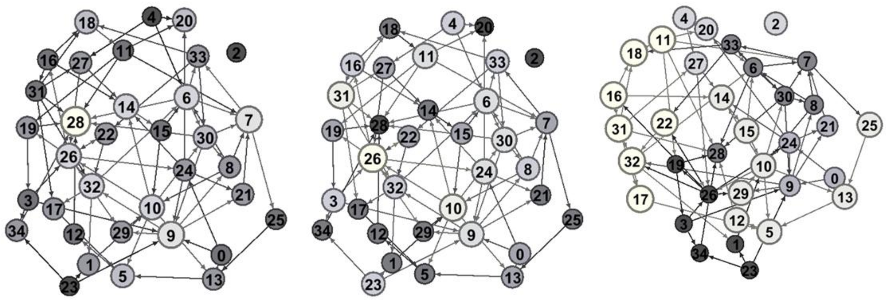


Fig. 3 Representation of input degree and output degree and modularity

Modularity is the term given to the nodes with links to similar nodes (Banos 2012) and, it also locates those nodes that are capable of establishing relations with other different ones. Thus, we may visualize isolated nodes and analyze the cause and possible solutions, at the same time as detecting problems or negligence that relate to a person or to management decisions.

Likewise, if the firm is hierarchically structured into departments, various groups of networks that interrelate between each other may form, where, in turn, some node appears that stands out in the intra and inter-departmental relations.

It is precisely the relations between the different departments and the different people that compose each department that can help to determine who takes the decisions, making problem-solving more flexible and maintaining fluid links with other departments.

5 Conclusions and Discussion

The objective of this study has been achieved, as it has been demonstrated that the multi-agent based simulation and social network analysis software allows us to study sociological circumstances that arise in the context of knowledge management, in particular its exchange and sharing. A powerful tool becomes available by relating both multiagent and network applications, with which to test some aspects of knowledge management, the application of which is practically impossible in the day-to-day reality of the firm. Thus, we can generate conclusions to guide future actions, in accordance with the results of the simulation. It also allows researchers and business directors to understand and to interpret some of the social relations that arise in the exchange of knowledge and to avoid certain circumstances that hinder knowledge management. This study, in addition to the novelty of its contribution, has served to recapitulate the utility of having a network associated with the knowledge map of the firm, as in this way, it becomes possible to locate who possesses the knowledge, who is the expert, who shares it and, even, who conceals it. All these responses are of vital importance for the survival and the competitiveness of the firm, as it makes the flow of knowledge between employees more agile and efficient, facilitating their learning and avoiding situations of alarm in the face of the exclusive possession of relevant knowledge in the hands of a single person. As demonstrated, relevant software can represent social problems and generate a visual display of the network.

Other interesting aspects, of great importance for the firm, are that it can detect people with leadership capabilities through the knowledge network as well as people who remain isolated or who have fewer links. Likewise, it may also detect the formation of subgroups segregated from the original network that can constitute their own relational structure independent from the latter.

The detection of leaders brings highly trained workers forward who were previously ignored, as they were not known and, on the contrary, other overvalued employees that demonstrate their isolation or lack of relations, and in consequence, lack of knowledge exchange with their subordinates. Finally, the position that the expert occupies in the network determines the degree to which they share their knowledge that, as demonstrated, may be broad or narrow. In the latter case, a narrow band would indicate a desire for the knowledge to remain tacit. Thus, the network map also warns of this and other types of barriers or obstacles for the exchange of knowledge in the firm.

6 References

Arcila C, Said-Hung E (2012) Factores que inciden en la variación de seguidores en los usuarios top20 más vistos en Twitter en América Latina y Medio Oriente. Interciencia 37(12): 875-882

Banos A (2012) Network effects in Schelling's model of segregation: new evidence from agent-based simulation. Environment and Planning B-Planning & Design 39(2): 393-405

Barber MJ, Fischer MM, Scherngell T (2011) The Community Structure of Research and Development Cooperation in Europe: Evidence from a Social Network Perspective. Geographical Analysis 43(4): 415-432

Caballero A, Botía J, Gómez-Skarmeta A (2011) Using cognitive agents in social simulations. Engineering Applications of Artificial Intelligence 24(7): 1098-1109

Cobo MJ, López-Herrera AG, Herrera-Viedma E et al (2012) SciMAT: A new science mapping analysis software tool. Journal of the American Society for Information Science and Technology 63(8): 1609-1630

Gutiérrez L,Flores M (2011) Un concepto sobre las redes de conocimiento entre organizaciones. Revista de Ciencias Sociales 17(3): 473-485

Irani Z, Sharif AM, Love PED (2009) Mapping knowledge management and organizational learning in support of organizational memory. International Journal of Production Economics 122(1): 200-215

Izquierdo L, Galán JM, Santos I et al (2008) Modelado de sistemas complejos mediante simulación basada en agentes y mediante dinámica de sistemas. EMPIRIA, Revista de Metodología de Ciencia Sociales 16: 85-112

Janhonen M, Johanson J-E (2011) Role of knowledge conversion and social networks in team performance. International Journal of Information Management 31(3): 217-225

Lee WL, Liu CH, Wu YH (2011) How knowledge cooperation networks impact knowledge creation and sharing: A multi-countries analysis. African Journal of Business Management 5(31): 12283-12290

Martin-Rios C (2012) Why do firms seek to share human resource management knowledge? The importance of inter-firm networks. Journal of Business Research 67(2): 190-199

McLinden D (2013) Concept maps as network data: Analysis of a concept map using the methods of social network analysis. Evaluation and Program Planning 36(1): 40-48

Mládková L (2012) Leadership in management of knowledge workers. Procedia - Social and Behavioral Sciences 41(0): 243-250

Pedraja-Rejas L, Rodríguez-Ponce E (2008a) Estilos de liderazgo, gestión del conocimiento y diseño de la estrategia: un estudio empírico en pequeñas y medianas empresas. Interciencia 33(9): 651-657

Pedraja-Rejas L,Rodríguez-Ponce E (2008b) Estudio comparativo de la influencia del estilo de liderazgo y la congruencia de valores en la eficacia de empresas privadas e instituciones públicas. Interciencia 33(1): 8-13

Pedraja-Rejas L, Rodríguez-Ponce E, Rodríguez-Ponce J (2006) Liderazgo y decisiones estratégicas: una perspectiva integradora. Interciencia 31(8): 577-582

Rodríguez S, de Paz Y, Bajo J et al (2011) Social-based planning model for multiagent systems. Expert Systems with Applications 38(10): 13005-13023

Sáiz-Bárcena L, Díez Pérez JI, Manzanedo del Campo MA et al (2013) Intercambio del conocimiento en la empresa. Aprendiendo de la experiencia. Interciencia 38(8): 570-576

Sáiz-Bárcena L, Díez Pérez JI, Manzanedo del Campo MA et al (2014) Predisposition of Workers to Share Knowledge: an Empirical Study. Lecture Notes in Management and Industrial Engineering, 2.

Shin J, Park Y (2010) Evolutionary optimization of a technological knowledge network. Technovation 30(11–12): 612-626

Simpson B, Markovsky B, Steketee M (2011) Network knowledge and the use of power. Social Networks 33(2): 172-176

Terán O, Quintero N, Ablán M et al (2010) Simulación social multiagente: Caso reserva forestal de Caparo. Venezuela. Interciencia 35(9): 696-703

Thiele JC, Kurth W, Grimm V (2012) RNETLOGO: an R package for running and exploring individual-based models implemented in NETLOGO. Methods in Ecology and Evolution 3(3): 480-483

Vaccaro A, Parente R, Veloso FM (2010) Knowledge Management Tools, Inter-Organizational Relationships, Innovation and Firm Performance. Technological Forecasting and Social Change 77(7): 1076-1089

Wang J, Gwebu K, Shanker M et al (2009) An application of agent-based simulation to knowledge sharing. Decision Support Systems 46(2): 532-541

Watthananon J, Mingkhwan A (2012) Optimizing Knowledge Management using Knowledge Map. Procedia Engineering 32(0): 1169-1177

Wu DJ (2001) Software agents for knowledge management: coordination in multi-agent supply chains and auctions. Expert Systems with Applications 20(1): 51-64

Yu Y, Hao J-X, Dong X-Y et al (2013) A multilevel model for effects of social capital and knowledge sharing in knowledge-intensive work teams. International Journal of Information Management 33(5): 780-790

191 Optimization of multihead weighing process using the Taguchi loss function

Pulido-Rojano AD, García-Díaz JC

Alexander De Jesús Pulido Rojano (✉e-mail: apulido3@unisimonbolivar.edu.co)
GEMAS group. Industrial Engineering Department. Universidad Simón Bolívar. Av. 59 No. 59-92. A.A. 50595. Barranquilla - Colombia.

J. Carlos Garcia-Díaz (✉e-mail: juagardi@eio.upv.es)
Applied Statistics, Operations Research and Quality Department. School of Industrial Engineering. Universitat Politècnica de València. C/Vera, s/n. 46022 Valencia.

Abstract: According to Taguchi, the quality of a product is the minimum loss to society during that product's life. Taguchi's idea is that the loss to society is minimal when the product's performance is at the nominal value and the loss increases quadratic ally as the product's functional performance derivate further from the nominal value, although the specifications have been met. In this paper we pro-pose to implement Six-Sigma concepts and measure the quality loss for a set of new strategies that seek to optimize the packaging process in multi head weighers, by combining weights algorithms managed to reduce the variability in the selection of the final weight to desired nominal value.

Keywords: Six-Sigma, lost quality,multi head weighers, Optimization, Combinations.

1 Introduction

The Six-Sigma program was developed by Motorola in the late 1980s as a response to the demand for their products. The focus of six-sigma is reducing variability in key product quality characteristics to the level at which failure or defects are extremely unlikely (Montgomery, 2009).

Taguchi's techniques have been used widely in engineering design (Liao and Kao, 2010; Wu et al., 2004; Taguchi, 1990; Ross, 1996). The Taguchi approach to quality engineering places a great deal of emphasis on minimizing variation as the main means of improving quality (Sauers, 1999). Taguchi defines quality as the loss imparted to society from the time a product is shipped to the market. Taguchi argues that the loss to society is minimum when the product's performance is at the nominal or target value (T). The quality improvement of a product is achieved by reducing the variability around the T of the product performance characteristic in every level of process or product design.

According to Taguchi, the quality of a product is the minimum loss to society during that product's life. Taguchi's idea is that the loss to society is minimal when the product's performance is at the nominal value and the loss increases quadratic ally as the product's functional performance derivates further from the nominal value, although the specifications have been met. The Taguchi loss function in the case "nominal is the best" for a product unit is defined as$L_{(y)} = c(y - T)^2$, where y is the value of the quantitative quality characteristic considered, Y. Let T be the nominal value (Target), c the quality loss coefficient, and $L_{(y)}$ the measure of quality loss when the quality characteristic is y units away from the nominal value, T. The value of the constant c depends on the social losses at the specification limits and the width of the specification. The expected quality loss per unit for a characteristic Y is given by $E[L_{(y)}] = c[\sigma^2 + (\mu - T)^2]$;where μ and σ^2represents the mean and variance of Y, respectively. Therefore, to minimize the quality loss, the product characteristic needs to be centred at the nominal value and the variance of that characteristic needs to be reduced.

We prefer a modern definition of quality. According to Montgomery (2009), Quality is inversely proportional to variability. Note that this definition implies that if variability in the important characteristics of a product decreases, the quality of the product increases. Quality improvement is the reduction of variability in processes and products.

Multihead weighing uses a combination principle to solve complicated portion weighing tasks. Using multiple weighing pans makes it possible to achieve high precision and speed while at the same time to reduce variability considerably. Multiheadweigher is important part of modern production lines, where weighing and packing of final product with narrow tolerance is requested. Using multiple weighing pans makes it possible to achieve high precision and speed while at the same time to reduce variability considerably. Core of combinatorial weighing is acquiring data from multiple weighing heads, calculating sums of all possible combinations and selecting the best one, i.e. combination that gives sum weight closest to "labelled" weight or nominal quantity. The regulations, specified in the EC Directives, require consumers to be informed on quantity and protect against short measure, while allowing businesses flexibility to control quantity on the production line within specific tolerances. In this context, the objective is to reduce the variability considerably respect to the nominal value to "labelled" weight in quantity control for packaged goods according to Six-Sigma approach using Taguchi loss function. Some authors have studied methods to variability reduction in packing processes (Keratia and Kim, 2007; Barreiro et al., 1998; Salicrú et al., 1996). The goal of this paper is to determine the optimal strategy for variability reduction respect to the nominal value in packing processes based on multiple weighing strategies. A computational experiment is carried out for the three strategies presented.

This paper is organized as follows: Section 2 introduces the packaging process in multiheadsweighers. In Section 3 the multiple weighing strategies are presented. Section 4 shows the results of computational study. In Section 5 offers the conclusions of this work.

2 Multi weighing Packing Proceedings

To illustrate the packaging process in multi head weighers consider the provision of feeders and hoppers in a weighing automatic Multihead combination. In this paper, for all the proposed strategies, a processor with sixteen weighing channels around a feeder loop is studied; each channel is equipped with a line feeder, a preliminary hopper (HP) and a weighing hopper (WH). The product is dispensed through the feed loop for each of the preliminary hopper through the feed line. When a certain amount of product is provided to the preliminary hopper the feeders stopped, and the content of the preliminary hopper is moved to the weighing hoppers. The products are weighed and are used in the combining process to achieve the target value. The products of selected hoppers are released to the packaging machine through discharge pipes. Then new products are supplied in empty hoppers and so continuous operation until reaching the desired amount of production (Pt).

To calculate the possible combinations (C_t) of n objects (total hopper weighers) taking k (number of elements combined) at a time, using $C_t = \frac{n!}{k!\,(n-k)!}$, where$k$ is the number of weighing hoppers whose contents are combined to provide the desired output weight.In this research, a number k = 4, 5 and 8 for analysis of combinatorial strategies proposals were considered. These, taking into account the filling process in a real environment.

3 Target value and variability in Weighers Multihead

Suppose a process Multi-head packaging in which the product is composed of the sum of the weights contained in k weigh hoppers whose combined variable follows a normal distribution $N(\mu_n, \sigma_n)$. The weight of each unit packed with this approach follows a normal distribution$N(k\mu_n, \sqrt{k}\sigma_n)$. In this case the variability with respect to the nominal value $\sqrt{k}\sigma_n$ is considered an index of quality in the packaging process. Now, if x_1, x_2... x_n are the weights contained in the weigh hoppers, x_{i1}, x_{i2}… x_{ik} are the weights that provide the optimal combination and n_{i1}, n_{i2} ... n_{ik} are hoppers containing these weights, then, the value of the desired final weight or the closest to the nominal value (Po) of the packaged product is given by the sum of the weights that provide the optimal combination, as followsPo = x_{i1}

+ x_{i2} + … + x_{ik}. Therefore, the deviation of each item to the nominal value (VN) is Po – VN. Is the minimum among the combinations, then when you consider the changes that standardize the variables x_i: $\mathrm{Y_i} = \frac{\mathrm{x_i} - \mu_n}{\sigma_n}$ The corresponding y_{i1},y_{i2} … y_{ik} provide the best combination in relation to the nominal value 0, so σ^2 (N (0, 1)) = VAR (y_{i1} + y_{i2} + … + y_{ik}).

Now, when you consider a filling process where the unit is composed of a variable number of parts and ksμ is the aim of packaging ($k$ys are natural numbers), we immediately chose a variable number of pieces ks. In these cases, an alternative is to subdivide the n hoppers in three groups (n_1, n_2, n_3) and to supply different quantities of parts in each subgroup (s-1, s, s +1). The offset value is obtained as follows:

$$\left[VAR\left(\sqrt{s-1}\sum_{i=i1}^{i\alpha}\mathrm{Y}_i + \sqrt{s}\sum_{j=j1}^{j\beta}\mathrm{Y}_j + \sqrt{s+1}\sum_{r=r1}^{r\gamma}\mathrm{Y}_r + \frac{ks-\alpha+\gamma}{h}\right)\right]^{1/2} \quad (1)$$

where Y_i, Y_j and $Y_r$are independent values associated with a random variable with normal distribution N (0,1) and h = σ/μ, the variation coefficient. The optimal combination in relation to the nominal value is obtained when the function (1) is minimized. It is anticipated that in this case n_1= n_3. Development of this has been presented by Salicrú et al (1996).

4 Multiple Weighing Strategies

The multiple weighing strategies are used in combination weighers Automatic Multihead, which consist of a terminal connected to a computer so that the filling process is performed following predetermined algorithms.

4.1 Compliance Strategy (E1)

This proposed feed each hopper with $\frac{VN}{k}$ product and considers only those combinations that weights obtained are within the desired limits or compliance, and then choose only one by any criterion. When a weight is not obtained within the requirements in the generated combinations of n hoppers should be unloaded and reloaded to generate new combinations. This ensures that each weight m at least packaged products are meeting the desired specifications. The process repeats until the full desired production (P_t).The results of this strategy are presented in Table 2.

4.2 Search for target value with equal supplied product (E2)

Like the strategy E1, feeding each of the hoppers with $\frac{VN}{k}$product and through a search between all the combinations obtained the closest to the target or nominal value is chosen. The process repeats until the full desired production (P_t).This ensures that all weights of packaged products obtained from all possible combinations are always the closest to the nominal value (VN), but not would fulfill with market specifications or any other desired specification. The results of this strategy are presented in Table 3.

4.3 Search for target value with unequal supplied product (E3)

This proposed to divide the n weigh hoppers in three groups and provide unequal quantities of products to each subgroup. Then, n_1, n_2 and n_3 are the subgroups of hoppers (each subgroup may contain a number equal or different hoppers). The subgroups n_1 and n_3 are filled with target value $\pm\ 1\sigma_n$, while the subgroups n_2 are filled with the target fill value, so:$n_1 = (\frac{VN}{k})\ -1\sigma_n$; $n_2=\frac{VN}{k}$;$n_3= (\frac{VN}{k})\ +1\sigma_n$.

Like E2 strategy, all weights of packaged products obtained from all possible combinations are always the closest to the nominal value (VN).The process repeats until the full desired production (P_t).The results of this strategy are presented in Table 4.For this case, the hopper groups are divided as follows: n_1 = 5, n_2 = 6 and n_3 = 5.

5 Results and Analysis

To measure the performance of the process based on the proposed strategies consider a combinatorial filling process in which we aim to obtain a packed weight or nominal value of 250 gr in each product. To calculate the deviations of each hopper, coefficients of variation of 1%, 2.5% and 5% were used. The other parameters are presented in Table 1.

Table 1 Study Parameters

$\sqrt{k}\sigma_n$	k	$\frac{\text{VN}}{k}$	σ_n
	4	62.5	1.25
2.5	5	50	1.12
	8	31.25	0.88

	4	62.5	3.13
6.25	5	50	2.80
	8	31.25	2.21
	4	62.5	6.25
12.5	5	50	5.59
	8	31.25	4.42

Simulating the process for 100,000 units of packaged products. The results obtained for each strategy are presented in Table 2. Whereas the percentage of discharge a key factor in the efficiency of the operation, these results are presented for the E1 strategy.

Table 2 Results Strategy

Parameters		E1				E2			E3		
$\sqrt{k}\sigma_n$	k	μ	σ	% Discharge	$E[L_{(y)}]$	μ	σ	$E[L_{(y)}]$	μ	σ	$E[L_{(y)}]$
	4	250.00	0.607	0.44	0.369	250.00	0.473	0.224	250.00	0.017	0.00030
2.5	5	250.00	0.619	0.59	0.384	250.00	0.525	0.275	250.00	0.016	0.00027
	8	250.00	0.652	1.47	0.425	250.00	0.707	0.500	250.00	0.075	0.00557
	4	250.00	0.588	1.13	0.346	249.99	1.185	1.403	250.00	0.043	0.00186
6.25	5	250.00	0.591	1.41	0.350	250.00	1.312	1.721	250.00	0.041	0.00169
	8	250.00	0.603	3.39	0.364	250.01	1.776	3.153	250.00	0.187	0.03515
	4	250.00	0.582	1.30	0.339	249.98	2.365	5.595	250.00	0.086	0.00743
12.5	5	250.00	0.583	1.79	0.339	250.00	2.619	6.859	250.00	0.082	0.00673
	8	250.00	0.586	4.15	0.344	250.02	3.552	12.614	250.00	0.375	0.14058

An analysis of variability for each strategy was realized, shifts in the supply of products to different hoppers δ = 0.5, 1.0, 1.5 and 2.0.The results are presented for a change of δ = 0.5 (Table 3). The other results are also equivalent.

Table 3 Results loss function(δ = 0.5)

Parameters		E1				E2			E3		
$\sqrt{k}\sigma$	k	μ	σ	% Discharge	$E[L_{(y)}]$	μ	σ	$E[L_{(y)}]$	μ	σ	$E[L_{(y)}]$
	4	250.51	0.455	10.83	0.469	252.51	2.113	10.785	250.14	0.551	0.326
2.5	5	250.56	0.429	14.00	0.501	252.79	2.173	12.557	250.22	0.678	0.509
	8	250.64	0.384	26.85	0.566	253.52	2.294	17.679	250.65	1.194	1.860
	4	250.23	0.555	14.23	0.363	256.22	5.268	66.519	250.37	1.386	2.059
6.25	5	250.28	0.544	18.27	0.376	256.99	5.433	78.489	250.54	1.696	3.178

	8	250.37	0.513	33.04	0.405	258.81	5.754	110.722	251.63	2.991	11.622
	4	250.10	0.574	15.46	0.340	262.49	10.541	267.154	250.71	2.682	7.708
12.5	5	250.12	0.572	19.64	0.344	263.99	10.853	313.656	251.09	3.386	12.657
	8	250.19	0.563	35.23	0.353	267.70	11.520	446.010	253.31	5.997	46.936

Noticed as the least variability when the process is in-control is provided by the E3 strategy. If we compare the results with the E1 and E2 strategy, E3 strategy decreases the variability of the data substantially even though there is an increase in the coefficient of variation the packing process.

The values reflect the strategy E2 (Search for target value with equal supplied product) do not provide the best results when the process is in-control or out-control.

For conditions where the variability increases and the process is out-control, the E1 strategy offers the lowest value of lost quality although the percentage of discharged increases to the level where the process is ineffective. For example, in case of δ =1.0 or more, the percentage of discharges can reach up to 98% due to the search for target weights within specification limits.

Regarding to the number of combinations, is noted that for E2 and E3 the variability of the weights obtained fail to improve with increasing the value of *k*. Only the E1 strategy allows to reduce the variability with increasing *k* but with aggravated mentioned above.

6 Conclusions

An application of Six Sigma approach to process weighing multi-head was presented. The "Loss Quality" for a new set of strategies designed to optimize the packaging process was calculated. The results show that compliance strategy (E1) little loss of quality is achieved but the efficiency of the process is severely impaired. Also, the simulation study show that a strategy with unequal supplied product (E3) provides better results when the process is in-control and is recommended even if the process is out-control. Strategy with equal supplied product (E2), is not recommended for this type of process.

Additionally, we can conclude that the use of a number *k* of elements that provide greater number of combinations not guaranteed to find a final weight closest to the target weight. Although, is recommended make deeper studies of the relationship that may exist between the number of combinations and the variability in the final weights obtained.

7 References

Barreiro, J., González, C., & Salicrú, M. (1998). Optimization of Multiweighing Packing Proceeding. Sociedad de Estadística e InvestigaciónOperativa, 6(1), 37-44.

G. Taguchi, Introduction to Quality Engineering, Asian Productivity Organization, Tokyo, 1990.

Keraita, J. N., & Kim, K.-H.(January de 2007).A Weighing Algorithm for Multihead Weighers. International Journal of Precision Engineering and Manufacturing, 8(1), 21-26.

Liao C-N, Kao H-P (2010).Supplier selection model using Taguchi loss function, analytical hierarchy process and multi-choice goal programming.ComputIndEng 58:571–577.

Montgomery, D. (2009). Statistical Quality Control (6 ed., Vol. 1).Arizona, Arizona, EE.UU: John Wiley and Sons.

Ross, P.J., (1996) "Taguchi Techniques for Quality Engineering: Loss Function, Orthogonal Experiments, Parameter and Tolerance Design-2nd ed.", New York, NY: McGraw-Hill.

Salicrú, M., González, C., & Barreiro, J. (1996). Variability Reduction with Multiweighing Proceedings.Society of Statistics and Operations Research, 4(2), 319-329.

Sauers, D. G. (1999).Using the Taguchi loss function to reduce common-cause variation.QualityEngineering, 12(2), 245-252.

199 Waste Identification Diagrams with OEE data

Dinis-Carvalho J, Guimarães L, Moreira F, Rodrigues J, Lima RM.

José Dinis-Carvalho (✉ e-mail:dinis@dps.uminho.pt)
Dpto. de Produção e Sistemas, Escola de Engenharia. Universidade do Minho. Campus de Azurém, 4800-058 Guimarães. Portugal

Abstract: Existing techniques to represent production units are not very effective in representing several dimensions of production, limiting the extent to which diagnose and problem identification is accrued. Value Stream Mapping is one such technique which, although very popular among lean practitioners, exhibits a number of practical limitations. In this paper the authors present the all new Waste Identification Diagram, encompassing a number of new features and improved graphics capabilities, which makes it a feasible alternative technique to that of VSM, while extending its breath of application by integrating Overall Equipment effectiveness data into the diagrams. An example application of the WID technique to a real production unit will be presented, screening its effectiveness for diagnosing problems, measuring performance and providing key visual information and precious clues for improvement.

Keywords: Waste Identification Diagram; Value Stream Mapping;

1 Introduction

A relative small number of visual techniques are available to assist the analyst in the process of representing, analysing and diagnosing production units. These techniques support the identification of important issues that characterize a given shop floor, such as the layout, its production performance, waste forms, waste values, the production flows, equipment utilization, etc. None of the existing techniques, when considered in isolation, is sufficiently complete and powerful to cover the greatest share of such issues. Each one of those techniques is fundamentally biased by narrow focus on partial systems and by specific application perspectives. Some techniques are mainly focused on representing the layout and production routes; others are intended at representing the worker's movements; while others are only focused on the production flow of certain products or a given family of products; and so on. The most popular technique applied in lean production environments is that of Value Stream Mapping (Rother and Shook, 1999). The VSM diagrams depict the chain of processes that are required to be executed to produce a product or a family of products, its production control system, the station related WIP, the value adding time, the throughput time as well as other information. The analyst uses aVSM map to identifypossible actions for value stream improvement while establishing an improved future-state VSM map. Although very popular, VSM holds many limitations, among which we emphasise the difficulty in representing multiple routes and its inadequacy to identify and evaluate many forms of wastes, such as transportation, movements and waiting.

Waste Identification Diagram (Dinis-Carvalho et al., 2014) is a visual tool, being developed at the Department of Production and Systems (University of Minho, Portugal), with the purpose of representing production units in an intuitive visual manner, exposing and evaluating most forms of waste, production flows and other important production data and indicators. Waste Identification Diagram (WID) was designed to overcome the limitations of VSM, eventually becoming a more intuitive and more effective visual tool.

In this paper we will present a new version of Waste Identification Diagram which integrates the Overall Equipment Effectiveness (OEE) information (Hasen, 2001), such as planned downtime, unplanned downtime, speed losses and quality losses. This OEE data is adapted to show its influence in *takt* time as well as station time values. This enhancement is particularly relevant where OEE data in regularly monitored by the company, allowing a more accurate analysis. As a way of illustrating the respective use and testing its applicability, we will present and explain the new version of the WID by representing a real production unit from the semiconductor industry located in the north of Portugal.

2 Existing graphical tools

Table 1 presents a list of graphical tools used in production environments. The tools were classified according to the following criteria: (1) process or product orientation ;(2) visual effectiveness ;(3) scope, and (4) waste types covered. The objective of the first criterion “Orientation” is to clarify if the tool is more focused on the production unit as a whole or more focused on a particular product or family of products. The second criterion “Visual Effectiveness” reflects our perception on the visual effectiveness of the tool. This aims at measuring the quantity and quality of the information that is detected by just looking at the graphical information. The criterion “Scope” measures the quantity of different types of production information that is covered by the tool. Finally the criterion “Waste Types Covered” is focused on identifying which types of production wastes, from the set of seven classic waste types, as defined by Ohno(1988), are covered by the tool.

The most commonly used tool, for the purpose of mapping production flow and production waste, is Value Stream Mapping. VSM is the most popular tool to represent production units and is widely used to record present state during kaizen events across many industries. These maps are used to diagnose problems, to identify improvement opportunities and also to establish future as well as ideal states.

Table 1 Evaluation of existing graphical tools

Tools	**Orientation**		**Visual Effectiveness**	**Scope**	**Waste Types Covered**
	Process	**Product**			
Flow Process Chart (ASME, 1947)	Low	High	Mid	Low	Transportation; Inventories.
Flowchart Map (Barnes, 1968)	High	Mid	High	Mid	Transportation; Inventories; Motion.
Spaghetti Diagram (Neumann&Medbo 2010)	High	---	High	Low	Transportation; Motion.
ModelofSupply Chain and Waste (Hicks et al, 2004)	Mid	Mid	Mid	Mid	Transportation; Defects.
Process Activity Mapping (Barnes, 1968)	---	High	Mid	Low	Transp.;Invent.; Motion;Waiting;Overprod.
Supply Chain Response Matrix (New, 1993)	Mid	Mid	Mid	Low	Inventories; Overproduction.
Production Variety Funnel (New,1974)	Low	High	High	Low	Inventories.
Quality Filter Mapping (Hines& Rich, 1997)	High	---	High	Low	Defects.
Demand Amplification Mapping (Forrester, 1958)	Low	High	High	Low	Inventories; Overproduction.
Decision Point Analysis (Hoekstra e Romme, 1992)	Low	Low	Mid	Low	Inventories; Overproduction.
Physical Structure (Miles, 1961)	Low	Mid	Mid	Low	
Value Stream Mapping (Rother e Shook, 1999)	Low	High	Mid	Mid	Transp.;Inventories; Overproduction.
Waste Identification Diagram (Dinis-Carvalho et al, 2013)	High	Mid	High	High	Transp.;Invent.; Motion;Wait.; Def.;Overprod.

A known limitation of VSM commonly reported on the literature is its inability to represent multiple routes (Irani& Zhou, 1999; McDonald, Van Aken&Rentes, 2002;Seth & Gupta, 2005;Braglia, Carmignani&Zammori, 2006;Chitturi, Glew&Paulls, 2007). Other reported limitations include the absence of layout visualization (Irani& Zhou, 1999) and lack of representation of several waste types (Lovelle, 2001; Huang & Liu, 2005).

Waste Identification Diagram (WID), as proposed by Dinis-Carvalho et al. (2014), is an alternative approach to that of VSM, which aims at overcoming some of itsdrawbacks. Waste Identification Diagrams are intended to give more intuitive visual information, are able to represent layouts, to represent multiple routes and evaluate more waste forms.

The evaluation of WID(see last line in table 1) assumed by the authors of this article is based on the following reasoning: (1) Process orientation criteria –WID is process orientated ("high") since it describes the whole process, all machines, layout. (2) Product orientation criteria –WID is also product oriented ("Mid") since it can contains the routes followed by all product. (3) Visual effectiveness criteria –The size of the items in the WID gives effective notion on important production information such as layout, waste and performance. (4) Scope criteria –WID show more information than any other tool. It shows layout, flows, idle capacity, OEE information, all waste forms, performance, personnel,

In the original form, the WID diagrams are composed by blocks, arrows and a pie chart. The blocks represent stations (benches, machines, equipment or even sectors),the arrows represent the required transportation effort for moving the parts from one station to the other (Sá, Carvalho and Sousa, 2011), and the pie chart depicts the activities and respective shares conducted by the workforce, i.e. the way workers spend their time. The block dimensions (see figure 1) include 4 main types of data: (1) the block length represents the amount of WIP waiting to be processed. It can be measured in units, in Kg, in meters, in cubic meters, in monetary units, or any other aggregate unit. (2) The block total height represents the takt time (TT). (3) The height of the bottom part of the block represents the station time (ST). The difference between the ST and the TT gives an idea about idle capacity. (4) The block depth represents the changeover time (C/O) of that process.

The arrowsbasically represent transportation effort, and, since transportation does not adds to product value, it is considered to be a waste. The thicker is the arrow, the higher is the waste involved on such operation. The transportation effort is calculated by multiplying the distance between the stations (client and supplier) by the quantity of products to be transported per unit of time.

Finally, the pie chart shows how the worker's time is used in different activities, from adding value to waste ones, such as motion, waiting or transportation. The values are gathered using work sampling techniques (Barnes, 1968).

3 Waste Identification Diagram with OEE information

The new WID version, under proposal, uses OEE data to enrich the quality of information regarding the station block icon. In fact, if we think carefully the takt time really useful value depends on OEE information, i.e. the planned stops as well as unplanned stops (see figure 1).

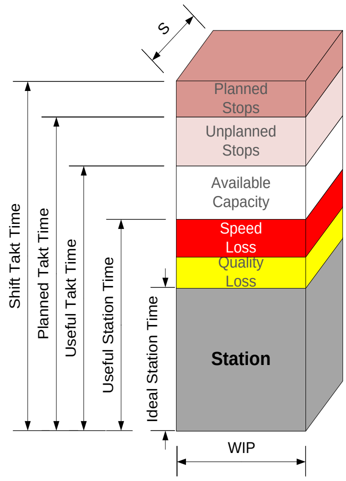


Fig.1 Ideal and Useful Station Times

The value of Useful Takt Time (U_{TT}) is given by the following equation:

$$U_{TT} = \frac{(S_T - Ps - Us)}{Qr} \tag{1}$$

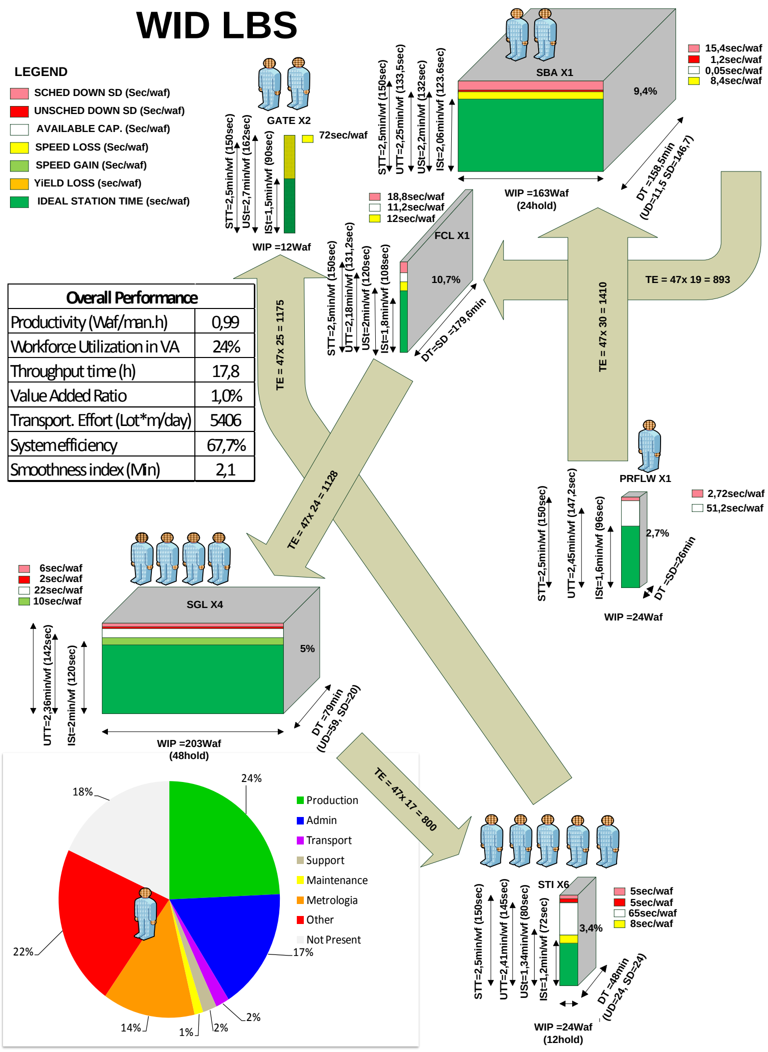
Where: S_T – Shift Time; *Ps*– Planned Stops; *Us* –Unplanned Stops;
Qr– Quantity Required in a shift.

Useful Takt Time can simply be described as the station time required per part in order to fulfil the quantity of parts required in a shift.

Station Time is also influenced by OEE data (see figure 2). In normal production the Ideal Station Time, frequently called standard time (which is determined by motion and time studies), will not be reached in average throughout the shift, since unplanned stops will occur and some parts may be rejected. Under these realistic assumptions, a higher value for station time should be assumed so that more effective planning can be performed. The proposed value for this Useful Station Time (U_{ST}) is given by the following equation:

$$U_{ST} = \frac{I_{ST}}{(QL * SL)} \tag{2}$$

Where: I_{ST} – Ideal Station Time; *QL* – Quality Loss; *SL* – Speed Loss



Overall Performance	
Productivity (Waf/man.h)	0,99
Workforce Utilization in VA	24%
Throughput time (h)	17,8
Value Added Ratio	1,0%
Transport. Effort (Lot*m/day)	5406
System efficiency	67,7%
Smoothness index (Min)	2,1

Fig. 2 Waste Identification Diagram forthe LBS unit

The WasteIdentification Diagram describing the current state of the LBS production unit in depicted in figure 2. On this particular diagram the depth of the blocks does not represent the changeover time, instead it represents the downtime information. This follows a specific request from the company managers. Another particularity is that the location of the blocks (representing equipment) corresponds to the relative position in the real layout, thus facilitating the understanding of the real production unit.

By observing at the WID diagram, depicted on figure 2, a person familiarized with the WID icons should rapidly come to the following readings: (1) The layout seems inadequate. The production flow is quite confusing. Transportation effort seems to be excessive. A new layout should be considered. (2) Most inventory (WIP) related waste is exist on SGL and SBA. The WIP associated to other processes is substantially smaller. A project on pull flow should be planned. (3) Speed loss is very high on the GATE process. (4) SBA is critical since it is working at near capacity limits. Planned downtime should be rethought and quality problems should be solved. On the other hand PRFLW and STI still have extra capacity available. (5) Only 24% of the workers time is actually spent on adding value, the remaining 76% is spent of non-value adding activities (waste). This fact requires attention since it represents a lot of waste (14 workers x 0.76 = 10.64 workers).We may roughly express that non-value adding activities (waste) require more than 10 workers. We think that this issue is important enough to justify actions targeting the reduction of the non-adding value activities. (6) The Value Added Ratio is very low (less than 1%). Meaning that 99% of the time the products are standing in queues to be processed.

4 Conclusions

In this paper we introduced and explained a new version of the Waste Identification Diagram, which includes OEE data. We applied it on a real production unit of the semiconductor sector, and conducted a brief analysis of the diagram highlighting a number of key issues that require further attention. The WID allowed a rapid detection of critical processes, available capacity, layout inadequacy and the location of most forms of waste as well as its values. The OEE data helped in detecting possible solutions to increase capacity in the most critical process, the SBA. We believe that these diagrams are very effective in representing and diagnosing production units, showing most forms of waste and giving clues for further improvement.

5 References

American Society of Mechanical Engineers (1947) ASME standard; operation and flow process charts. New York. ASME.

Barnes R M (1968) Motion and Time Study: Design and Measurement of Work. 6th edition, John Wiley & Sons, Inc.

Braglia M, Carmignani G, Zammori F (2006) A new value stream mapping approach for complex production systems. International Journal of Production Research, 44(18-19), 3929-3952.

Chitturi R M, Glew D J, Paulls A (2007) Value stream mapping in a jobshop. Paper presented at the Agile Manufacturing, 2007. ICAM 2007.IET International Conference on.

Dinis-Carvalho J, Moreira F, Bragança S, Costa E, Alves A, Sousa R (2014) Waste Identification Diagrams, Production Planning and Control, Accepted for publication.

Forrester J (1958) Industrial dynamics: a major breakthrough for decision makers, Harvard Business Review, July-August, 37-66.

Hasen R C (2001) Overall Equipment Effectiveness: A powerful production/maintenance for increased profits, New York, Industrial press inc.

Hicks C, Heidrich O, McGovern T, Donnelly T (2004) A functional model of supply chains and waste. International Journal of Production Economics, 89(2), 165-174.

Hines P, Rich N (1997) The seven value stream mapping tools. International Journal of Operations & Production Management, 17(1-2), 46-64.

Hoekstra S, RommeJ (Eds) (1992) Towards Integral Logistics Structure – Developing Customer-Oriented Goods Flows, McGraw-Hill, New York, NY.

Huang C C, Liu S H (2005) A novel approach to lean control for Taiwan-funded enterprises in mainland China. International Journal of Production Research, 43(12), 2553-2575.

Irani S A, Zhou J (1999) Value Stream Mapping of a Complete Product.MS thesis, The Ohio State University, Columbus, OH.

Lovelle J (2001) Mapping the value stream. IIE Solutions, 33(2), 26-32.

McDonald T, Van Aken E M, Rentes A F (2002) Utilising simulation to enhance value stream mapping: a manufacturing case application. International Journal of Logistics Research and Applications, 5(2), 213-232.

Miles L (1961) Techniques of Value Analysis and Engineering, McGraw-Hill, New York, NY.

Neumann W P, Medbo L (2010) Ergonomic and technical aspects in the redesign of material supply systems: Big boxes vs. narrow bins. International Journal of Industrial Ergonomics, 40(5), 541-548.

New C (1974) The production funnel: a new tool for operations analysis, Management Decision, Vol. 12 No. 3, 167-78.

New C (1993) The use of throughput efficiency as a key performance measure for the new manufacturing era, The International Journal of Logistics Management, Vol. 4 No. 2, 95-104.

Ohno T (1988) Toyota production system: beyond large-scale production: Productivity press.

Rother M, Shook J (1999) Learning to see: value stream mapping to add value and eliminate muda: Productivity Press.

Sá JC, Carvalho JD, Sousa RM, 2011 Waste Identification Diagrams. 6º CongressoLuso-Moçambicano de Engenharia.Maputo, Aug 29-Sept 2.

Seth D, Gupta V (2005) Application of value stream mapping for lean operations and cycle time reduction: an Indian case study. Production Planning & Control, 16(1), 44-59.

207 Supply Chain Sourcing Strategies in Wind Business

Castelló J, De Castro R

Rodolfo de Castro (✉ e-mail:rudi.castro@udg.edu)
Dpt. d'OrganitzacióGestió Empresarial i Disseny de Producte. Escola Politècnica Superior.
Universitat de Girona. C/ Mª AurèliaCapmany, 6117071 Girona.

Abstract: This contribution is a case study of supply strategy application in wind business. It considers two attributes for classifying the components for a wind turbine manufacturer. Based on a matrix from the literature and adapted through a supply chain management perspective, we present a wind turbine components classification methodology designed to distinguish various supply strategies depending on the attributes of the components themselves. In this article we describe the wind sector, the wind turbine Bill of Materials (BOM) and the results. This methodology has contributed in directing efforts towards component supply so as to reduce lead time, supply risk, and uncertainty when delivering final wind farm projects.

Keywords: Supply Chain, case study, Wind Turbine, Wind Turbine Manufacturers, Wind Farms.

1 Introduction

The Wind Business (WB) is a relatively new industry and in Western Europe its origins date back to the 1970's. Despite its relative infancy, the global wind energy market has experienced a steady 25% per annum growth rate over the past 10 years. Nowadays, wind energy represents a major trend as countries try to establish renewable energy technologies and diversify their energy mix.

The investment required to install a Wind Farm (WF) is massive: the cost of an onshore 2MW turbine is estimated to be 1.3 million Euros per MW. Besides the determination of governments to rely less on unsustainable fossil fuels, a further reason as to why the WB future is bright is because the wind energy input is free and unlimited; providing that the WF is located strategically in regions that have strong winds.

2 Wind Energy As a Business

The WB has expanded exponentially in recent years. The increase in the megawatt power of these machines is constantly increasing. Furthermore, customer requested technological requirements and product customization has increased as well (Kaldellis and Zafirakis, 2011). The majority of customer profiles are large power generating "public utilities" (e.g.Iberdrola, EON, EDP, EDF), although there are also independent investors (IPPs - Independent Power Producers) who are WF owner-operators that sell the energy they generate to the public utilities.

One key point to bear in mind, so as to understand the complexity of the business, is that these customers do not actually buy the Wind Turbines (WT, rather customers buy WF or power generation capacity (MWxh). Moreover, there is the uncertainty of demand, not only from the standpoint of concrete contracts, but also from the uncertainty in executing these WF contracts as well. This uncertainty is sometimes caused by administrative barriers; mainly those concerned with the project licensing process. These barriers to these licenses arise from the public administration and regulations of each individual country, environmental impacts, etc., and sometimes stem from infrastructure or electric network connection problems. Consequently they can delay WF construction permits for years, making it, duet such erratic demand and forecasting, even more difficult to align Wind Turbine Manufacturers (WTM) production capacity.

Further, one of the main challenges to meet is the high technological requirements that a WT stipulates i.e. it needs to run and work efficiently 97.5- 98 %, of the time according to the contract, although this is a median value (Willburn, 2011), and have an estimated 20-year lifespan. This technological demand on the efficiency and machine life, which is required for a WT, is disaggregated on an individual component level; consequently making any new development of key components available only to a few skilled suppliers. This high risk technology assumption causes a shortage of so-called key components, which in turn creates bottlenecks in the supply chain (MAKE, 2013; BTM Consult, 2011; Aubrey, 2007).

In other words, long lead times of these key components, along with demand uncertainty, force the WTM to slot their short-term planning work (backlogs of administrative authorizations and forecasts) in between orders. As a result, supply chain management becomes not only a powerful strategic weapon, but also an order winning criteria when contracts are awarded.

3 Objectives

This contribution, by applying the different paradigms found in the literature (Lean, Agile, or Leagile Supply Chain), aims at efficient design supply strategy in

WB, from the point of view of the WTM. We can characterize the WB from the perspective of manufacturing and operations under the following attributes: (1) Low volume or One-off(2) High variability (3) High customization (4) High technology (5) High quality levels and (6) the short life cycles of a WT.

We present the application to supply chain segmentation in WB, but this could be applied to sector which is characterized by the same attributes as listed above.

4 Wind Energy Basics and Main Component Description

Wind power technologies transform the kinetic energy of the wind into useful mechanical power. The kinetic energy of the air flow provides the force that turns the WT blades which, via a drive shaft, provide the mechanical energy to power the generator in the WT. The modern era of wind power began in 1979 with the mass production of WT by the Danish manufacturers NecMicon, Vestas, Nordex and Bonus. These early WT typically had small capacities (10 kW to 30 kW) by today's standards, but they did pioneer the development of the modern wind power industry that we see today. The current average size of grid-connected WT is around 1.16 MW (BTM Consult; 2011), while most new projects use WT between 2 MW and 3 MW.

WT consists of three principal elements (Wilburn; 2011; Blanco, 2009), (1) the nacelle, (2) the rotor, (3) and the tower (figure 1).

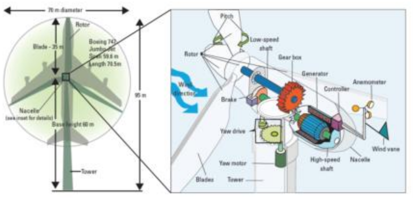


Fig. 1 Main components of a Wind Turbine; nacelle, rotor and tower (Wilburn, 2011)

A typical WT will contain up to 8,000 different components (Aubrey, 2007) and is reported to contain, by weight, 89.1% steel, 5.8% fiberglass, 1.6% copper, 1.3% percent concrete (primarily cement, water, aggregates, and steel reinforcement), 1.1% adhesives, 0.8% aluminium, and 0.4% core materials (primarily foam, plastic, and wood) (Willburn, 2011). The cost of the turbine itself accounts for 76% of the total capital cost of a WF project (EWEA; 2009).

5 The Wind Energy Supply Chain Landscape

The WB landscape is composed of developers, manufacturers and operators. WTM generally embrace a range of activities including development, design, production, WF construction, operation and on-shore and off-shoreWT servicing.

The Wind Energy Supply Chain (WESC) – Figure 2 – is basically composed of five entities: (1) raw material component suppliers, (2) component suppliers (3) assembly plants – WTM, (4) WF construction, including civil works installation and commissioning and wind farms technical service, (5) and finally, the customer, who is usually responsible for the operation and maintenance of the WF. However, utility companies might also be involved in generating, transmitting and distributing the wind energy.

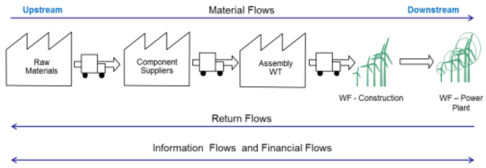


Fig. 2 Wind Energy Supply Chain (WESC) (Source: Authors)

As the contribution of this article focuses on supply strategy, we focus on the "sourcing “activity carried out by the WTM. This activity includes the overall management of suppliers, finding new supply sources, selecting and rating suppliers, negotiating and procuring new contracts, monitoring the quality of contract purchases, as well as meeting deadlines, negotiating contracts and servicing technical assistance guarantees for those components that affect the availability of the WF turbine.

Component suppliers are strategic in the WESC (MAKE, 2013; BTM, 2011a, 2011b; Aubrey, 2007), because many of the components are developed in collaboration with suppliers (partnership), following an outsourcing strategy based on letting suppliers develop their core competence in a sector where both large doses of R&D and equipment (CAPEX) (i.e. blades, gearboxes, converters, generators, etc.) are needed.

In this WTM supplier partnership there are many factors determining the different strategies to take into account. The foundation of the relationship is based on the determining the position of Order Decoupling Point (ODP) as this determines the point where forecasts are replaced by the assignment of a specific project. Some authors (Mason -Jones et al, 2000; Naylor, et al, 1998) distinguish between lean and agile supply chains, where a lean supply chain would be applied upstream of the ODP, while an agile supply chain would be more suitable for downstream operations.

Supplying Strategies

According to the characteristics of the components, a different strategy should be followed as each component pipeline has different needs and features depending on the market it serves. While there are some models for existing Supply Chain design in the literature review (Kraljic1983, Fisher, 1997; Mason -Jones, et al., 2000; Christopher et al., 2006) and while they are very rich in their contribution contents, they are simply not specific enough when the design is required for a particular sector. By designing a sourcing strategy in the WB, we develop a simplified model based on Kraljic (1983) and Christopher et al., (2006) to apply to this case study. The particular attributes have been listed above highlighting the fact that, in this sector, the supply of components is fundamental (MAKE, 2013; BTM, 2011a, 2011b; Aubrey, 2007).

Therefore we classify families of components in two dimensions:

• **Profit impact**: this is the cost of the component that in turn influences the working capital and work in progress supported by WTM. Bear in mind that the cost of the ex-work component is around 70 % to 76 % of the cost of an installed WT and, as a WT has around 8000 references and by classifying and monitoring these references more efficiently, we can reduces costs. can (Aubrey, 2007).

• **Supply Risk**: this is the delivery lead time of a component, which determines the time we must wait for a particular component. It has a direct relationship with the few key components suppliers there are as they have such a limited capacity it could actually increase uncertainty In fact, this in itself limits the current key components capacity and causes business uncertainty.

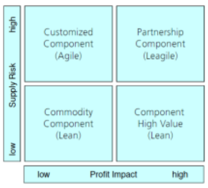


Fig. 3 WB Component Segmentation Matrix for WTM (Source: Authors)

These two attributes classified as either "low" or "high" impact, result in the portfolio components (2x2 matrix) depicted in Figure 3. This classification allows us to apply different strategies for the supply of each family of components (lean, agile, league, etc.) and model the different paradigms all the while seeking the maximum overall efficiency. The resulting four strategies are described below:

Commodities

These are basically commercial components that are purchased from a catalogue and have low economic value compared to the cost of construction as well as relatively short lead times (weeks or sometimes only days). Usually there is no procurement strategy around these families of components and they are purchased at the best price and terms, and customer-supplier relationships are temporary "win-lose" deals, project by project. The lean supply strategy is "Continuous Replenishment" (Christopher; Peck, Towill, 2006) under a Kanban system, for instance. Supply management is the responsibility of the supplier who has to maintain a "point of order" according to the demand of the assembly plant

Customized

These are bought according to specific commercial references and technical characteristics as specified in a catalogue or, generally, where the WTM can choose certain attributes for configuring them to their particular requirements (e.g. low voltage electric motors, electrical equipment, high voltage cables, hydraulic power, instrumentation, etc.). Usually, these components have lead times of about 2 months. Here, there is a clear strategy of the customer's purchasing and the supplier relationships being "win-lose" so generally alternative suppliers are monitored to help source better prices and service levels. This kind of agile supply is because the supplier customizes these components and gives a quick response to customer-driven demand.

High Value

These are components that are purchased from drawings or according to particular technical specifications because, as they usually are structural components, their fabrication requires meticulous attention and they require high quality and are complex in terms of the technology implementation processes, such as foundries, forges, machining, welding, etc. (e.g. hubs, main frames, towers, flanges , covers, etc.)They demand. In these types of components, suppliers are involved from the beginning in the design phase, as the methods and processes used have a huge influence on the final attributes of the product. They generally have lead times between 2-3 months and around these components there is a clear purchasing strategy and supplier relationships are "win- win" and long-term. Such components often reach bottleneck capacity and, some of them often limit the ability of the whole chain itself to meet its deadlines. Hence some WTM have decided to follow a vertical integration strategy (MAKE, 2013; BTM, 2011a, 2011b). The type of supply is lean and there is an annual agreement with annual forecasts and quarterly adjustments based on demand.

Partnership

For developing these types of components closer cooperation with suppliers is required from beginning of the design (Kraljic, 1983), since it is actually the supplier who design the piece based on the statement of required conditions determined by the WTM and so that it can be integrated with other components. The correct and precise definition of specifications by the WTM, determines the results of the design (e.g. blades, gearbox, converter, pitch system, generator, etc.) and, to a large extent, the reliability of the final components.

There is a clear sourcing strategy around these components, based on the long-standing and mutual cooperation. The relationship is "win-win" as it is based on long-term co-design. These components have long lead times, since both the supply of the raw materials and the technological complexity of the processes mean that lead times are 5 to 7 months long. The supply strategy should usually be leagile. As there are framework capacity agreements (lasting for several years) and technological developments, the supplier can plan their factories and raw material supplies accordingly to, finally, customize products based on real demand needs in quarterly planning. Moreover suppliers use the same platform for different customers as a strategy to exploit economies of scale and even some WTM have also opted for vertical integration because some components can be considered as supply chain bottlenecks

6 Results

The application model in the WESC classifies WTM components as in the accompanying Figure 4. This makes it possible to classify each and every one of the WTM components, thus determining a clear sourcing strategy for each.

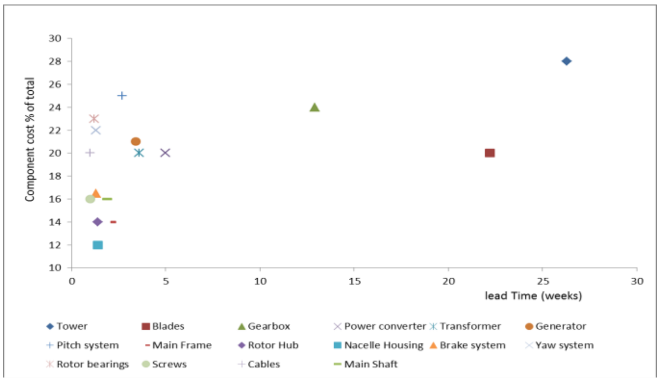


Fig. 4 Matrix results from model application. Component segmentation (Source: Authors)

The unavailability of some of these parts could condition WF delivery, especially in some regions such as North America, Latin America or Asia Pacific, so that, considering the global character of the chain, some WTM (e.g.Vestas , Gemesa, Enercon, etc.) have opted for vertical integration strategies (MAKE, 2013; BTM, 2011a, 2011b; Aubrey, 2007).Through this approach is based on Profit Impact and Supply Risk, it is possible to determine the best sourcing strategy of key components.

To sum up, and as Figure 4 shows, depending on the nature of the components and their attributes four different pipelines for a WTM have defined which in turn determines four different ways of managing supplier relationships.

7 Conclusions

From the application of a methodology based on supply strategies from Kraljic (1983) and improved with the development of theories in Supply Chain Management by Christopher et al., (2006), we have presented a case where supply strategies are determined for a project to build a WF.The clamour of needs and requirements, in particular administrative barriers, involved in a WF installation planning, makes component supply a crucial element when the WF is completely defined. Component sourcing has to be as fast and efficient as possible following the component classification. Depending on each of the strategies, it is possible to determine a different ODP for each pipeline so that the assignation of a purchased component for a tangible WF installation project is the most appropriate way to manage the working capital and work in progress, for both WTM and suppliers, in the most efficient way possible. To sum up, the WTM must become skilled in management and Supply Chain integration, since the variable costs are the same cost as the components, meanwhile the WTM must efficiently manage capacity, time limits and the uncertainty of WF projects.

8 References

Aubrey, C. (2007) “Supply chain: The race to meet demand”, Wind Directions Jan / Feb pp 27-34

Blanco, M. I. (2009). The economics of wind energy. Renewable and Sustainable Energy Reviews, 13(6-7), 1372–1382.

BTM (2011a) “International Wind Energy Development. Supply Chain Assessment 2012-2015”. November 2011

BTM (2011b) World Market Update, BTM Consult. RingkØbing.

Christopher, M. (2000), “The Agile Supply Chain: Competing in Volatile Markets”, Industrial Marketing Management, Vol. 29 No. 1, pp. 37-44.

Christopher, M. and Towill, D.R. (2001) “An integrated model for the design of agile supply chains”, International Journal of Physical Distribution & Logistics Management, Vol. 31 No. 4, pp. 235-46.

Christopher, M., Peck, H. and Towill, D. (2006).A taxonomy for selecting global supply chain strategies. *The International Journal of Logistics Management*, *17*(2), 277–287.

EWEA - European Wind Energy Association (2009), Wind Energy - The facts. The economics of Wind Power.

Fisher (1997) “What is the right supply chain for your product?” Harvard business review, March April pp 105-117

Kaldellis, J. K., &Zafirakis, D. (2011). The wind energy (r)evolution: A short review of a long history. Renewable Energy, 36(7), 1887–1901.

Kraljic (1983) "Purchasing must become supply management" Harvard business review, sept-Oct pp 109-117

MAKE Consulting (2013) Market Report "Global Wind Power Supply Chain". August 2013

Mason-Jones, R. and Towill, D., (1999), "Using the Information Decoupling Point to Improve Supply Chain Performance", International Journal of Logistics Management, Vol. 10, No. 2, pp 13-26

Naylor, J. B., Naim, M.M., and Berry, D., (1999), Leagility: Integrating the lean and agile manufacturing paradigm in the total supply chain, Engineering Costs and Production Economics, 62, 107-118.

Wilburn D.R. (2011). Wind Energy in the United States and Materials Required for the Land-Based Wind Turbine Industry from 2010 through 2030. Scientific Investigations Report

210 Foreign Trade of the Basque Country: internationalisation policies

Alvarez I, Zarrabeitia E, Cantonnet M L, Aldasoro J C

Izaskun Alvarez(✉ e-mail:izaskun.alvarez@ehu.es)& Enara Zarrabeitia (✉e-mail: enara.zarrabeitia@ehu.es)
Dpto. de Organización de Empresas. Escuela Superior de Ingeniería de Bilbao. UPV/EHU. C/ Alameda Urquijo s/n, 48013 Bilbao.

Maria Luisa Cantonnet& Juan Carlos Aldasoro
Dpto. de Organización de Empresas. Escuela Politécnica de Donostia-San Sebastián. UPV/EHU. C) Plaza Europa 1, 20018 Donostia-San Sebastián.

Abstract: Almost all territories currently consider the internationalization of their enterprises and economy as a key enabler to realize their competitiveness, welfare and regional development. However, it has thus far conducted very few studies that analyze the relationship between the internationalization policies and the degree of internationalization achieved by a territory. Because of this, the aim of this research paper is to analyze the evolution of the indicators related to foreign trade of the Basque Country together with the internationalization policies promoted by the Basque public administration over the last two decades.

Keywords: Foreign Trade, internationalisation policies, Basque Country.

1 Introduction

At present, the countries consider their economy, enterprises and people internationalisation as a key driver to achieve their competitiveness, welfare and regional development (Azua, 2010). Against this background, the progress of internationalisation is probably the most relevant change experimented by the Spanish Economy in the second half of the twentieth century. The process has taken place in different stages, driven by the adhesion to the Community project in the eighties and consolidated after the introduction of the single European currency (Consejo Superior de Cámaras, 2007).

However, even though the benefits of putting on the market abroad are clear, there are obstacles that end up having more or less importance, depending on the country of destination (Sánchez, 2012). Thus, throughout this process, the policies to support the internationalisation play an important role. Several studies have proved that without the government support measures a substantial number of enterprises have not succeeded in internationalisation process (European Commission, 2007; Lambrecht y Pirnay, 2005). Most small and medium-sized enterprises (SMEs), due to the lack of financial resources, time and skills needed for internationalisation, need help to acquire the necessary competences in order to compete successfully in the global market (OECD, 2009; European Commission, 2007).

In this way, the Spanish public administration, aware of the process of economic and commercial liberalisation which involved the creation of Single Market, began to enhance the foreign activity of the Spanish companies in a more active manner from the 1987, through the "Plan of Export Promotion", which has evolved to the present day (Villarreal, 2006).

As well, in the case of the Basque Country, according to the plan of competitiveness developed by the Basque Agency for Business Development SPRI (SPRI, 2010), the internationalisation of enterprises has been one of the strategic objectives of the Basque Government policies. In general, the process of opening to the outside of the Basque economy has been understood from a commercial perspective, promoting the creation of commercial and/or production establishments abroad, the attraction of investment, the establishment of foreign companies in the Basque Country or the technology transfer.

According to Schmiele (2012), policy implications can be directed to promote international innovation projects for firms or generally to set incentives to perform research and development on a continuous basis and overcome innovation disadvantages domestically.

However, although there are policies, programmes and instruments to make easier the process of internationalisation of economies and to improve the external competitiveness of enterprises, there is a scarcity scientific studies that analyze the relationship between the policies of internationalisation and the degree of internationalisation achieved by a territory.

2 Internationalisation vs. Foreign Trade

While foreign trade is an ordinary exchange, usually products in exchange for money, crossing a “border” (Bustillo, 2000), the internationalisation of the enterprise means a lot more than commercialize products and services abroad. In particular, the internationalisation can be defined as a strategy for economic grow through access to new geographic markets, in all domains of the business: sales, purchases, financial aspects and knowledge, among others (Departamento de Industria, Innovación, Comercio y Turismo, 2010).

Nevertheless, foreign trade operations are the evident feature of the business internationalisation. Thus, the interest subjects of researchers, social agents and public institutions are focused on knowing the causes and the conditions of the external balance of goods and services (Consejo Superior de Cámaras, 2007).

3 Objectives and methodology

The objective of this research paper is to analyze the relationships between the indicators which characterise internationalisation as a set of target parameters of the Basque Country foreign trade and the internationalisation policies driven by Basque public administration.

The external sector liberalisation was an opportunity for businesses and a stability source in the economy as a whole. But, from the statistical point of view, the liberalisation results in an increased difficulty in capturing data that, previously, were collected passively in the administrative records (Sanz, 2002). In this situation, new indicators have been developed to analyze the behaviour of foreign trade. In this case, Basque Government's Plan for Business Competitiveness 2010-2013 was taken as a reference to define the studied indicators that are listed below:

Table 1 Indicators of Internationalisation

Indicators	Description
Exports	Direct sales abroad of goods produced in the Basque Country
Imports	Purchases abroad of products for joining in both the production process or final consumption.
Rate of growth	Variation of percentages over the previous year
Degree of openness	(Exports + Imports) / GDP
Trade balance	Exports - Imports
Coverage rate	Exports / Imports

Moreover, in order to carry out the research study, the necessary data has been obtained from two information sources. In one hand, the Statistic Institute of Basque Country (Eustat) provides the historical series related to foreign trade for the period 1990-2013 that have been used to develop the indicators (Eustat, 2014); and in the other hand, the industry policies have been studied in order to list the aid programmes developed by the Basque Government and autonomous agencies, public bodies and companies, as it is SPRI.

4 Results

The main results obtained in the study of the indicators of the Basque Country foreign trade and the internationalisation policies are summarised below.

4.1 The evolution of foreign trade of the Basque Country

The behaviour of the foreign trade in the Basque Country shows ongoing positive developments in both exports and imports; but, this trend came to an end in 2009 as a consequence of economic crisis (see figure 1 and 2). Furthermore, the degree of openness of the Basque economy peaks in 2008 (59, 5%), shortly before the economic crisis unfolded (see figure 3).

Moreover, the trade balance experiences a significant increase from 2009 (see figure 4) due to there are more exports than imports. In turn, the coverage rate exceeds 100 % from 2009 (see figure 5); therefore, the proportion of payments related to the imports is covered with the exports receipts.

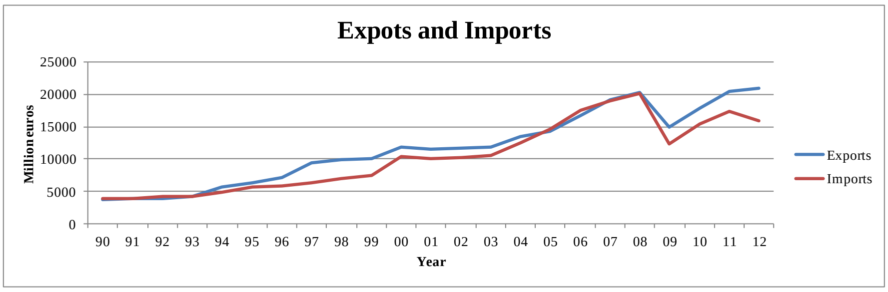


Fig. 1 The evolution of good exports and imports in the Basque Country.

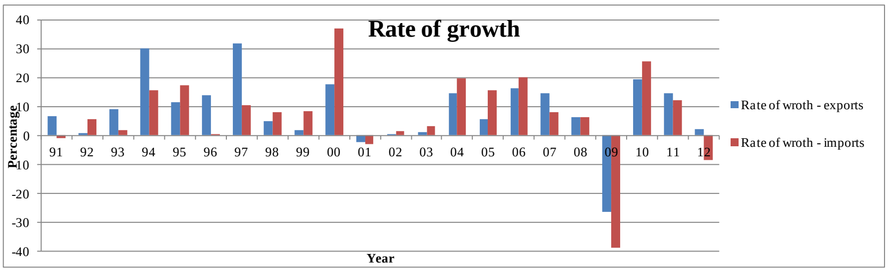


Fig. 2 The evolution of the rate of growth of exports and imports in the Basque Country.

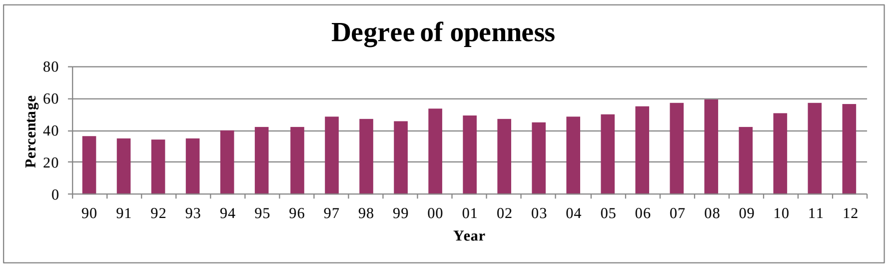


Fig. 3 The evolution of the degree of openness in the Basque Country.

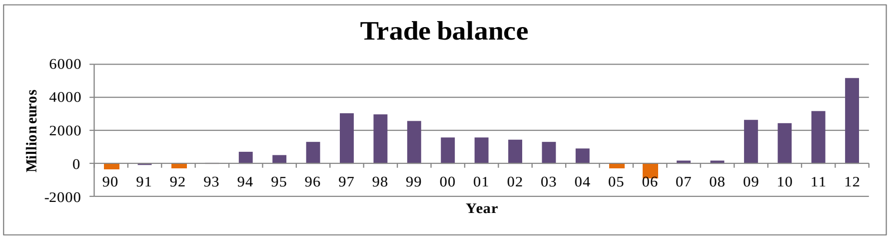


Fig. 4 The evolution of the trade balance in the Basque Country.

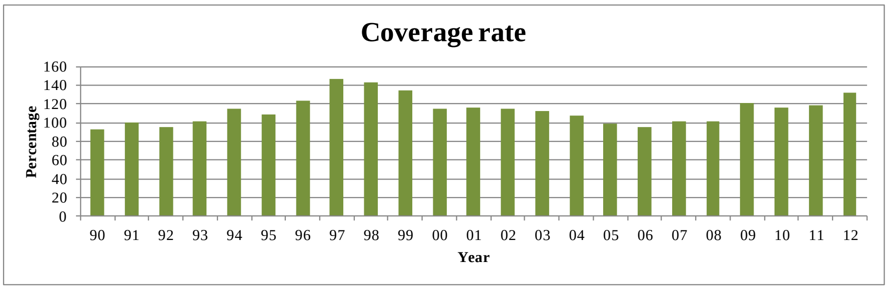


Fig. 5 The evolution of the coverage rate in the Basque Country.

4.2 Internationalisation policies promoted in the Basque Country

In order to address the challenging task of internationalisation, the Basque public administration has combined different actions to promote the internationalisation. The first steps in becoming internationalisation an interest area back to 80s. Accordingly, the creation of an external network of the SPRI[3], among others, was

[3] The SPRI group is the business development agency of the Basque Government. The SPRI group manages 75% of the budget of the Basque Government Department of Economic

launched, and it goes on to do its work at present. But, the first Strategic Plan of Foreign Trade Promotion of Basque Enterprises 1993-1996 was the strong support to business internationalisation (Castillo y Patón, 2010). After this first specific plan, the different industrial policies have identified the internationalisation as a strategic line to improve the competitive position of the industrial fabric of the Basque Country through the access to new markets and customers. For this reason, the development of different programmes has allowed to support the initiation and consolidation of enterprises internationalisation, to encourage the international vocation, to promote cooperation in the international level and to train persons and organizations on the internationalisation (see table 2).

Moreover, it is note that the last Science, Technology and Innovation Plan (PCTI) 2015 (Gobierno Vasco, 2011) marks a shift in the strategic lines related to internationalisation in order to develop new forms of community relationships. For this, the objectives of this plan are oriented to support the internationalisation of the SME and the social economy and to promote the internationalisation of the Scientific and Technological System as a whole which provides added value to productive fabric and is internationally recognized.

The study of the evolution of the different programmes promoted by the Basque Government and the public company SPRI (see table 2) will allow to compare whether there is any association between the parameters that study the foreign trade as the indicators of internationalisation and the aids promoted by administration for this purpose.

Table 2 Internationalisation policies promoted in the Basque Country. Prepared by the authors on the basis of Castillo and Paton (2010) and SPRI (2010)

AIDS TO INTERNATIONALISATION FROM BASQUE GOVERNMENT AND AUTONOMOUS AGENCIES, PUBLIC BODIES AND COMPANIES			
INDUSTRIAL AND COMPETITIVENESS POLICIES	**SCIENTIFIC, TECHNOLOGIC AND INNOVATION POLICIES**	**INTERNATIONALISATION POLICIES**	**PROGRAMMES**
Industrial Policy 1980-1990	**Technology Strategic Plan (PET) 1990-1992**		
		Economic Promotion Programmes 1980-1990 (SPRI) Internationalisation 1981-1992	BASKEXPORT (1981-1987) SOFAD (1982-1989) RED EXTERIOR SPRI (1986-ACTIVE)
General Framenwork of Indutrial Policy 1991-1995	**Industrial Tecbnology Plan (1993-1996)**		
		Strategic Plan of Foreign Trade Promotion of Basque Enterprises 1993-1996	GARAPEN (1992-1995) PLAN DE INICIACION A LA EXPORTACION PIE (1994- 1996)
General Framework of Industrial Policy 1996-1999	**Science and Technology Plan (PCT) 1997-2000**		
		Strategic Plan of Foreign Trade Promotion of Basque Enterprises 1997-1999	INDOBASK (1995-1998) PLAN DE INICIACIÓN A LA EXPORTACION PIE-PIPE 2000) (2000-2004)
Interinstitutional Plan for the Economic Promotion (PIPE) 2000-2003	**Science, Technology and Innovation Plan (PCTI) 2001-2004**		
		Internationalisation Plan (PIPE) 2000-2004	PROGRAMA DE INTERNACIONALIZACIÓN PROINTER (1998-2014) included in GLOBAL LEHIAN PROGRAMA ATZERRI (2000-2009) PROGRAMA ELKARTZEN (2000- ACTIVE) GAUZATU IMPLANTACIONES EXTERIORES (2000-ACTIVE)

Development and Competitiveness and ensures that it is distributed through services, programmes, investments and subsidies.

Table 2 (continued).

AIDS TO INTERNATIONALISATION FROM BASQUE GOVERNMENT AND AUTONOMOUS AGENCIES, PUBLIC BODIES AND COMPANIES			
INDUSTRIAL AND COMPETITIVENESS POLICIES	**SCIENTIFIC, TECHNOLOGIC AND INNOVATION POLICIES**	**INTERNATIONALISATION POLICIES**	**PROGRAMMES**
Competitiveness Forum Basque Country 2015/Competitiveness Strategic Basque Country 2015 (2003-2015) **Plan for Business Competitiveness and Social Innovation (PCEIS) 2006-2009**	**Science, Technology and Innovation Plan 2007-2010**	Internationalisation Plan	PLATAFORMAS EUSKARRI-BASQUE BUSINESS PLATFORM (BBP) (2006- ACTIVE) CONSULTBASQUE-DEVELOPMENT EXPERT PLATFORM (2008-2009) BASQUE SOFT-LANDING SERVICE (2009-2010) PROGRAMAS DE BECAS PARA TITULADOS EXTRANJEROS (2007-2010) VENTANILLA UNICA DE INTERNACIONALIZACIÓN – INTERSAREA (2001- ACTIVE) PROYECTOS INTERNACIONALES Y MULTILATERALES (2007- ACTIVE) REDES Y COOPERACIÓN (2008- ACTIVE) DIFUSIÓN Y SENSIBILIZACIÓN (2006- ACTIVE) EUSKADI INTERGUNE: PUNTO DE ENCUENTRO (2006- ACTIVE) PROGRAMA DE BECAS DE INTERNACIONALIZACIÓN (1994- ACTIVE) APOYO A LA REFLEXIÓN ESTRATEGICA – PROGRAMA INTERBIDE (2005-2009) included in *GLOBAL LEHIAN*
Plan for Business Competitiveness 2010-2013 Actions: Open Economy, promote internationalisation	**Science, Technology and Innovation Plan 2015** Strategic line: Science and Technology System internationalisation		GLOBAL LEHIAN (replace PROINTER) (2014- ACTIVE) BECAS GLOBAL TRAINING (2012- ACTIVE) INNOBIDEAK-LEHIABIDE – ACELERADOR DE LA COMPETITIVIDAD DE LAS EMPRESAS EN ENTORNOS GLOBALES (2013- ACTIVE) INVEST IN THE BASQUE COUNTRY (2011- ACTIVE)

5 Conclusions

The regions with more open economies are those that have higher levels of wealth and welfare. Also, going outside is not an option for a long time, but it has become a need that the level of globalization reached by the world economy has imposed (Sánchez, 2012).

In this case, the study allow us to conclude that the growth of the internationalisation of the Basque business fabric has been positive in the last two decades, highlighting the rate of growth in the nineties and the years before and after 2009, a critical point in which the foreign trade decreases values due to the economic crisis that affected all regions. But, it is noteworthy that the indicators of internationalisation begin to recover from 2010, becoming the exports once again a key pillar of enterprises.

In turn, the Basque public administration has considered the internationalisation as a key factor to the competitiveness of the region, and in this way the industrial and technological plans have shown, developing aid programmes in order to create the necessary empathy between the Basque business fabric and the open economy. The study of these policies allows us to conclude that the number of aid programmes related to internationalisation grew from the year 2000 due to the first Internationalisation Plan (PIPE), but they don't follow the same trend as the indicators that go down during the years 2000-2004 and 2009. So, the aid programmes were not able to help enterprises at that moment, perhaps because the ignorance of enterprises needs or because the crisis overcame all the aids.

This discussion allows us to do future researches about the relationships between the foreign trade parameters and the budgets for internationalisation plans.

6 Referencias

Azua, J. (2010): *La internacionalización de las empresas vascas. La paradoja de su internacionalización en un mundo glokalizado. Realidad y futuro en y desde Euskadi*. Disponible: http://www.basqueinfo.net/wp-content/uploads/2012/04/GT11_AN_Internazionalizazioa_Azua.pdf. Cited 3 March 2014.

Bustillo, R. (2002): *Comercio exterior*. Servicio editorial de la Universidad del País Vasco.

Castillo, J., Patón, J. (2010): "Políticas de promoción y reconversión industrial", *Ekonomiaz*, nº 25, pp 96-125.

Consejo Superior de Cámaras (2007): Internacionalización de la empresa española. Cooperación empresarial e inversión exterior. Ed. Cámaras de Comercio.

Departamento de Industria, Innovación, Comercio y Turismo (2010): *Plan de competitividad empresarial 2010-2013*. Servicio central de publicaciones del Gobierno Vasco, Vitoria.

European Commission (2007): *Supporting the internationalisation of SMEs*. Directorate-General for Enterprise and Industry. Brussels, Belgium.

EUSTAT, (2013): *Banco de datos. Series históricas. Economía. Comercio exterior*. Disponible: http://www.eustat.es/bancopx/spanish/tipo_N/id_2811/indice.html#axzz2vw0Py6WS.. Cited 5 March 2014.

Gobierno Vasco (2011): *Plan de Ciencia, Tecnología e Innovación (PCTI) 2015*, Gobierno Vasco, Vitoria-Gasteiz.

Lambrecht, J., Pirnay, F. (2005): "An evaluation of public support measures for private external consultancies to SMEs in the Walloon region of Belgium", *Entrepreneurship and regional development*, vol. 17, nº 2, pp 89-108.

OECD (2009): *Top barriers and drivers to SME internationalisation*. OECD, Report by the OECD Working Party on SMEs and Entrepreneurship, Paris.

Sánchez, N. (2012): "Internacionalización. Exportar para sobrevivir", *Confebask*, nº 1, pp 10-27.

Sanz, A. (2002): "Sector exterior español: indicadores de apertura, integración, especialización y competitividad", *ICE*, nº 798, pp. 149-162.

Schmiele, A. (2012): "Drivers for international innovation activities in developed and emerging countries", *Journal of Technology Transfer,* vol.37, nº 1, pp. 98-123.

SPRI (2010): Internacionalización. Marco de actuación. Disponible http://www.politicaindustrialvasca.net/PIGV/politicaindustrial_es.nsf/vwPrototipoVistas/774539E54DF4B1CDC1256E90006308B8/$File/0.0%20MARCO%20ACT_Vf.pdf?OpenElement. Cited 5 March 2014.

Villarreal, O. (2006): *La estrategia de internacionalización de la empresa. Un estudio de casos de multinacionales del País Vasco*. Tesis Doctoral, Universidad del País Vasco.

214 Importancia de los modelos de conducta en la intención emprendedora en estudiantes de ingeniería

The importance of role modelsfor the entrepreneurial intention of technical degrees students

Morales-Alonso G, Pablo-Lerchundi I, Vargas-P. A M

Gustavo Morales-Alonso (✉e-mail: gustavo.morales@upm.es)
Departamento de Ingeniería de Organización, Administración de Empresas y Estadística. E.T.S.I. Industriales. Universidad Politécnica de Madrid. c/ José Gutiérrez Abascal, 2. Madrid

Iciar Pablo – Lerchundi (✉e-mail: iciar.depablo@upm.es)
Instituto de Ciencias de la Educación (ICE). Universidad Politécnica de Madrid. c/ Profesor Aranguren, 3.Madrid

Ana M. Vargas – P. (✉ e-mail: ana.vargas@upm.es)
Departamento de Ingeniería de Organización, Administración de Empresas y Estadística. E.T.S.I. Industriales. Universidad Politécnica de Madrid. c/ José Gutiérrez Abascal, 2. Madrid

Abstract: Technology-based entrepreneurship is a critical issue for the generation of economic growth. For this reason, the determinants of entrepreneurial intention of students from technical universities are of particular relevance. This study analyzes the importance of role models for the entrepreneurial intention among students of technical degrees. The results show that students whose parents are entrepreneurs score higher than the average in entrepreneurial intention. Contrarily, those whose parents are civil servants are below average in entrepreneurial intention. Furthermore, the absence of role models for entrepreneurship in the near environment decreases entrepreneurial intention, while the lack of role models of civil servants does not influence it.

Resumen: El emprendimiento de base tecnológica es un tema crítico para la generación de crecimiento económico, por lo que conocer los determinantes de la intención emprendedora de estudiantes de universidades técnicas adquiere una especial relevancia. En este estudio se analiza la importancia de los modelos de conducta en la intención emprendedora entre los estudiantes de carreras técnicas. Los resultados muestran que los estudiantes de padres empresarios tienen una intención emprendedora superior a la media, mientras que los de hijos de padres funcionarios están por debajo de ella. Igualmente, la ausencia de modelos de conducta emprendedora en el entorno cercano disminuye la intención emprendedora, mientras que la ausencia de funcionarios no la hace aumentar.

Keywords: entrepreneurship, technology-based companies, parental influence, knowledge transference, engineering students.

Palabras clave: emprendimiento, empresas de base tecnológica, influencia de los padres, transferencia de conocimiento, estudiantes de ingeniería.

1 Introducción

La crisis económica que ha sufrido España en el último lustro ha afectado al tejido industrial del país. Según el informe de Global Entrepreneur ship Monitor para España en 2012 (Hernández et al., 2012) la creación de nuevas empresas se ha resentido. En concreto, se resalta que ha aumentado el porcentaje de emprendimiento por necesidad, que ha pasado de un ratio de 14,5% al 25,6% en ocho años de crisis. También se ha reducido el ratio de nuevas empresas que se fundan por oportunidad. El aumento del emprendimiento por necesidad es preocupante, ya que está asociado a la necesidad de auto-empleo en épocas de crisis. Por el contrario, el emprendimiento de base tecnológica está asociado a la generación de riqueza (Fernández & Hidalgo, 2011; Molero & Maldonado, 2012).

Es en este contexto donde se aprecia la importancia de los estudiantes en ingeniería ya que son ellos de quienes podría esperarse la creación de empresas de alto contenido tecnológico con buenas posibilidades de crecimiento y creación de empleo. Cabe destacar que fomentar la intención emprendedora de sus estudiantes es una de las responsabilidades sociales de las universidades técnicas. Desde un punto de vista cognitivo, la intención es el desencadenante de la conducta (Bygrave, 1989). Es decir, nadie llegará a fundar nunca una empresa si no tiene intención de ello. Entre los modelos intencionales cabe destacar la Teoría de la Conducta Planificada (*Theory of Planned Behavior, TPB*) de Ajzen (1991), el Modelo de la Conducta Empresarial de Shapero y Sokol (1982) y el de Krueger y Brazeal (1994).

En esta investigación se parte de la Teoría de la Conducta Planificada, TPB, de Ajzen para analizar la importancia que los modelos de conducta tienen en los estudiantes de ingeniería de la Universidad Politécnica de Madrid (UPM). De acuerdo con este autor, la intención viene determinada por tres factores socio-cognitivos: la actitud hacia la realización de la conducta, la norma subjetiva en relación con la acción, y la creencia en la propia capacidad para llevar a cabo con éxito el comportamiento, en este caso, la fundación de una nueva empresa. En una revisión meta-analítica de 185 estudios empíricos en los que se aplicaba el modelo TPB, Armitage y Conner (2001) muestran que el mismo es eficaz en la predicción tanto de las intenciones como de los comportamientos.

En la figura 1 se recoge el esquema del modelo, resaltado en color negro. La actitud conductual se relaciona con el nivel de atractivo y sugestión que tiene la acción, lo cual genera un comportamiento favorable o desfavorable hacia la misma, mientras que la norma subjetiva se traduce en la percepción de una presión social por el individuo en cuanto a realizar o no la conducta. Por último, el control percibido es un factor que puede facilitar o impedir el desempeño de la conducta, de acuerdo con la percepción del poder de dichos factores.

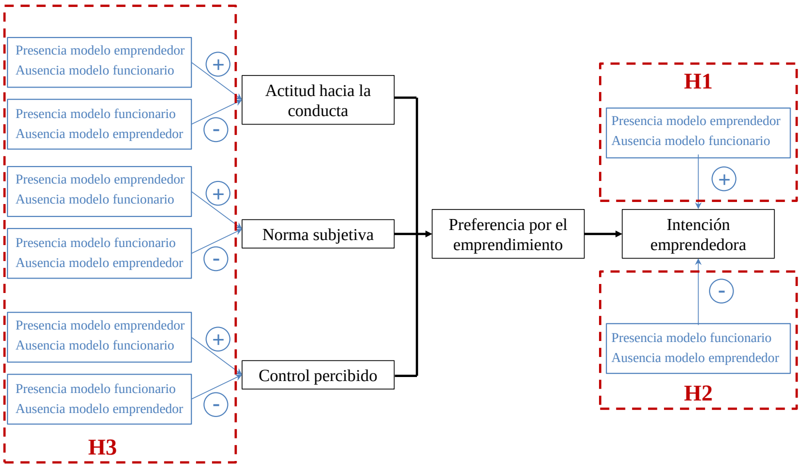


Fig. 1 Modelo Theory of Planned Behavior (TPB) de Ajzen (1991), resaltado en color negro. En color azul, el modelo que se prueba en este trabajo, y en rojo, las tres hipótesis en estudio.

Un número considerable de estudios ha demostrado una correlación positiva entre la ocupación de los padres como empresarios y la probabilidad de que sus hijos se conviertan ellos mismos en empresarios (Bosma, 2012; Carr, 2007; Laspita, 2012; Oren, 2013). Esto se atribuye a que, en general, los padres se encuentran en una posición única para influir en el comportamiento futuro de sus hijos, convirtiéndose en modelos de conducta para ellos. En concreto, Shapero y Sokol (1982) argumentan: "La familia, y en especial el padre y la madre, desempeña el papel más poderoso en el establecimiento de la conveniencia y la credibilidad de la acción empresarial para el individuo”. Si el hecho de tener padres empresarios supone una mayor probabilidad de que los hijos lo sean, es de suponer que tener padres funcionarios también puede tener alguna influencia, si bien esto no se ha estudiado hasta la fecha. En este estudio nos hemos centrado en la influencia que dos modelos de conducta contrapuestos (empresario y funcionario) tienen en la intención emprendedora de los estudiantes de carreras técnicas. La pregunta de investigación es ¿se puede considerar que existen dos modelos de conducta en lo relativo a la intención emprendedora, (i) el que fomenta el emprendimiento y (ii) el que lo desalienta? Como corolario de esta pregunta se plantea una segunda: ¿la ausencia de modelos de conducta tiene la misma importancia que su presencia?

Con el objeto de responder estas preguntas, se ha realizado una encuesta sobre intención emprendedora a estudiantes de la UPM, precisando en ella si sus padres tienen su propio negocio, o si bien no hay nadie de su entorno que lo tenga, así como si sus padres son funcionarios o si no hay ningún funcionario en el entorno cercano. Los casos de los alumnos que tenían cada uno de sus progenitores en una de las dos situaciones se han eliminado de la muestra.

Las hipótesis que se quieren comprobar en este estudio, de acuerdo a lo que muestra la figura 1, son:

H1: la presencia de un modelo de conducta emprendedor en los padres y la ausencia del modelo de funcionarios aumenta la intención emprendedora de los hijos.

H2: la presencia de un modelo de conducta funcionario en los padres y la ausencia de un modelo de empresarios influye negativamente sobre la intención emprendedora.

H3: ambas hipótesis H1 y H2 se cumplen para las dimensiones que forman el modelo TPB (actitud hacia la conducta, norma subjetiva y control percibido).

2 Metodología

La muestra de esta investigación se ha obtenido en cinco escuelas diferentes de la Universidad Politécnica de Madrid (UPM). Los datos se recogieron mediante una encuesta que los alumnos respondieron al inicio de una de sus clases, tras una breve introducción del proyecto de investigación. Las escuelas en las que se llevaron a cabo las encuestas se encuentran entre las de más tradición y mayor demanda dentro de la UPM: ETSI Aeronáuticos, ETS Arquitectura, ETSI Caminos, Canales y Puertos, ETSI Industriales y ETSI Telecomunicaciones. Los datos se recogieron durante cuatro semanas en el primer semestre del curso 2012/2013.

Del total de la muestra de 1004 estudiantes se eliminaron las encuestas de alumnos de nacionalidad no española, así como las que marcaban simultáneamente tener padres empresarios y funcionarios para asegurar la homogeneidad de la muestra, quedándose la muestra final en 851 alumnos. De ellos, un 67,3% son hombres y un 32,3% mujeres, mientras que un 0,4% de los encuestados no dieron información al respecto. Esta distribución resulta congruente con el porcentaje de alumnas en esta universidad. Como ya se ha mencionado, se eligieron cinco carreras para obtener los datos, siendo la distribución porcentual en cada una: 31,7% Aeronáuticos, 18,3% Arquitectura, 20,1% Caminos, 24,2% Industriales y 5,6% Telecomunicaciones. Los cursos en los que se recogieron las encuestas fueron el primero y el último de cada carrera, con una distribución equilibrada de 50,9% de alumnos de primero y de 49,1% de último curso. En cuanto a edad, la media se sitúa en 20,52 años con una desviación típica de 2,90, siendo el mínimo 17 y el máximo 34.

La encuesta ha sido diseñada de acuerdo con el modelo TPB de Ajzen, con el objetivo de medir la intención emprendedora de los alumnos e incluyendo las dimensiones de actitud hacia la conducta, norma subjetiva y control percibido. Junto con estas dimensiones, se han estudiado otras variables socio demográficas, tales como el género, la edad y la ocupación y nivel de estudios de los padres.

La *intención emprendedora* se ha medido mediante seis ítems de la encuesta, adaptados de Liñán y Chen (2009). Estos ítems exploran distintos aspectos de la intención y se miden mediante una escala Likert de 1 (totalmente en desacuerdo) a 7 (totalmente de acuerdo). La media de los seis ítems otorga una puntuación de la intención emprendedora del alumno, que es una de las variables dependientes.

Otras variables dependientes son la *actitud hacia la conducta*, medida con 5 ítems, la *norma subjetiva*, definida por 4 ítems y el *control percibido* formado por 6 ítems. En todos ellos, se utiliza una escala Likert de 1 a 7 como la descrita para la intención emprendedora, adaptada igualmente de Liñán y Chen (2009).

Como ya se ha adelantado, las variables independientes hacen referencia a la presencia de modelos de conducta cercanos al alumno. Por este motivo, se incluye en la encuesta la presencia o ausencia de emprendedores y funcionarios en el entorno del estudiante.

3 Resultados

A nivel descriptivo, encontramos que los alumnos encuestados muestran una media de 3,57 sobre 7 en *intención emprendedora*, por lo que se sitúan en la mitad de la escala. Del mismo modo, la media total en *control interno* hacia la conducta supone 3,32, lo cual denota que en general se ven medianamente capaces. La media obtenida para la variable de *actitud conductual* es mayor, con un 4,87, por lo que puede interpretarse que tienden a ver el emprendimiento como una salida atractiva. Finalmente, el factor de la *norma subjetiva*, en este caso el apoyo percibido por parte de padres y hermanos en caso de crear su propia empresa, los encuestados denotan la media más alta (5,64).

Pero lo que resulta de interés en el presente estudio, es determinar cómo el entorno, especialmente el modelo familiar, podría estar influyendo en dichas variables. Para comprobar si el modelo de conducta imperante en la familia influye en la intención emprendedora, se llevó a cabo un análisis de diferencia de medias (t de student), determinando si los hijos de padres con negocio propio o con alguien en su entorno que lo tuviera, diferían en su media en intención emprendedora de aquéllos con padres funcionarios o funcionarios en su entorno. Para ello se analizaron los ítems donde se preguntaba a los estudiantes si sus padres tenían su propio negocio o si eran funcionarios, así como ítems similares referidos a su entorno.

Como se puede observar en la tabla 1, tanto si los padres son emprendedores, como si existe algún emprendedor en el entorno cercano, la intención emprendedora de los estudiantes es mayor (t=-3,54; p<,001 y t=4,76; p<,001 respectivamente). Asimismo, el hecho de que los padres sean o no funcionarios supone una diferencia en la media en intención emprendedora, a favor de los hijos cuyos padres no trabajan en la administración pública (t=3,49; p<,001). Sin embargo, el hecho de que alguien del entorno sea funcionario, no tiene repercusión en la intención emprendedora, puesto que el análisis no arroja diferencias significativas entre las medias (t=-1,62; p=,106). Por tanto, H1 sólo puede aceptarse parcialmente, mientras que H2 se cumple en su totalidad.

Tabla 1 Diferencia de medias en la intención emprendedora

Modelo de conducta	N	Media intención emprendedora (sobre 7)	t	gl	Sig.
Padres sin negocio	669	3,48	-3,54	844	,000
Padres con negocio	177	3,91			
Entorno sin negocio	249	3,20	4,76	844	,000
Entorno con negocio	597	3,72			
Padres no funcionarios	505	3,71	3,49	845	,001
Padres funcionarios	342	3,35			
Entorno no funcionarios	220	3,70	-1,62	845	,106
Entorno funcionarios	627	3,52			

Adicionalmente, se analizaron las diferencias existentes en el resto de variables del modelo, es decir, actitud hacia la conducta, norma subjetiva y control interno, en base al modelo conductual de los sujetos.

Como se puede observar en las tablas 2, 3 y 4, la presencia de un modelo emprendedor, bien a través de los padres o bien a través del entorno cercano, influye sobre los tres factores determinantes de la intención emprendedora y siempre a favor de ésta, con puntuaciones medias significativamente más altas. Del mismo modo, la presencia de padres funcionarios, influye sobre todos los factores del modelo, arrojando dichos sujetos medias más bajas en su actitud conductual, norma subjetiva y control interno. Sin embargo, tal y como se ha visto con anterioridad, la presencia de algún funcionario en el entorno de los encuestados no repercute en las variables estudiadas, puesto que no se encuentran diferencias significativas entre los individuos que sí tienen a personas cercanas que trabajan en la administración pública y aquéllos que no cuentan con ellos.

Tabla 2 Diferencia de medias en actitud emprendedora

Modelo de conducta	N	Media actitud emprendedora (sobre 7)	t	gl	Sig.

Padres sin negocio	667	4,81	-2,380	842	,018
Padres con negocio	177	5,06			
Entorno sin negocio	249	4,64	3,39	842	,001
Entorno con negocio	595	4,96			
Padres no funcionarios	504	4,97	3,12	843	,002
Padres funcionarios	341	4,71			
Entorno no funcionarios	219	4,94	-0,98	843	,325
Entorno funcionarios	626	4,84			

Tabla 3 Diferencia de medias en norma subjetiva

Modelo de conducta	N	Media apoyo percibido por padres y hermanos (sobre 7)	t	gl	Sig.
Padres sin negocio	666	5,54	-4,29	841	,000
Padres con negocio	177	6,06			
Entorno sin negocio	249	5,24	5,41	841	,000
Entorno con negocio	594	5,82			
Padres no funcionarios	504	5,77	3,19	842	,002
Padres funcionarios	340	5,45			
Entorno no funcionarios	219	5,69	-0,58	842	,565
Entorno funcionarios	625	5,62			

Tabla 4 Diferencia de medias en control interno

Modelo de conducta	N	Media control interno (sobre 7)	t	gl	Sig.
Padres sin negocio	668	3,26	-3,59	843	,000
Padres con negocio	177	3,59			
Entorno sin negocio	249	3,01	5,32	843	,000
Entorno con negocio	596	3,46			
Padres no funcionarios	504	3,44	3,67	844	,000
Padres funcionarios	342	3,15			
Entorno no funcionarios	219	3,36	-0,56	844	,577
Entorno funcionarios	627	3,31			

4 Conclusiones

La creación de empresas innovadoras de base tecnológica con alto potencial de crecimiento sería de gran importancia en un contexto de crisis económica como el que existe en España actualmente. Esto pone de manifiesto el importante papel de las universidades técnicas, que alimentan a la sociedad con los profesionales capaces de crear este tipo de empresas.

En esta investigación se muestran los resultados de una encuesta a estudiantes de ingeniería y arquitectura en la UPM, la mayor universidad técnica en España. Se ha analizado cómo se ve influida su intención emprendedora por la existencia o ausencia de modelos de conducta emprendedores y funcionarios. En base a los resultados del análisis, se han extraído las siguientes conclusiones:

- Los padres emprendedores son un modelo de conducta que hace que sus hijos tengan una mayor intención emprendedora en relación al resto de estudiantes cuyos padres no son empresarios.
- Por el contrario, los padres funcionarios son un modelo de conducta que induce a sus hijos a tener una menor intención emprendedora en comparación con los estudiantes cuyos padres no son funcionarios.
- La ausencia de emprendedores en el entorno cercano de los estudiantes también influye negativamente en su intención emprendedora, lo que demuestra la hipótesis de que los emprendedores son un importante modelo de conducta.
- En cuanto a la ausencia de funcionarios en el entorno cercano, no se ha podido comprobar que repercuta positivamente en la intención emprendedora.
- Los resultados obtenidos para intención emprendedora se han confirmado también para las tres dimensiones que forman el modelo TPB de Ajzen.

5 Referencias

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179-211.

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. British Journal of Social Psychology, 40, 471-499.

Bosma N., Hessels J., Schutjens V., Van Praag M., Verheul I. (2012). Entrepreneurship and role models. Journal of Economic Psychology 33, 410–424.

Bygrave, D. (1989). The entrepreneurship paradigm (1): A philosophical look at its research methodologies. Entrepreneurship Theory and Practice, 14(1), 7–26.

Carr, J. C., Sequeira, J. M. (2007). Prior family business exposure as intergenerational influence and entrepreneurial intent: A Theory of Planned Behavior approach. Journal of Business Research 60, 1090–1098.

Fernández Doblado, J.C., & Hidalgo Nuchera, A. (2011). New technology-based firms created in Spain between the years 2000 and 2010: profile of their entrepreneurs and importance of the public support in their development. Dirección y Organización, 45, 11-19.

Hernández, R., Coduras, A., Vaillant, Y., Batista, R.M., Sosa, S., Mira, I., & Martínez, J. (2012). Global Entrepreneurship Monitor. 2012 Informe GEM España.

Krueger, N. & Brazeal, D. (1994). Entrepreneurial potential & potential entrepreneurs. Entrepreneurship Theory & Practice 18(1): 5-21.

Laspita S., Breugst N., Heblich S., Patzelt H. (2012). Intergenerational transmission of entrepreneurial intentions. Journal of Business Venturing 27, 414–435.

Liñán, F. & Chen, Y. W. (2009). Development and cross-cultural application of a specific instrument to measure entrepreneurial intentions. Entrepreneurship Theory and Practice, 33(2), 593-617.

Molero, J. & Maldonado, G. (2012). Contrasts between university spin-offs and independent technology-based firms: the case of Madrid Science Park. Dirección y Organización, 46, 16-30.

Oren L., Caduri A., Tziner, A. (2013). Intergenerational occupational transmission: Do offspring walk in the footsteps of mom or dad, or both?. Journal of Vocational Behavior 83, 551–560

Shapero, A. & Sokol, L., Eds. (1982). The social dimensions of entrepreneuship. The Encyclopedia of Entrepreneurship. . Kent, Prentice Hall

222 How Can Local Manufacturing Improve Economic Development? Saint Brissant: a case study of local manufacturing in Spain

Karaosman H, Morales-Alonso G, Grijalvo M

Hakan Karaosman (✉ e-mail: hakan.karaosman@upm.es)
Department of Industrial Management, Business Administration and Statistics; School of Industrial Engineering; Universidad Politécnica de Madrid (UPM); Spain

Gustavo Morales-Alonso (✉e-mail: gustavo.morales@upm.es)
Mercedes Grijalvo (✉ e-mail: mercedes.grijalvo@upm.es)

Abstract: Fast-fashion retailers and mass production dominate the fashion and apparel industry. Increased globalization, labor intensity and outsourcing to developing countries are fostering the interest in sustainability within the industry. There is a growth of a new movement attempting to offset the demand for fast fashion, "Slow Fashion" movement. Slow fashion is not time-based but quality-based approach in which designers, buyers, retailers and consumers are more aware of the impacts on workers, communities and ecosystems (Fletcher 2007). European Union has also some critical targets to reach by 2020. Spain, specifically, has to meet some requirements in terms of economy and sustainability. This exploratory study analyzed how slow fashion concept, precisely manufacturing locally, could improve economic development. Local manufacturing, its impact on economic development and the challenges of Spanish market are illustrated through a case study of one Spanish fashion brand, Saint Brissant.

Keywords: Local manufacturing, Slow fashion, Economic development, Sustainability, Spain.

1 Introduction

United Nations described sustainability in "Our Common Future" report in 1987. Sustainable Development is to meet present generations' needs without endangering future generations' ability to satisfy theirs (United Nations 1987). On the European level, sustainability is a significant issue. "Europe 2020", European Union's growth strategy, has set sustainability targets to be reached by 2020. Spain is expected to decelerate the unemployment rate, which rose from 8% in 2007 to

26% in 2013 (Central Intelligence Agency 2014). 74% of the 20-64 year-olds is anticipated to employ by 2020 (Europe 2020 2011). To accomplish these goals, new job opportunities should be developed, economy should be fostered and workforce should be improved in Spain. The 2008-2009 financial and economic crisis affected the growth and employment performance of Small and Medium Enterprises (SMEs) in many OECD countries (OECD 2013). Particularly, in Spain, a decline has been recorded. SMEs' employment and value added in Spain declined by about 21% and 24% respectively between 2008 and 2012 (European Commission 2013a). More specifically, at the sector level, the manufacturing sector has been especially hit with a decrease of 30% in value added and number of employees for SMEs between 2008 and 2012 (European Commission 2013b). Manufacturing is an important enabler for both sustainability and globalization (World Economic Forum 2012). The global fashion and apparel industry, on the other hand, is forecast to have a value of $1.222,7 billion in 2014, an increase of 13.4% since 2009 (Reportlinker Adds Apparel Retail 2010). Despite the economic crises, global fashion industry still gets right. Hence in order to strengthen the European economy and enhance sustainability, manufacturing and the fashion industry should be designed and continued through a sustainable methodology.

Fletcher (2007) formed the term "Slow Fashion". This is a sustainable fashion movement, which gains momentum in order to slow the rate of change for a more sustainable step. By encompassing eco-design, local manufacturing, and conscious consumption, slow fashion concept could empower local economies, boost social conditions and reduce environmental impact (Aakko & Koskennurmi-sivonen 2013). This study aims to explain how to improve local economies through local manufacturing through a case study. The paper is structured as follows: in Section 2, a literature review is presented. In Section 3, research objectives and methodology are introduced. While, the case study is depicted and results are provided in Section 4. Conclusions are presented in the last section of the paper in Section 5.

2 Theoretical Background

2.1 Sustainability and Slow Fashion Concept

Sustainability creates and maintains the conditions under which humans and nature could occur in a productive harmony, which permits achieving the social, economic and environmental goals (EPA 2011). The fashion and apparel industry contributes to the sustainability challenge in a number of ways. Labor intensity, global sourcing, energy intensity, short deadlines, greenhouse gas emissions, and natural source depletion are some industrial features. (Woo 2013). Therefore, sustainability should be integrated into business models in this industry. Slow

Fashion is a new concept based on the sustainable development (Fletcher 2007). Due to the fashion and apparel industry's inevitable impact on sustainability, this new concept seeks ways to create sustainable economies by incorporating good quality, small production lines, local manufacturing and fairer labor settings. Slow fashion process thus encompasses utilizing more environmental friendly raw materials during the **design** phase; reducing waste besides establishing better production schemes based on quality during the **manufacturing** phase and encouraging consumers to consume less during the **consumption** phase (Pookulangara & Shephard 2013). How ever slow fashion challenges the industry to make an effort to comprise sustainable, ethical and environmental practices. Fashion and apparel brands, mostly fast fashion retailers, aim at reducing lead-time and providing their consumers with fashionable merchandise continuously (Pookulangara & Shephard 2013). Therefore slow fashion seems difficult to be used by various stakeholder groups from retailers to consumers. Nevertheless it could bring significant and enriching opportunities through sustainability.

2.2 Benefits of Slow Fashion Through Sustainable Design, Local Manufacturing, Conscious Consumption

Through slow fashion concept, local economies could be empowered, social conditions could be enhanced and environmental impact could be reduced. On the whole, sustainability could be further improved. The examples of slow fashion practices mostly come from small scale productions (Aakko & Koskennurmi-sivonen 2013). Energy could be saved at various stages of life cycle, from production to disposal. Using environmental friendly materials and higher quality manufacturing garments could bring some other advantages regarding laundering (washing, drying and ironing) (Karst et al. 2009). Creating local jobs is another important indicator. Due to the nature of fast fashion, consumers are encouraged to purchase and dispose more. In most cases, buying a new garment is cheaper than repairing the older one. This affects local economies negatively since repair services and local craftsman become less required. Yet through slow fashion concept and utilizing local manufacturing, economies could be fostered.

2.3 Local Manufacturing for Economic Development

"Europe 2020" is the European Union's growth strategy (European Commission 2011). Within this strategy, five fundamental objectives have been set for 2020. Areas enlist employment, innovation, education, social inclusion and climate/energy. Each of these categories have been adopted for member states (Europe 2020 2011). Specific "2020 Targets" for Spain are as follows; 74% of the 20-64 year-olds to be employed, 3% of the EU's Gross Domestic Product (GDP) to be invested in R&D, greenhouse gas emissions to be 10% lower than in 1990, 20% of energy to come from renewables and 20% increase in energy efficiency

(Europe 2020 2011). Therefore sustainability should be a strategic objective for EU as well as for Spain. The manufacturing industry, which is a big driving force in Europe, accounts for 16% of EU's GDP and the main goal is to increase GDP share up to 20% (Flegel 2013). To strengthen the European economy and foster economic development, manufacturing industry should be designed and sustained through a sustainable methodology.

2.4 Spanish Economy and SMEs

The SMEs are major players in the Spanish economy through their important contribution to the total economic value added and, in particular, to the large share of workforce they employ (European Commission 2013b). According to the European Commission's Small Business Act Report (2013), in Spain, the number of SMEs is 2.239.814 (as a share of 99.9% in Spain vs. 99.8% in EU-27). The SMEs in Spain employ a significant number of people (74.9% vs. 67.5% in the EU), a long way from the level of approximately 60% in Germany and France (Maudos 2013), and they generate more value added as €284 billion (64.8% compared to 58.4% in the EU) (European Commission 2013b). In Spain, the SMEs are mostly from wholesale and retail trade, communication, business services and construction sectors (European Commission 2013b). Spanish firms are specialised in low-tech manufacturing and less-knowledge-intensive services. Nevertheless, new loans to SMEs fell noticeably each year since 2007 (OECD 2013), and since mid-2009 bank credit to the private sector has contracted by 9.2%, a drop of around 172 billion euros (equivalent to 17% of GDP) (Maudos 2013). Therefore, lack of finance is a serious problem in Spain. 27% of the Spanish SMEs declared that this was the biggest challenge encountered. This percentage is relatively higher compared to Germany (10%) or France (13%) (European Commission 2013b).

3 Research Objectives and Methodology

The purpose of this paper is to provide a new understanding into the following research question: "How could local manufacturing improve economic development?". As previously explained, design, manufacturing and consumption constitute slow fashion concept that represents a vision of sustainability (Pookulangara & Shephard 2013). Despite its close relationship, in existing literature few studies examined the slow fashion influence on economic growth. This study attempts to explore how local manufacturing can empower Spanish economy. A case study research is an empirical investigation, which examines a contemporary fact when the boundaries between the fact and its context are not clear (Woodside 2010). Therefore, it could be stressed that case study would be an ideal methodology when an in-depth exploration is required (Tellis 1997). This research conducted a case study for these reasons. Due to its multi-perspectival nature, case study is accepted as a triangulated research strategy that involves some analytic techniques: pattern-matching, explanation-building, and time-series analysis (Tellis 1997). For the purposes and intentions of this research, explanation-building technique was pursued to deeply understand and explain the case in order to answer the research question. In-depth interviews were conducted to gain new insights on outcomes with the aim at understanding the phenomenon and revealing established findings. In order to ensure and increase the credibility and validity of the results, this research utilized data triangulation, which is a method used by qualitative researchers to check and establish validity by analyzing a research question from multiple perspectives (Guion et al. 2011).

4 Saint Brissant Case: How Could Spanish Economy Be Improved through Local Manufacturing?

4.1 Background

Spain has faced a continued recession due to the global financial crisis. GDP growth trend, which continued during 16 years, ended at 2009. The unemployment rate rose from 8% in 2007 to 26% in 2013 (Central Intelligence Agency 2014). Spain's budget deficit peaked at 11.1% of GDP in 2009. The country gradually reduced the deficit to 6.8% of GDP in 2013, slightly above the 6.5% target negotiated with the EU (Central Intelligence Agency 2014). GDP was estimated $1.480 trillion in 2012 and $1.457 trillion in 2011 (World Bank 2014). With a minus growth (-1.3%) in 2013, GDP accounted for $1.389 trillion (Central Intelligence Agency 2014). The service sector in Spain was responsible of the 70.8% of the GDP in 2013 while the remaining was shared by the agriculture sector, 3.1%, and the industry sectors, 26% (World Bank 2014; Central Intelligence Agency 2014). Amongst industries, the fashion and apparel industry is one of the most influential ones due to its global import, export and trade figures. Spanish consumers, on the other hand, have become lower-price seeking, critical and more demanding for a fair balance between price and quality. Accordingly, Spanish manufacturers have begun producing basic lines with lower prices. Therefore, fast fashion and unsustainable manufacturing has been fostered. While SMEs are slowly disappearing, branded stores are becoming widespread through franchising and they conquer the best positions in the Spanish cities (Euromonitor International 2013). Therefore, it can be stated that in order to achieve EU based targets such as reducing unemployment rate, reducing the deficit, and reducing environmental impact; new business models are needed. Innovation, awareness and responsibility should be integrated into business models of fashion companies with an attempt to reach economic growth. Saint Brissant was founded by a group of young entrepreneurs with an unstoppable creativity and love for fashion. Despite all the challenges faced by the industry, the brand was officially launched in September 2011. Saint Brissant is a small sized fashion company located in Madrid, the capital of Spain. Primary business activity is to produce shirts, sweaters and fashion accessories. Saint Brissant's signature designs are 100% handcrafted in order to ensure the highest quality and preserve the uniqueness of designs. One of the objectives of the company is to utilize local manufacturing in Spain as a means to improve Spanish economy. Innovation, creativity and drive for sustainability are essential elements of the business model.

4.2 Results

After the in-depth interviews with Saint Brissant's entrepreneurs, the following results have been obtained. As previously stressed, local manufacturing could bring further advantages such as having supply chain near by, so that active participation in production phase would be possible. That is, through local manufacturing, the designers of Saint Brissant can monitor and intervene the process while a garment is being produced. Trust and reliable communication was observed as the key outcomes of closely working with manufacturers. When interviewee was asked about operational costs, it was indicated that having garments manufactured in some other yet cheaper countries would be more cost-effective, in spite of diminishing the quality of the final product. Nonetheless, it was articulated that Saint Brissant would keep working with Spanish local manufacturers in order to both foster Spanish economy and provide consumers with the best quality. Another big advantage gained through local manufacturing was to be able to produce in small quantities. Unlike mass production, using local manufacturers in Spain enabled designers to produce continuously in small amounts by preserving quality and style. This is an important indicator for the industry given fast fashion retailers are generally criticized because of their low quality materials. Due to globalization, manufacturers that are located at overseas defeated local manufacturers. Despite the small number of manufacturers located in Spain, Saint Brissant aims to further collaborate with them. Thus new ways of income generation could be created for local communities. When selection criterion was discussed; manufacturers' service quality, facility location, price range and references were cited.

4.3 Disincentives and Needs

Saint Brissant dedicated its resources to manufacture locally due to the competitive advantages that it brings, and at the same time because it helps empower local economy inside the country. Subsequent to interview, results stressed that consumer awareness was a big challenge. Due to the financial crisis, consumers have become more demanding and price sensitive. Self-interest is an important parameter that shape purchasing decision (Pookulangara & Shephard 2013). It was indicated that governmental support would be important to improve designers' and manufacturers' conditions. Despite EU's 2020 target and various incentives, local subsidies and lack of finance were listed as the biggest problems (European Commission 2013b). Existing subsidies or open calls have high standards and therefore for small enterprises requirements are too difficult to be complied with. The interviewee pointed out that SMEs could be encouraged and further supported to achieve sustainability targets. To boost economy and reach economic growth, Spanish government is expected to encourage SMEs, re-arrange regulations and provide more incentives.

5 Conclusions

Due to economic recession, natural resource scarcity and rapid changes in trends, a growing number of people including designers, academicians, practitioners and consumers pay a significant attention to an emerging concept called Slow Fashion (Pookulangara & Shephard 2013). In this study, an attempt has been made to contribute to the literature by investigating how local manufacturing could improve economic development. Saint Brissant is a Spanish SME that manufactures in Spain to (i) ensure its products' high quality and (ii) to empower Spanish economy. Through this case local manufacturing was discussed and challenges as well as outcomes were presented. Not only does local manufacturing ensures to deliver the best quality by utilizing local resources with a rich diversity, but it also boosts Spanish economy by helping create local workforce. However, governmental subsidies and financial aids could be rearranged to better support SMEs. In order to reach EU targets, efforts should be made jointly. Furthermore, culture and awareness are seen as important indicators. Conscious consumption should be transmitted and sustainability should be delivered as a common "language".

6 References

Aakko, M. & Koskennurmi-sivonen, R., 2013. Designing Sustainable Fashion : Possibilities and Challenges. , 17(1).

Central Intelligence Agency, 2014. The World Factbook. *The World Factbook: Europe_Spain*. Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/sp.html [Accessed March 19, 2014].

EPA, 2011. US Environmental Protection Agency. Available at: http://www.epa.gov/ [Accessed March 14, 2014].

Euromonitor International, 2013. Retailing in Spain-Country Report. Available at: http://www.euromonitor.com/retailing-in-spain/report [Accessed March 19, 2014].

Europe 2020, 2011. Europe 2020 Targets. Available at: http://ec.europa.eu/europe2020/pdf/targets_en.pdf [Accessed March 16, 2014].

European Commission, 2013a. *A Recovery on the Horizon? Annual Report on European SMEs*, Brussels.

European Commission, 2011. Europe 2020 – EU- Wide Headline Targets for Economic Growth. *Europe 2020*. Available at: http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/targets/index_en.htm [Accessed March 15, 2014].

European Commission, 2013b. *Small Business Act (SBA) Fact Sheet 2013 Spain*, Brussels.

Flegel, H., 2013. Manufacturing Inside – Modern Manufacturing: the Key to High Added Value and Wealth. In *Manufacturing Performance Day 2013*. pp. 1–23.

Fletcher, K., 2007. Slow Fashion. *The Ecologist*, p.37. Available at: http://www.slowfashion.at/en/about-us.html [Accessed March 14, 2014].

Guion, L.A., Diehl, D.C. & Mcdonald, D., 2011. Triangulation□: Establishing the Validity of Qualitative. , pp.2–4.

Karst, D., Hain, M. & Yang, Y., 2009. Care of PLA Textiles. , 13(4).

Maudos, J., 2013. Spanish SMEs ' financial restrictions□: The importance of bank credit. *Spanish Economic and Financial Outlook*, 2(1), pp.28–39.

OECD, 2013. *Financing SMEs and Entrepreneurs*,

Pookulangara, S. & Shephard, A., 2013. Slow fashion movement: Understanding consumer perceptions—An exploratory study. *Journal of Retailing and Consumer Services*, 20(2), pp.200–206. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0969698912001506 [Accessed January 28, 2014].

Reportlinker Adds Apparel Retail, 2010. Apparel Retail: Global Market Analysis - Market Research Report. Available at: http://www.reportlinker.com/p0120059-summary/Apparel-Retail-Global-Industry-Almanac.html [Accessed March 12, 2014].

Tellis, W., 1997. Application of a Case Study Methodology. , 3(3), pp.1–16.

United Nations, 1987. *Report of the World Commission on Environment and Development: Our Common Future*, Available at: http://conspect.nl/pdf/Our_Common_Future-Brundtland_Report_1987.pdf.

Woo, H., 2013. *Do consumers want a "Good" apparel brand? The effects of apparel brands' corporate social responsibility (CSR) practices on brand equity moderated by culture*. The University of North Carolina,Greensboro,NC.

Woodside, A., 2010. *Case Study Research: Theory . Methods . Practice* 1st ed., Boston: Emerald Group Publishing Limited.

World Bank, 2014. World Development Indicators_ Spain. Available at: http://databank.worldbank.org/data/views/reports/tableview.aspx [Accessed March 19, 2014].

226 A Historical Perspective of Sustainable Approaches for Product Development

Lütkemeyer Filho M G, Vaccaro G L R, Moraes C A M

Mario Gilberto Lütkemeyer Filho (✉ e-mail:mariogl.filho@gmail.com)
GraduateProgram in Production Engineering and Systems. Universidade do Vale do Rio dos Sinos.Av. Unisinos, 950 São Leopoldo - Brazil

Guilherme Luís Roehe Vaccaro (✉e-mail: guilhermev@unisinos.br)
GraduateProgram in Production Engineering and Systems. Universidade do Vale do Rio dos Sinos.Av. Unisinos, 950 São Leopoldo - Brazil

Carlos Alberto Mendes Moraes (✉ e-mail: cmoraes@unisinos.br)
Graduate Program in Civil Engineering. Universidade do Vale do Rio dos Sinos.Av. Unisinos, 950 São Leopoldo - Brazil

Abstract: This paper presents a perspective of some relevant antecedents that contributed for the emergence of the concepts of eco-efficiency and eco-effectiveness under the context of product development. Based on literature review, we compile reference publications and concepts depicted from indexed references in order to produce a map of influences on the subject. The results do not intend to exhaust the existing literature, but instead to present a possible understanding of different aspects that historically define the concepts of eco-efficiency and eco-effectiveness, their similarities and differences.

Keywords: Product development; sustainability; eco-efficiency; eco-effectiveness.

1 Introduction

Sustainable development is a systemic concept that can be formulated as a model incorporating environmental, social and economic dimensions (Elkington, 1997; Hawken et al., 2007).

Issues related to the demand for non-renewable natural resources and their impacts on the future of humanity had already been discussed in socioeconomic agendas and operations management (Brown, 1970; Ford, 1927). At the beginning of the 1970s, Meadows et al. (1972) recognized an unsustainable panorama of development, whereby the sustained rate of growth of industry, the population and the consumption of non-renewable natural resources would compromise intergenerational equality. Alvin Toffler and Victor Papanek concurrently published seminal books that became references to later generations. In “Future Shock”, Toffler (1970) envisioned future impacts of industrialization on society. In the 70’s, Victor Papanek published “Design for the Real World”, in which he discussed the role of innovation in design, the close relationship between the designer and consumer and the impacts that result from dysfunctional design.

In such sense, keeping business on its current state is not a solution for driving sustainability to future generations. This is reflected by continuous increase for natural resources, environmental impact and social issues as a result of imbalance between ecosystems and the economy (Assadourian, 2012). This scenario represents the traditional economical and industrial model that has sustained the growth of large nations (Meadows et al., 1972; Spangenberg et al., 2010). A relevant cause of these problems is related to the design of products and their life cycles. Thus, re-orienting an unsustainable society towards mental model change is grounded in sustainable development, requires integration of economic, social and environmental aspects in design and product development (PD) (Byggeth et al., 2007; Karlsson and Luttropp, 2006; Spangenberg et al., 2010).

The design phase is part of initial stages of PD. Decisions taken at this time affect the cost, performance, appearance, and, systemically, the factors associated with the product life cycle (Lagerstedt, 2003).While considering environmental concerns, is it essential to evaluate if the PD process is linked to the internal process (Baumann et al., 2002). Another possibility is to evaluate if companies’ actions are implemented aiming at supporting external processes (Chertow, 2000; Braungart et al., 2007).

Within the context of design, PD and their relationships to nature, existing approaches may be classified as eco-efficient or eco-effective. From a general perspective, approaches oriented towards eco-efficiency seek to reduce environmental impacts (Dyllick and Hockerts, 2002; Fiksel, 1996; WBSCD, 2000), whereas approaches oriented towards eco-effectiveness, seek to mimic natural biological cycles (Braungart et al., 2007; Stahel, 2010).

Facing a myriad of different approaches for orienting sustainable development in design and PD, organizations indicate difficulties on clearly identifying the core ideas associated to those concepts. In such sense, visualizing a historical perspective of influences for eco-efficient and eco-effective approaches may be valuable for understanding the trade-offs associated to such approaches in PD as value enablers to customers. The historical perspective leans on seminal publications and seeks to provide a general understanding of these two schools of thought.

2 Eco-Efficiency and Eco-Effectiveness

The current economic and industrial model, generally speaking, has prioritized actions for reducing the costs of extraction, natural resource processing and the transformation of raw materials into products. It has contributed to the pollution levels and waste volumes in the lithosphere. The economic trade-off between purchasing inexpensive raw materials or investing in systems and technologies to add value to wastes has generally been the determining factor in choosing the first option (Ellen MacArthur Foundation, 2012; Hawken et al., 2007).

Such model stands over a perspective of unlimited availability of natural resources. It shaped the development industrial societies until events such as the petroleum crises, for example (Elkington, 2006). As a result of this unsustainable perspective, climate changes and unbalance on ecological footprint arose, thereby acting on social actors mental models is crucial to change the current scenario (Meadows et al., 1972).

Historical facts related to the search for sustainable solutions show the emergence of conferences, publications and events related to sustainable development (SD), such as the Club of Rome (Meadows et al., 1972), ECO-92 (UN, 2013) and the Kyoto Protocol in 1997 (UN, 2013). These events have motivated the development of techniques, approaches and scientific progress. As a result of the concept offs, the Brundtland Report (WCED, 1987) has been revisited since the Rio 92 conference. Discussions on new mechanisms and methods for limiting the use of resources and alternative processes for making, using and discarding less-polluting and environmentally-aggressive products have echoed globally (Braungart and McDonough, 2002; Hawken et al., 2007).

In such context, the term eco-efficiency emerged. The work of Fiksel (1996) was based on the manifesto of the Business Council on Sustainable Development, which was published in 1992.Similarly, the World Business Council for Sustainable Development (WBCSD, 2000) defined eco-efficiency as a management philosophy for facilitating improvements on environmental performance in parallel with business profitability for organizations.

Although the focus on eco-efficiency reflects good intentions and has exhibited short-term results, a group of authors have rebutted the benefits of reducing non-renewable natural demands and waste generation. Business strategies must decouple material and energy from economy growth, therefore increasing resource intensity by five times or more (Assadourian, 2012; Hawken et al., 2007; Stahel, 2010).

The central point is that reduction, one of the central elements of eco-efficiency, does not change the linear consumption of resources. This criticism has been established on the perception that eco-efficiency fails on complying long-term results, as incremental movements in companies' process and business strategies are implemented. The concept of reducing implies on outcomes for making industrial systems "less destructive" (Braungart and McDonough, 2002; Braungart et al., 2007).

Dillyck and Hockerts (2002) moved beyond the concept of eco-efficiency by asserting that the economic value added by a company is relative to its ecological impact, and recognized that sustainability cannot be supported only by incremental improvements. So they concluded that, from an environmental standpoint, eco-effective strategies are required.

Transitioning from eco-efficiency to eco-effectiveness requires the redesign of products and industrial systems related to materials circulation. Eco-effectiveness is based on the regenerative interdependence and productivity of natural systems, such that the outputs from one process become the inputs to another process (Ayres and Ayres, 2002).The concept of eco-effectiveness aids industrial systems by imitating the abundance of nature and living organisms and thus resembles biomimetics (Benyus, 2006; Braungart and McDonough, 2013). Therefore, eco-effectiveness stimulates a thinking process for PD based on not impacting natural systems, departing from the assumption that production systems and supply and distribution chains operate through closed technological and metabolic flows of materials from cradle to cradle (Braungart and McDonough, 2002; Braungart et al., 2007).

3 Historical Antecedents for the Emergence of the Concepts of Eco-Efficiency and Eco-Effectiveness

In this section, we explore the historical emergence of the concepts of eco-efficiency and eco-effectiveness, delineating their development, thoughts and influences based on scientific and technical publications. However, it is not intended to present an exhaustive or definitive view of these concepts, rather than identifying some key contributors for the formation of those approaches.

Figure 1 presents a diagram showing the influences associated to the eco-efficient and eco-effective approaches. The eco-efficient trend is highlighted in yellow; the eco-effective trend is highlighted in blue. Influences that supported the development of both approaches are shown in green. Finally, operational concepts used to evaluate the environmental impacts of products are shown in gray. Influences are identified by arrows and supported by citations in the literature.

The historical perspective begins with Smith (1776), which influenced Malthus' ideas. Later on, Malthus principles pulled Rachel Carson, who published "The Silent Spring" in 1962. Carson influenced James Lovelock, whose "The Gaia Hypothesis "had been published six years later. She also influenced Timothy O'Riordan, who published "Environmentalism" in 1976, displaying a world-view of future uncertainties. O'Riordan developed concepts of eco-centrism and techno-centrism with intent to motivate the development of technologies that minimize environmental impact (Madge, 1997). Over the same period, Lovelock's concepts were appropriated by Victor Papanek in "Design for the Real World", which was published in 1972. The author vehemently criticized design, viewed as being pernicious to the environment. Also, John Elkington has been influenced, at some extent, by the ideas of O´Riordan by the time the book "The Ecology of Tomorrow's World" was published in 1980.

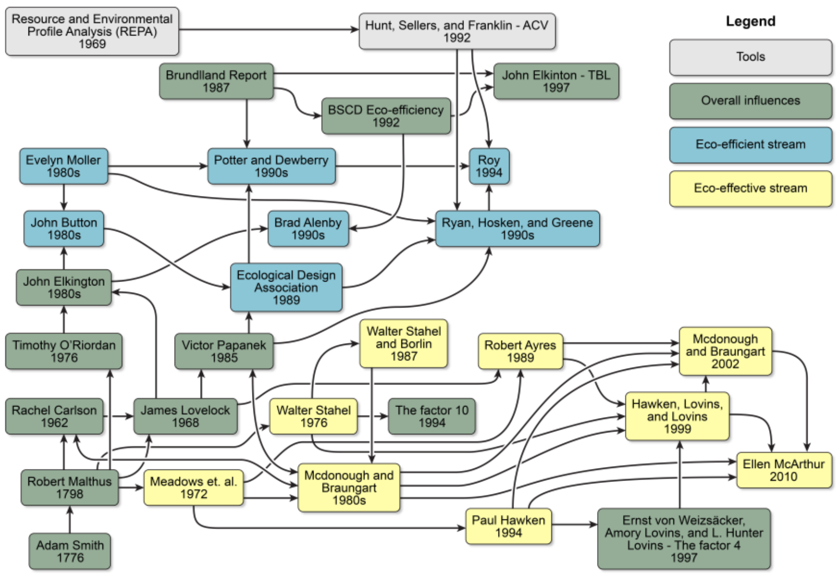


Fig. 1 A historical perspective of the antecedents for the emergence of concepts of eco-efficiency and eco-effectiveness

In the eco-efficient trend, evolution of ideas is related to connections between theorists and practitioners. At the beginning of the 1980s, environmental awareness resulted in the development of green products, which stimulated the development of a culture of consuming products with minimal environmental impact. Thus, the term “green” has been introduced to indicate the objective of reducing consumption, and promoting interests in the political sphere (Madge, 1997; Ryan et al., 1992). At the end of the 1980s and at the beginning of the 1990s, the term “green” was replaced by “eco”, as identified by John Button, and was officially instituted in Europe to promote ecological concerns in design (Madge, 1997).

From references, it is possible to infer that Papanek influenced Ryan et al. (1992) and the Ecological Design Association over a period of time. The latter authors contributed to the implementation of Ecodesign in Europe and Australia (Ryan et al., 1992). In the United States, Design for Environment (DfE) emerged as equivalent to the concept of Ecodesign (Baumann et al., 2002). The BrundtlandReport (WCED, 1987), followed by the definition of the Business Council for Sustainable Development BCSD (Fiksel, 1996), and the WBCSD (2000) consolidated the term eco-efficiency and associated it with the triple bottom line (TBL).

In the eco-effective line of thinking, it is inferred that Malthus influenced both Meadows et al., in “The Limits to Growth”, which was published in 1972, and Walter Stahel (1976) in “Jobs for Tomorrow” (The Product-Life Institute, 2013).

Stahel summarized his 1976’s work in a new publication, released in 1981 and named “The product-life factor”. His central idea consisted of extending product life cycles by substituting the extractive activities of manufacturing industries by labor intensive and locally integrated units for reducing, reusing or recycling components. As a result, lessening the demand for resources by maintaining goods within a “spiral-shaped-closed-loop” economy. Stahel has also influenced the chemist Michael Braungart and the architect William McDonough to develop concepts associated with eco-effectiveness. At the same time, Meadows et al. (1971) also caused some inspiration on them, as well as on Robert Ayres, from the Industrial Ecology perspective, and Paul Hawken, authoring “The Ecology of Commerce” book. Such influence brought to people´s attention the need for directing more responsible business in terms of better resources management. Later, in 1999, Hawken, Lovins and Lovins (2007) published the book “Natural Capitalism”, which were also inspired on Braungart and McDonough, Robert Ayres and Stahel’s ideas.

Finally, it is worthy to point out to The Ellen MacArthur Foundation, which spread the concept of Circular Economy (introduced by Stahel years before). This discussion has been also mainly impacted by Braungart and McDonough, Hawken and Hawken and Lovins’ concepts and principles.

4 Final Remarks

This paper has presented a historical perspective that links sustainable approaches with PD. Our intention is that understanding such concepts and theirs historical perspectives allows companies and practitioners to better relate the myriad of options for adopting and moving towards sustainability as an enabler of value-added to customer and society. A historical perspective, although not exhaustive, provides broader understanding of the key factors that distinguish or approximate some of the existing sustainable PD approaches, and allows identifying gaps still to be explored. In such sense, we understand it contributes for better decision-making, even though it is not possible to touch all cornerstones and authors along the historic timeline, especially in a short paper.

One of the key contributions of this seminal piece of research is that it enables companies, designers, and engineers to comprehend which types of gains would be achievable from short term (eco-efficient) perspectives and from long term (eco-effective) perspectives. In other words, by understanding the implications of following some path toward sustainable PD, one may assess adequate choices, for minimizing inefficiency and losses through design and PD, with effects also on the service lifecycle.

In our perspective, eco-efficient and eco-effective approaches are both relevant, and compliment each other in a way that may lead to results with focus on both short and long term. In academia, however, researchers and practitioners still diverge in terms of considering either eco-efficient perspective as short term driven or eco-effective perspective as long term driven.

In such sense, similar studies are recommended, in order to examine if sustainable PD approaches could be unified in the future. Also, discussing about adequate categorization of innovation strategies associated to each perspective in PD seems to be a gap in the literature to be further explored.

Finally, this study is not exhaustive, and has limitations associated to: an in-depth explanation of the logical connections among authors; the under development influences and the implementations of sustainable strategies through the past decades; and the formation of concepts in the existing approaches related to PD.

Under the perspective of SD, maintaining the current development process is not an optimal solution. In fact, academy and companies can both decide if taking any of the existing sustainable PD approaches is adequate for unveiling economic and sustainable results. We hope this proposal could serve as contribution for bringing attention to this complex subject called sustainability

5 References

Assadourian E (2012) The path to degrowth in overdeveloped countries, in: Starke, L. (Ed.), State of the World 2012: Moving Toward Sustainable Prosperity. Worldwatch Institute, Washington

Ayres R U, Ayres L W (2002) A Handbook of Industrial Ecology. Edward Elgar, Cheltenham

Baumann H, Boons F, Bragd A (2002) Mapping the green product development field: engineering, policy and business perspectives. J Clean Prod 10, 409-425

Benyus J (2006) Biomimética, InovaçãoInspiradaPelaNatureza [Biomimetics and Innovation Inspired by Nature].Cultrix, São Paulo.

Braungart M, McDonough, W (2002) Remaking the Way We Make Things: Cradle to Cradle. North Point Press, New York

Braungart M, McDonough W, Bollinger A (2007) Cradle-to-cradle design: creating healthy emissions. J Clean Prod 15, 1337-1348

Braungart M, McDonough W (2013) The Upcycle: Beyond Sustainability – Designing for Abundance. North Point Press: New York, 2013

Brown H (1970) Human materials production as a process in the biosphere. Sci. Am. 223, 194-208

Byggeth S, Broman G, Robèrt K H (2007) A method for sustainable product development based on a modular system of guiding questions. J. Clean. Prod. 15, 1-11

Capra F (2012) O Ponto de Mutação: A Ciência, a Sociedade e a CulturaEmergente [The Turning Point: Science, Society and the Emergent Culture]. Cultrix, São Paulo

Carson R (1962) The Silent Spring. Houghton Mifflin, Boston

Chertow M R (2000) Industrial symbiosis: literature and taxonomy, Annual Rev of En and Env 25, 313–337.

Dewberry E, Goggin P (1995) EcoDesign and beyond: steps towards sustainability. In: 1st International Conference of the European Academy of Design, Salford University

Dyllick T, Hockerts K (2002) Beyond the business case for corporate sustainability. Bus. Strategy Environ 11, 130-141

Elkington, J B (1980) The Ecology of Tomorrow's World: Industry's Environment. Associated Business Press, London

Elkington J B (1997) Cannibals With Forks: The Triple Bottom Line of 21st Century Business.

Oxford: Capstone Publishing
Elkington J (2006) Governance for Sustainability. Corporate Governance: An International Review.14, 522–529
The Ellen Macarthur Foundation (2012). http://www.ellenmacarthurfoundation.org/business/reports/ce2012. Cited 7 Jan 2012
Factor 10 Institute (2013). http://www.factor10-institute.org/. Cited 15 mar 2013
Fiksel J (1996) Design for Environment.Total Quality Environmental Management. John Wiley & Sons, Inc
Ford H (1927) Hoje e Amanhã [Today and Tomorrow]. Companhia Editora Nacional, São Paulo
Hawken P (1994) The Ecology of Commerce: a declaration of sustainability. Harper. NY
Hawken P, Lovins A, Lovins H (2007). Capitalismo Natural: Criando a PróximaRevolução Industrial [Natural Capitalism: Creating the Next Industrial Revolution]. Cultrix, São Paulo
Hunt R G, Sellers J D, Franklin W E (1992) Feature Resource and Environmental Profile Analysis: a life cycle environmental assessment for products and procedures. History of Resource and Environmental Profile Analysis. 245–269
Karlsson R, Luttropp C (2006) EcoDesign: what’s happening? An overview of the subject area of EcoDesign and of the papers in this special issue. J Clean Prod 14, 1291–1298
Lagerstedt J (2003) Functional and environmental factors in early phases of product development.Eco functional matrix. PhD thesis, KTH Machine Design
Lovelock J (1974) Atmospheric homeostasis by and for the biosphere: the Gaia hypothesis. http://www.jameslovelock.org/page34.html. Cited on 30 mar 2013
Madge P (1997) Ecological Design: A new critique. Design Issues 13, 44-54
Meadows D H, Meadows D L, Randers J, Behrens W W (1972) OsLimites do Crescimento [Limits to Growth], first ed. Perspectiva, São Paulo
O’Riordan T (1976) Environmentalism. Pion Ltd., London
Papanek V J (1985) Design for the Real World: Human Ecology and Social Change, second ed. Academy Chicago, Chicago
Roy R (1994) The evolution of ecodesign. Technovation 14, 363–380
Ryan C, Hosken D, Greene D (1992) EcoDesign: design and the response to the greening of the international market. Des. Stud. 13, 3-22
Smith A (1981) InquéritoSobre a Natureza e as Causas das Riquezas das Nações [An Inquiry into the Nature and Causes of the Wealth of Nations].FundaçãoCalousteGulbenkian, Lisboa
Spangenberg J H, Fuad-Luke A, Blincoe K (2010) Design for Sustainability (DfS): the interface of sustainable production and consumption. J.Clean Prod 18, 1485-1493
Stahel, W (2010) The Performance Economy, second ed. Palgrave Mcmillan, London
The Product-Life Institute (2014). http://www.product-life.org/. Cited 01 mar 2014
Toffler A (1970) O choque do futuro [The future shock], Record, Rio de Janeiro
United Nations (UN) (2013) Framework convention on climate change. https://unfccc.int/kyoto_protocol/items/2830.php. Cited 12 mar 2014
United Nations Environmental Programme (UNEP) (1992) http://www.unep.org/Documents .Multilingual/Default.asp?documentid=78&articleid=1163. Cited 07 feb 2014
World Business Council for Sustainable Development (WBSCD) (2000) http://www.wbcsd.org/Pages/EDocument/EDocumentDetails.aspx?ID=14852&NoSearchContextKey=true. Cited 13 Jan 2014
World Commission on Environment and Development (WCED) (1987) Our Common Future. Oxford University Press, Oxford

229 The use of computer simulation model for the analysis and modification of a production system of automotive painting

Soares B B, Vacaro T, Kalnin J L

Bernardo Bregoli Soares (✉ e-mail: bernardo.soares@endosul-pa.com.br)
Tiago Vacaro (✉ e-mail: tiago.vacaro@endosul-pa.com.br)
Eisenmann do Brasil Equipamentos Industriais Ltda. Av. Abramo Randon 770, 95055-010, Caxias do Sul, Brasil.

Joanir Luís Kalnin (✉ e-mail: jlkalnin@ucs.br)
Centro de Ciências Exatas e Tecnologia. Universidade de Caxias do Sul. Rua Francisco Getúlio Vargas 1130, 95070-560, Caxias do Sul, Brasil.

Abstract: The aim of this paper is the application of computer simulation in the factory environment for an automotive paint shop, in order to analyze proposals for future modification in the factory to meet a new level of production demand. The painting process occurs on an intermittent production line, with conveying by automatic cranes. The flow shop system consists basically of blasting, e-coat (electrode position) and top-coat (powder) painting operations. The study consisted of a structured analysis of the production process using scientific methods, in this case the computer simulation, and not only the tacit knowledge of the company's managers, aiming for fastness and solid foundation for making decisions with regard to different market scenarios. Through the results, there were savings of 64% compared to the investment required for the proposed increase in capacity.

Keywords: Production Simulation; Factory Project; Tecnomatix Plant Simulation; Automotive Painting.

1 Introduction

Given the current market dynamics and the constant need for the companies to maintain and gain new customers, it is essential to operationalize the decisions taken on strategic and tactical levels. With this purpose, it is crucial that organizations have a deep understanding of their production processes. This way, they can act preventively in relation to future market scenarios.

Therefore, there is the need for dynamic understanding of the production processes, aiming for their continuous improvement. To this end, some important tools can be highlighted, such as: lean production techniques; value stream mapping; and computer simulation (Cassel, 1996).In the field of management science, Moreira (2001) presents some models commonly used in the decision process: game theory; queuing theory; Gantt chart; CPM (Critical Path Method); PERT (Program Evaluation and Review Technique); forecasting; probability (statistical analysis); linear programming; dynamic programming; and simulation.

According to Barronio (2000), some rules must be considered on the choosing of a particular model. Mathematical or linear programming models are recommended for systems with low variability and a low number of variables. When the variability is low, but the number of variables is high, the use of heuristic models is adequate. The probabilistic model is a good option for systems with high variability and a low number of variables. For systems with high variability and a high number of variables, the method of computer simulation is recommended.

The simulation allows the understanding of the characteristics of a real system via a similar virtual system (Prado, 1999). Simulation uses a process of experimentation aiming the observation of the system reactions to the proposed changes. Therefore, it is possible to understand, on a virtual environment, how changes on the variables affect the behavior of the real system (Bateman et al., 1999).

With the development of information technology, the greater availability of information on industrial processes has provided the study of this database using quantitative simulation tools (Wolff, 2003). Besides the use as a resource for analysis of production problems, simulation has also been used in the design of industrial facilities (Castilho, 2004).

To Bangsow (2010), the purpose of simulation varies from strategic to tactical up to operational goals. From a strategic point of view, users can solve problems related to: logistics conditions, efficiency of manpower, storage costs, etc. On an operational level, users can solve problems related to: lot sizes, sequence of production orders, necessary resources, among others. However, in both cases, the simulation can be used for the decision on new or existing production systems.

Given this context, this study presents an application of computer simulation in an automotive paint shop. The goal was to analyze proposals for future modification in the factory to meet a new level of production demand.

2 Description of the Problem

The plant analyzed in this study is a paint shop applied for the painting of parts and frames for trucks. The facility has two productive levels (floors), called here as lower and upper floors. The facility also has two different process flows in its productive structure, which can be classified according to the type of the processed item: parts or frames. The scope of this study is the flow of frames, which come from the client at the upper level. The frames are horizontally loaded with load bars, submitted to a blasting operation, and then they are rotated to the vertical position. After, they are transported to the lower floor, for the operations of surface pre-treatment, e-coat (electrode position) painting, cure (ovens) and cooling. The operations of surface pre-treatment and e-coat painting are applied in tanks, by immersion. After, the frames are sent to a preparation area and then they return to the upper floor, where they receive top-coat (powder) painting and are unloaded at the customer's assembly line.

Table 1 presents an analysis of the current capacity of the system, as well as the current and future demands. Data is referred to the production flow of frames.

Table 1 Analysis of demand and capacity (frames)

Scenario	Demand	Capacity	Utilization(%)	Available capacity (%)
Current	70	110	64	+ 36
Future	130	110	118	- 18

The current demand represents the daily average amount of frames processed in 2012, while future demand is the daily average of frames expected to be processed in 2015. As can be seen, there is a capacity deficit of 18% to the future demand.

Based on the tacit knowledge of project managers, the main bottlenecks of the process were identified. In order to act on these bottlenecks, a list was created, containing changes with potential to eliminate the deficit of capacity shown in Table 1. The changes are listed below:

- Change 1: Increase of the speed of the powder painting line, reducing the processing time at this workstation;
- Change 2: Reduction of processing times of the tanks for surface pre-treatment and e-coat painting. This implies in changes on the applied technologies;
- Change 3: Reduction of the processing times of ovens and coolers. This change requires improvements on the equipments;
- Change 4: An additional overhead crane in the tanks area (The current number of cranes is three). For this change, five different configurations of crane distribution were tested (this distribution means which cranes work on each tank);
- Change 5: A second workstation at the exit of the tanks area. At this area there is a workstation called UF cleaning, used to remove the excess of ultra-filtrate (the liquid applied in the last two immersion tanks). This change was tested with two variants:
  - Change 5.1: No additional changes;
  - Change 5.2: In addition to the second workstation, the replacement of an e-coat oven by a cooler. The current number of equipment for the e-coat

process is 10 ovens and 4 coolers. With this new configuration, there would be 9 ovens and 5 coolers;

- Change 6: Replacement of two e-coat ovens by coolers;
- Change 7: An additional overhead crane for the area of e-coat ovens and coolers. The current number of cranes in this area is two.

The computer simulation was applied in order to identify constraints and bottlenecks of the process, and also to analyze the responses of the system to the application of the changes listed above. The goal was to answer if the proposed changes would provide the necessary increase of the production capacity. The changes were analyzed separately and combined.

3 Methodology

This study followed a structured flow of activities. Initially a theoretical foundation was sought, covering the concepts related to the studied topic. Then the production system was modeled on computer simulation software, using the database collected in the company. The initial model represents the current status of the process and the variants contain the proposed changes. Based on indicators for analysis and successive simulation runs, the proposed changes were tested, aiming for the appropriate results to meet the new demand of production.

The study outputs were generated from the different steps proposed in the simulation project, which are briefly described below.

- Definition of the problem and objectives

The problem consists on the need to analyze, before the approval of investment, if the proposed changes in the production system would meet the new demand of production. The objectives are related to the analysis of the proposed changes and to offer consistent subsidies for the decision-making of investment.

- Analysis of the system

The simulated system is the painting facility. The scope of the simulation is the complete painting process of frames, since the loading of the frames on load bars until the unloading of the frames for the costumer. Variables related to the supply and withdrawal of frames by the customer were not considered.

- Collection of data

Input data were collected and grouped as follows: kinds of products; process flows; product mix; processing times; and conveyors data.

- Creation of the model

The plant was simulated using the software Tecnomatix Plant Simulation, version 10.1, from Siemens. A screenshot of the model can be visualized in Figure1.

- Validation of the model

For the validation of the model, several indicators were set, which can be divided in the following categories: workstation times; occupation of ovens, coolers and buffers; indicators for the tanks area; and general process indicators.

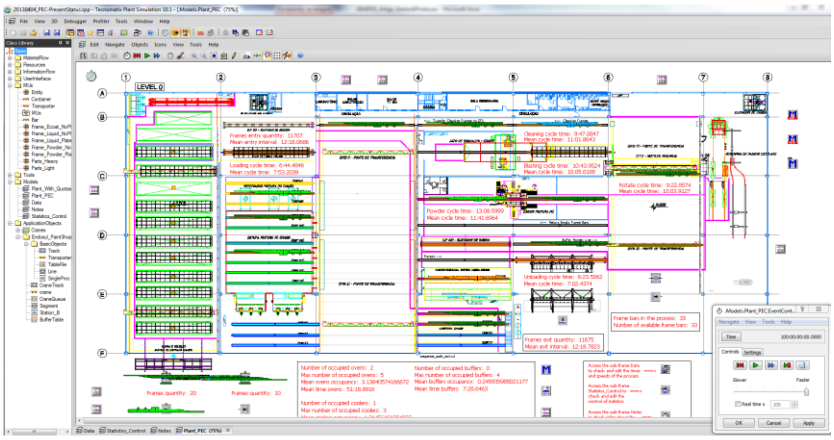


Fig. 1 Screenshot of the simulation model

- Experimentation and analysis of the model

The final stage of the study was the analysis of the different models, referring to the proposed changes on the facility. The results were compared to the outputs of the current status model, which represents the current behavior of the facility.

4 Results and Discussion

The first implemented model was the one related to the current status of the facility. Next, the proposed changes were implemented in different simulation models. The changes were first analyzed separately and after combined in some groups. A new model was implemented for each change, or group of changes.

The main indicator set for the evaluation of the results was the average cycle time of the frames flow. Table 2 lists the resultant cycle time for each model, and grouped by similarity of results. The numbering used in the name of the models refers to the change or group of changes implemented. The table also contains the estimated value of investment related to the changes implemented in each model.

Table 2 Results of cycle time (frames)

Model	Average cycle time [h:min:s.ss]	Investment (millions of €)	Model	Average cycle time [h:min:s.ss]	Investment (millions of €)
Current_status	0:12:18.78	0.00	Changes_3+5.1	0:11:00.98	0.20
Change_1	0:12:20.51	0.33	Changes_3+4.5+5.1	0:11:01.52	0.70
Change_2	0:12:20.06	0.33	Changes_2+3+5.1	0:11:01.91	0.53
Change_3	0:12:25.60	0.03	Changes_2+3+4.5+5.1	0:11:02.97	1.03
Change_4.1	0:12:21.00	0.50	Changes_1+2+3+5.1	0:11:01.28	0.87
Change_4.2	0:12:22.06	0.50	Changes_1+2+3+4.5+5.1	0:11:03.35	1.37
Change_4.4	0:12:20.03	0.50			
Change_4.5[1]	0:12:19.27	0.50	Changes_4.5+5.2	0:11:00.11	0.83
Change_5.1	0:12:27.28	0.17	Changes_3+4.5+5.2	0:11:00.14	0.87
Changes_1+3	0:12:24.44	0.37			
Changes_2+3	0:12:25.19	0.37	Change_5.2	0:10:47.17	0.33
Changes_1+2+3	0:12:24.78	0.70	Changes_3+5.2	0:10:47.29	0.37
Changes_2+4.5	0:12:19.29	0.83			
Changes_2+5.1	0:12:21.41	0.50	Changes_2+5.2	0:10:24.52	0.67
Changes_4.5+5.1	0:12:25.68	0.67	Changes_2+4.5+5.2	0:10:24.57	1.17
Changes_2+4.5+5.1	0:12:27.64	1.00	Changes_2+3+5.2	0:10:24.14	0.70
			Changes_2+3+4.5+5.2	0:10:24.60	1.20
Change_4.3	0:12:52.89	0.50	Changes_1+2+3+5.2	0:10:24.81	1.03
			Changes_1+2+3+4.5+5.2	0:10:24.59	1.53
Change_6	0:11:56.82	0.33	Changes_1+2+3+4.5+5.2+7	0:10:28.45	1.87

[1] Among the changes 4.x, the smaller cycle time was obtained with the variant 4.5. Therefore, this variant was the one chosen to be combined with the other changes.

Analyzing the results of the models for changes made separately (changes 1, 2, 3, 4x, 5.1 and 6), it can be verified that almost all the models presented results similar or worse than the current status. The exception is change 6, where two e-coat ovens were replaced by coolers, which resulted in a reduction of approximately 22 s on the average cycle time. The resulting decrease in the cycle time with change 6 is in agreement with one of the main conclusions obtained on the model of the current status, which was the sub-capacity of e-coat coolers. This can also be seen in the good results obtained with the change 5.2, which is a combination of the changes 5.1 and 6 (change 5.2 refers to the inclusion of a second workstation for UF cleaning and the substitution of an e-coat oven by a cooler).

With respect to the inclusion of additional overhead cranes, it can be concluded that the inclusion of a fourth crane in the tanks area (changes 4.x) did not bring positive results for the process. Comparing the different models with the same changes and with/without the change 4.5, it can be verified that the results are always similar or worse for the model with the change 4.5, as can be seen when comparing the results of the models "Change_5.2" and "Changes_4.5+5.2".In the same way, the inclusion of a third crane at the area of e-coat ovens and coolers (Change 7) did not bring better results for the process. Comparing the results of the models "Changes_1+2+3+4.5+5.2" and "Changes_1+2+3+4.5+5.2+7", it can be verified an increase of nearly 4 s on the cycle time of the second model.

Making a global analysis of the results of Table 2, it can be observed the existence of four value ranges of cycle time, lower than the value of the current status:

- 11:56 min: time obtained with the change 6;
- 11:00 min: although this result has been obtained in various combinations, it can be noticed that only the changes 3 and 5.1 are sufficient. There are also two models with the change 5.2 and results in this time range, but derived from the worsening of results due to the combination with the change 4.5;
- 10:47 min: cycle time obtained with the change 5.2;
- 10:24 min: although this result has been observed in various combinations, it can be verified that the changes 2 and 5.2 are the determinants.

Based on the results obtained from the models and the established correlations, three levels of reduction of the cycle time can be defined from the process changes. Table 3 lists the three levels, with the determinant changes, the reduction of the cycle time, the increase of throughput, and the necessary investment.

Table 3 Determinant changes to reduce the cycle time

Changes	Cycle time reduction	Increase of throughput	Investment (millions of €)
reduction of processing times of ovens and coolers, and inclusion of a second workstation for UF cleaning	78 s	12%	0.20
inclusion of a second workstation for UF cleaning, and the substitution of an e-coat oven by a cooler	91 s	14%	0.33
inclusion of a second workstation for UF cleaning, the substitution of an e-coat oven by a cooler, and the reduction of processing times on thetanks for surface pre-treatment and e-coat painting	114 s	18%	0.67

Recalling the Table 1 of this paper, the capacity deficit to meet the future demand of 130 frames was 18%. The simulation results presented the proof, as well as the appropriate combination of changes to achieve the new level of production.

The condition proposed by the company, prior to the simulation analysis and based only on the knowledge of the managers, was that all the proposed changes would be necessary to meet the future demand. However, these changes are based only on the tacit knowledge of the managers, without scientific confirmation.

Thus, the simulation study presented important results. The outputs of the study showed the scientific proof of the increase of capacity by doing the changes on the facility. However, the most important result was that the increase of capacity can be achieved with a smaller investment, as shown in Table 4.

Table 4 Comparison between the proposed changes before and after the simulation

Proposal	Changes	Investment (millions of €)	Increase of capacity
Before simulation	Changes_1+2+3+4.5+5.2+7	1.87	18%
After simulation	Changes_2+5.2	0.67	18%

Analyzing the results of the table, it can be verified that the necessary increase of capacity can be achieved by doing all the changes, but the same increase is obtained by doing just the changes 2 and 5.2. This means to use only 36% of the originally proposed investment, i.e., a saving of resources of 64%.

5 Conclusion

This study presented an application of computer simulation to the planning and decision making of modifications on a paint shop for trucks (parts and frames).

The application proved to be valuable for the analysis of results and guidance for decision making about changes in the factory. The modifications were analyzed separately and in combination, while still in the planning phase, which gives security in the decision making regarding production strategies.

The obtained results indicate significant gains, especially the saving of 64% on the resources to be applied to obtain the necessary increase of capacity.

6 References

Bangsow S (2010) Manufacturing simulation with plant simulation and Simtalk. Springer, Berlin

Barronio S (2000) Development of computer simulation models for analysis and improvement of productive systems. Master's Dissertation. Federal University of Rio Grande do Sul, Porto Alegre

Bateman RE et al. (1999)Simulation: Improving systems. Belge, Sao Paulo

Cassel RA(1996)Developing an approach to the dissemination of simulation in gaúcho footwear segment. Master's Dissertation. Federal University of Rio Grande do Sul, Porto Alegre

Castilho MR(2004) The use of computer simulation as a tool to aid decision making: Application in a company of corrugated cardboard. Master's Dissertation. Federal University of Rio Grande do Sul, Porto Alegre

Moreira DA (2001) Management of production and operations. Pioneira, Sao Paulo

Prado DS (1999) Queuing theory and simulation. Editora de Desenvolvimento Gerencial, Belo Horizonte

Wolff JF (2003) Simulation of a call center: An application. Master's Dissertation. Federal University of Santa Catarina, Florianopolis

236 A new model of international trade. The role of NEMs and SMEs

Muñoz, A

Andrés Muñoz Machado (✉ e-mail:AMM1105@telefonica.net)

Dpto. Ingeniería de OrganizaciónUPM/ETSII.Urb. Montepríncipe c/Tilos 3, 35. Boadilla del Monte .28660 Madrid

Abstract: The research that we present uses data, obtained from several international organizations publications, to demonstrate the growing consolidation of a new paradigm of industrial products international trade that replaces partially the current Foreign Direct Investment and highlights the importance of industrial policies to support SMEs

Keywords: Trade, intermediate goods, capital goods, non equity models, mittelstands.

1 Summary

UNTACD, UNIDO, EUROSTAT, OECD and other international organizations publish, from time to time, reports on economy and international trade. These reports show the increasing importance of intermediate goods traffic, An analysis of these data leads to conclude that world trade is grounded in value chains, which links are companies, mainly SMEs; activities of the chains are shared by different countries according to their technological level, that is related to their income level.

Direct Foreign Investment (DFI) is going replaced for contracts or agreement between companies.

2 Introduction

Globalization has meant an increase, without precedent, in international trade. GATT and World Trade Organization (WTO), propitiate a progressive elimination of tariff-non- tariff barriers. In addition, a bigger number of countries acceded to international trade. Industrial policies orientated to export, practiced mainly by Far

East Countries, gave birth to a new panorama. Table nº1 data show this growth. The increasing importance of non- OECD countries can be verified.

Table 1. World trade growth

Country	1999 (%)	2011 (%)
Canada	4	**2.5**
France	5.4	**3.4**
Germany	8.8	**8.2**
Italy	4.1	**2.9**
Japan	6.4	**4.1**
United Kingdom	5.5	**3.4**
USA	14	**9.2**
Other OECD countries	27.3	**26.5**
Total OECD	75.5	**60.1**
China	3.1	**9.4**
Other Asian industrialized	11.6	**12.6**
Brasil	0.8	**1.3**
Russia	1.2	**2.7**
Other oil producing countries	3.5	**8.2**
Rest of the World	4.3	**5.7**
All non OECD countries	**24.5**	**39.9**

Source. OECD. 2011 (OCDE (2011)) and own working out

3 International trade of merchandises

International trade of merchandises, according to relevant estimations, between 1948 and 1997, was multiplied by 14, while world production was multiplied only by 5.5. “International Trade Statistics” (OMC (2011)) data, published by WTO, show that interchanges are mainly composed by industrial products and carried out between developed countries. According to the cited publication, manufactures trade amount, in 2010, to 9,962 million US dollars, contrasting to world service trade that only amount to 3,695 million US dollars.

Types of merchandises interchanged have an especial interest. We offer some data taken from UNCTAD (UNTAD (2011)) reports and worked out further by us.

Table 2. Main items of exported merchandises

MERCHANDISE	MMM $US (2010)	% WO RLD TRA DE	GROWTH 2005-2010 (%)	GR OW TH 201 0 (%)
Agriculture	1362	9.2	10	**15**
Fuels and minerals	3006	20.4	11	**33**
Fuels	2348	15.8	10	**30**
Manufactures	9962	67.1	6	**20**
Iron and steel	421	2.8	6	**29**
Chemicals	1706	11.5	9	**18**
Office and telecommunication	1603	10.8	5	**21**
Car industry	1092	7.4	3	**29**
Textiles	251	1.7	4	**19**
Dressmaking	**351**	**2.4**	**5**	**11**

Source: UNCTAD 2011 (3) and own working out

Table nº2 shows that manufactures correspond to 67% of world export of merchandises, from which it is possible to infer that most exporting companies of an economy are industrial companies.

One of the most known models of companies' international strategy is the "eclectic paradigm" (Durán (2001)). This model suits properly with expected behavior of companies practicing Direct Foreign Investment (DFI), which install a factory in the market they are interested, with enough capacity to supply to the local market and to export from it if de opportunity arises.

4 The change of paradigm. Some facts

Eclectic paradigm seems to be changing rather quickly, as much as it refers to starts a new company in a foreign country and to the role played by other countries in manufacturing a final product, commercialized by the emerging multinational company.

Export seems to be every day more grounded in parts or intermediate products interchange than in "complete goods" trade. Current international trade is better explained when considering that it is based in coordination by a company of many activities carried out by others in many countries. The coordinating company commercializes the "final product". Logistic, technology and production capacity of each country integrating the chain have now an outstanding importance. It is easy to conclude that activities of the chain are carried out either by SMEs, or by business strategic units of big companies.

Table nº3 shows the percentage of intermediate goods in the European Union members' trade (EUROSTAT). It is possible to observe that almost in all cases, either in export or import, more the 50% of the goods interchanged are intermediate goods. Adding to intermediate capital goods, the percentage makes, in many cases, 70% or 80% of the total.

This conclusion corresponds reasonably to destination of Direct Foreign Investment, as much about countries it is destined as to the kind of goods traded. In the last years, DFI was addressed to developed and undeveloped economies and that, in 2010, the ones made in the latter surpassed the one made in the further, amounting to a 50% of the total.

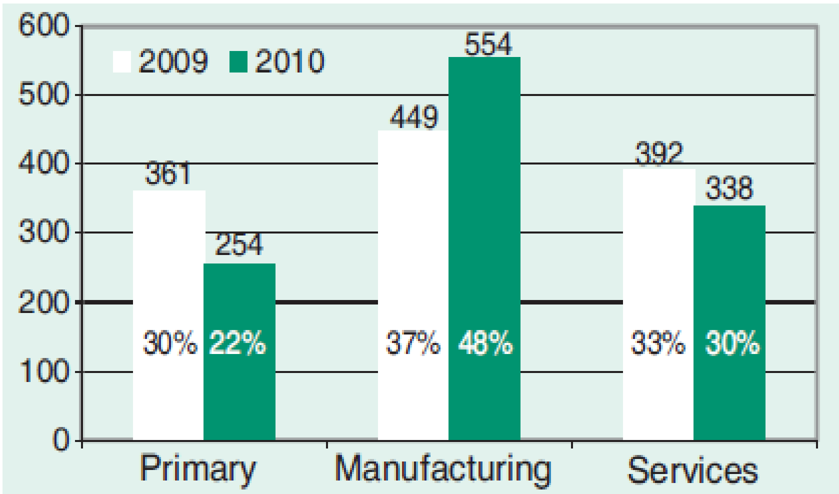


Fig 1. World DFI sector distribution

Table 3. Trade of merchandises. European Union

	Imports				Exports			
	Inter-mediates	Consumer goods	Capital goods	Mixed category	Inter-mediates	Consumer goods	Capital goods	Mixed category
AT	54.2	22.0	17.8	6.0	55.7	18.1	21.6	4.6
BE	55.4	24.8	12.2	7.6	55.8	25.6	10.6	8.0
BG	52.4	19.6	21.5	6.5	61.9	24.6	8.4	5.0
CY	45.7	29.2	12.9	12.2	34.8	48.0	11.6	5.7
CZ	59.5	17.7	19.7	3.1	55.0	15.2	21.9	7.9
DE	58.0	19.3	17.8	4.9	49.0	16.0	23.8	11.1
DK	48.2	27.4	19.9	4.5	41.8	35.7	20.9	1.6
EE	51.9	21.7	15.0	11.4	58.0	20.9	11.6	9.5
ES	55.2	23.6	14.3	6.9	50.2	24.5	11.9	13.4
FI	51.8	19.2	21.6	7.4	53.0	7.4	33.9	5.8
FR	52.6	25.0	16.0	6.4	49.1	25.6	19.0	6.2
GB	46.8	28.1	17.3	7.7	50.7	22.8	17.3	9.3
GR	38.7	34.5	20.2	6.7	54.5	35.3	9.6	0.6
HU	60.8	15.4	19.5	4.3	46.7	19.5	26.6	7.3
IE	44.5	25.8	24.4	5.3	53.0	30.9	16.0	0.1
IT	54.7	22.9	14.3	8.2	50.2	26.8	19.4	3.5
LT	46.7	24.7	20.2	8.4	52.4	22.2	12.0	13.3
LU	43.8	15.9	32.0	8.3	50.6	9.5	37.8	2.1
LV	46.2	27.3	18.5	8.0	56.6	26.5	13.6	3.3
MT	59.4	26.4	9.6	4.6	68.2	22.2	8.2	1.4
NL	51.1	20.3	24.7	3.9	52.1	20.3	24.1	3.5
PL	57.5	17.4	20.2	4.9	51.8	28.6	13.0	6.6
PT	50.7	26.0	16.5	6.8	53.3	28.4	11.5	6.8
RO	53.9	18.7	21.4	6.0	57.8	21.8	12.8	7.5
SE	55.1	21.7	17.9	5.2	58.1	15.4	19.9	6.6
SI	56.6	16.7	16.2	10.5	51.7	22.8	12.7	12.8
SK	62.3	17.1	15.8	4.8	47.7	23.9	11.1	17.4
EU-27	53.7	22.6	17.6	6.1	51.2	21.6	19.6	7.6

Source: Eurostat COMEXT; wiiw calculations.

Distribution of DFI by sectors is showed in figure nº 1. A clear increase of DFI in manufactures is registered, accounting for about 50% of total amount. Investment in manufacturing has to be interpreted as corresponding to intermediate products, what is coherent with other data collected in this research.

5 International Specialization

Intermediate goods traffic corresponds to an international specialization in manufacturing activities. Figure nº2 shows (UNIDO (2011)) a relation between technology and development level, stated in terms of GDP per capita.

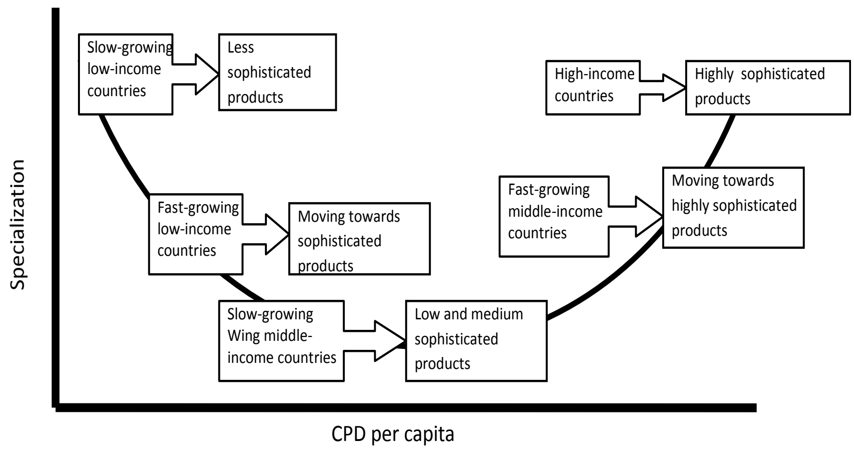


Fig 2 Technology and development level. Source. UNIDO

It can be observed, on the left, that countries with a low income level are specialized in products of a very simple technology; in the center of the graphic, countries with a moderate income level are specialized in low and mature technologies; while, on the right, appear countries with a high income and technological level, with a high specialization. Figure nº2 corresponds to the fact that less development countries, chiefly African ones, undertake starting of low technology companies, belonging to sectors as agroindustry, textiles, dressmaking, offering sustained employment and productivity increases. Countries with moderate incomes undertake companies in the sector of metallurgy, steel, metallic structures, boilers, hand tools and many intermediate goods. Countries on the right of the figure nº2 with high incomes, manufactures articles of high technology as computers, electromedical apparatuses, communications, nanotechnology, pharmacy.

These data allow to conclude that activities of the international value chain are carried out by countries according to their technological level, which related to their income level too. Comparative advantage of each country is linked to its technological level and, this level determines the chain value activities assigned to it.

6 Anew paradigm of international trade

Data above allow affirming that a new paradigm on international trade is arising. The new paradigm best examples are the “Non Equity Models” (NEMs) (Muñoz (2013)). NEMs are contractual compromises either between multinational companies or between multinationals and local companies, extending to manufacturing, services outsourcing, agricultural production, franchise, license, management. NEMs allow the use of foreign companies' capacities without carrying out a direct investment. NEMs are a way to create international networks, placed between export/ import and FDI, having characteristics of both practices.

NEMs are growing faster than sectors where they operate and are obtaining remarkable profits.

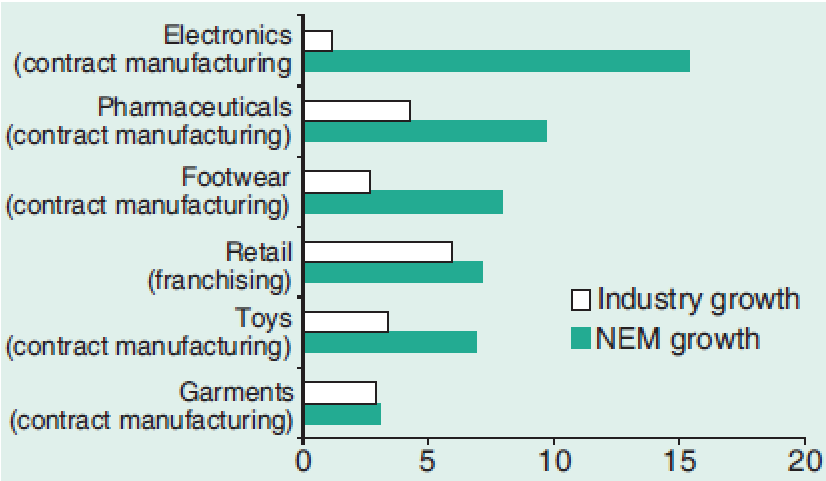


Fig. 3 NEMs growth by industrial sector

7 Conclusions

Conclusion of this research is that, the known fact that globalization encourages coordination of big value chains, shows a special face when MEMs are concerned.

NEMs, as a new paradigm, means that links in the value chain may belong to the same company, and be considered either as business strategic units placed in different countries; either as business strategic units of others companies or SMEs of other countries. The new situation is provoking:

- A change in the internationalization patterns of companies
- An increasing possibility of horizontal specialization of the industry of a country. Even, the possibility to concentrate its R&D in a certain class of activities, designing new or more advanced technologies and favoring a national income increase. Emerging countries come move their industrial activities to the right of figure nº2
- An increase in the role of SMEs in international trade, what emphasized the role of these companies in employment generation and technology

development, demonstrating the importance of industrial policy supporting SMEs, especially when R&D is concerned
- A decrease of investment risks of any company
- A higher volatility in contractual relations between local and multinational companies, between national and foreign companies. Short terms contracts have a higher possibility with NEMs
- A change in government policies to attract foreign companies to their countries.

8 References

Durán J.J. (2001) Estrategia y economía de la empresa multinacional.Edit. Pirámide. Madrid.
EUROSTAT (2008) COMEXT. EU- 27.
Muñoz A (2013) La política Industrial. Un reto de nuestro tiempo. Edit. Díaz de Santos. Madrid
OCDE (2011) OECD Economic Outlook
Organización Mundial de Comercio (OMC) (2011) International TradeStatistics
UNIDO (2011) Industrial Development Report 2011
UNTAD (2011)World Investment Report. World Economic Situation and Prospects. 2011

244 Determining Service Level per Item in a Multi-item Environment

Cardós M, Babiloni E, Guijarro E, Estellés S

Manuel Cardós Carboneras (✉ e-mail: mcardos@doe.upv.es)
Dpto. de Organización de Empresas.Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia.

Eugenia Babiloni Griñón (✉e-mail: mabagri@doe.upv.es)
Dpto. de Organización de Empresas.Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia.

Ester Guijarro Tarradellas (✉ e-mail:esguitar@upvnet.upv.es)
Dpto. de Organización de Empresas.Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia.

Sofía Estellés Miguel (✉ e-mail:soesmi@omp.upv.es)
Dpto. de Organización de Empresas.Universidad Politécnica de Valencia. Camino de Vera S/N, 46022 Valencia.

Abstract: Cost models and service models are usually considered as equivalent, so that stock out penalty costs can replace service level constraints without loss of generality. However recent developments show that service models are more general than cost models. Moreover, not only there is not a generally accepted procedure for the estimation of stock out penalty costs, but also managers usually establish the business policies in terms of minimizing costs while reaching a specified service level. Both reasons endorse the use of a service model. In this paper we apply this approach to a very common problem: determining the service per item so that total stock costs are minimized while global service level is above a target. We propose a service model that can be easily applied and seems to outperform the usual procedure based on the value ABC analysis.

Keywords: inventory management; stockout cost; service level; multi-item service level.

1 Literature review

1.1 The cost model and the service model

The stochastic problems in stock management are usually classified into two main group: cost models and service models (van Houtum and Zijm 2000).Cost models establish the optimal inventory policies as a result of minimizing the costs related to the stock management including ordering costs, holding costs and penalty costs caused by the inability to serve the demand. On the other hand, service models are almost identical to the cost model and the only difference is that a service level constraint replaces the penalty costs.

The study of models of stochastic stock policies started with (Arrow et al. 1951)that is based on the cost model. In fact, they affirm that “the organization… has a general idea of the value it would attach to the damage that would be caused by the non availability of an item”. However, later authors differ because penalty costs should include not only the gross margin of the unmet demand but also the effect that the lack of service produces in terms of future sales decrease. This difficult estimation is in practice even worse given that accounting systems cannot help as they do with the other type of costs.

Therefore very different approaches have been proposed such as letting the manager to establish subjectively the penalty costs (Badinelli 1986), solving the service model and estimate the penalty cost as the shadow price of the service constraint (Aardal et al. 1989)or even using fuzzy logic to represent the penalty and to determine the optimum policy (Vijayan and Kumaran 2008). However these approaches have not proved to be very useful so that (Zipkin 2000)points out that the difficulties to estimate penalty costs make many people to give up the cost model. Other authors (Fogarthy et al. 1991)conclude that it is virtually impossible to estimate penalty costs explicitly and straightforwardly, so the most usual approach is based on service level constraints.

1.2 The equivalence between both models

(van Houtum & Zijm 2000) show that, when there exist a linear relationship between the penalized metric (usually units not served or periods with unmet demand) and the service metric, then the optimal policy for the cost model is also optimal for the service model.

In spite of the difficulties to estimate the penalty costs and its scarce practical application, cost models have received much more attention in the literature than service models. (Chen and Krass 2001)states that several reasons explain this contradiction: (i) the service model is perceived to be less tractable mathematically; and (ii) there seems to be a general believing that each service model is equivalent to a cost model with a properly defined penalty (known as *imputed shortage cost*) so that cost models are equivalent (Zipkin 2000).

However, (Chen & Krass 2001)observe that: (i) the definitions of service metrics are usually ambiguous and incomplete; (ii) there is a general believing that cost models are mathematically more tractably than cost models; and (iii) some service models consider as a constraint the average service during a planning horizon, although the most usual approach in practice is considering that the expected service must be above a target service level in every period of the planning horizon. However, these authors examine the relationship between the optimal (s, S) policies in the cost model and service model with minimum service level constraint and show that no transformation of the service model to the cost model is possible through an imputed shortage cost. Therefore, service models are more general than the cost models.

Additionally, service models are more suitable for modeling a number of different problems, as will be shown below.

1.3 The multi-item service level problem

A well known unresolved problem is the assignment of a service level target to a number of items when management establishes a global target service level while minimizing total costs. The global target service level can be computed (Thonemann et al. 2002)as average service level of the items weighted with the demand fraction corresponding to each item. Inventory managers may choose the same target for every item but then the reference stock will be one unit for the low demand items so that the expected service level will exceed the target and dealing to overstock.

Managers may also set up different target service levels depending on the ABC class they belong to(Silver et al. 1998). However the question is what target must be used for each ABC class because literature provides little help. On the one hand some authors (Armstrong 1985)state that class A items should have the highest targets in order to avoid frequent unmet demand, but on the other hand (Knod and Schonberger 2001)argue that class C items should have the highest targets for avoiding frequent stockouts. Moreover, (Zhang et al. 2001)propose an ABC ranking criterion based on the ratio $D/(L\,v^2)$being D the expected annual demand, L the lead time and v the unit cost. Recently (Teunter et al. 2010)propose a ranking criterion based on acost model perspective dealing to the ratio $(D\,b)/(Q\,h)$ being b the penalty cost, h the holding cost and Q the order size. This criterion includes a measure of the criticality of the item in terms of its penalty cost due to it is considered by some authors especially for spare parts management.

Although ranking criteria have been improved, a method for assigning a target service level to each item has not been proposed yet. This is the main aim of this paper.

1.4 Organization of this paper

The remainder of this paper is organized as follows. In Section 2 we present the notation used in this paper. In Section 3 we propose a service model for determining the service level of several items whose constraint is the global cycle service level target. This model is applied to a dataset to illustrate its performance compared to the usual ABC value classification. Finally in Section 4 we provide our conclusion, some managerial insights and direction for further re-search.

2 Notation

The notation used in the rest of this paper is listed below. Note that in a multi-item context sub-indexes may be used to denote a particular item:

A	ordering cost,
r	cost of holding 1€ stock value during a unit time,
v	unit cost,
h	holding cost ($h = rv$),
SS	safety stock,
s	reorder point,
Q	order quantity,
$Q*$	economic order quantity ($Q^* = \sqrt{2AD/h}$),
D	demand per unit time,
L	lead time,
$f_L(.)$	probability distribution of demand in L time periods,
$F_L(.)$	cumulative distribution of demand in L time periods,
CSL	cycle service level,
CSL_{target}	global cycle service level target,
p	fraction of demand value corresponding to an item,
N	number of items considered.

3 Determining service levels using a service model

3.1 Modeling the problem

We propose a service model in order to illustrate its superior ability modeling business situations exceeding the ability of the cost model approach. Additionally, we gain some insight into the multi-item service level assignment. For the sake of simplicity, we consider the cycle service metric, a continuous review stock policy and allowed backlogs so that the model can be expressed quite straightforwardly

$$\min \quad \sum_{i=1}^{N} (h_i\, SS_i + h_i \frac{Q_i}{2} + A_i \frac{D_i}{Q_i}) \tag{1.1}$$

subject to

$$\min \quad \sum_{i=1}^{N} p_i\, CSL_i \geq CSL_{\text{target}} \tag{1.2}$$

On the one hand, the terms in Equation 1 represent the safety stock cost, the cycle stock cost and the ordering cost. On the other hand Equation 2 expresses the global service level constraint using the cycle service level metric, although other metrics could be used. Assuming that backlogs are negligible and demand is independent and identically distributed, the safety stock can be expressed as

$$SS_i = s - D_i L_i \tag{1.3}$$

Therefore we have to determine N different stock policies *(s_i, Q_i)* subject to the global service level constraint (2). Fortunately Q_i only takes part in the cycle stock costs and the ordering costs, so the minimum of the cost function includes the economic order quantity Q_i* as order quantity. This constrained optimization problem can be solved using the marginal analysis; if s_i is increased by one unit then the cost function increases in h_i whereas the left hand side of (2) increases in

$$p_i \left[CSL(s_i+1) - CSL(s_i) \right] = p_i \left[\frac{F_L(s_i+1) - F_L(0)}{1-F_L(0)} - \frac{F_L(s_i) - F_L(0)}{1-F_L(0)} \right] = \\ = p_i \frac{f_L(s_i+1)}{1-F_L(0)} \tag{1.4}$$

So, if we use a gradient-like optimization technique, the next unit should be assigned to the item with the highest service to cost ratio (SCR_i)

$$SCR_i = \frac{p_i}{h_i} \frac{f_L(s_i + 1)}{1 - F_L(0)} \tag{1.5}$$

As long as we only need to determine the reorder points s_i that minimize the cost function, we simplify the objective function into

$$\min \sum_{i=1}^{N} h_i \, s_i \tag{1.6}$$

3.2 Numerical example

Our interest is to assess the performance of the proposed model when compared to the usual value ABC assignment. The first step is to generate a dataset with just *N=100* items using the parameters shown in Table 1.

Table 1 Parameters used to generate the example dataset, being demand Poisson distributed and *D* is the annual demand from 260 workable days

Parameter	Values	Parameter	Values
D	1 .. 1000	r	0,20 .. 0,30
L	1..10	v	1 .. 1000
A	30 .. 100		

Table 2 Different arrangements considered in value ABC analysis

Class	Percentage of items	Percentage of demand value	CSL target per class I	CSL target per class II
A	20	0,492	0.90	0.95
B	40	0,421	0.75	0.80
C	40	0,087	0.50	0.00
		Global target	0.802	0.804

The next step is to set the CSL target to 0.80 and to disaggregate it into 90%, 75% and 50% CSL targets for classes A, B and C respectively (see arrangement I in Table 2) dealing to a cost of141.907 €/year (see Table 3).

The third step is to compute the optimal cost given by (6) subject to the global service level constraint (2). We have used a heuristic that balances a gradient-like strategy and the gain of assigning the first units to each item. The result is an optimum of 58.815€/year (see Table 3) including 41% of items with $s_i=0$, that is, items that release an order just when they are out of stock. These items present a CSL of 0%, lower than the CSL target of 50% previously set for class C item. The other items show an average CSL of 93% and that completes a picture of the service level of the items where some of them have a very high CSL and the others just 0, with no items with medium values. This picture differs greatly from the value ABC assumptions, so it seems reasonable to repeat the value ABC analysis with a 0% target for class C (see Table 2 in arrangement II).

Table 3 Resulting costs from different service level disaggregation approaches

Approach	Cost (€/year)	Overcost
Value ABC - I	141.907	141%
Optimization	58.815	--
Value ABC - II	90.310	54%

The last step is a repetition of the value ABC analysis with the CSL targets of the new arrangement. The result is a dramatic cost reduction from 141.907 €/year to 90.310 €/year, although it is 54% higher than the optimum.

4 Discussion and future research

We have proposed a service model for coping with the multi-item service level problem. Not surprisingly this new model overcomes the usual ABC approach because: (i) the proposed model focuses on cost minimization while preserving the global service level; (ii) the proposed model represent in a natural way this problem exactly in the terms it is usually formulated by management; (iii) there is no need of estimating penalty costs for every item involved, a crucial advantage given the complex and costly procedures that have been proposed for its estimation; and (iv) the criticality of selected items can be represented when needed by simply adding an additional service level constraint for that items.
Additional research is needed to provide: (a) a simple ranking criterion in order to improve the performance of the ABC analysis the “Equation”; and (b) a simple closed formula to estimate the service level setting for every item without the need of using optimization procedures.

5 References

Aardal, K., Jonsson, O., & Jonsson, H. 1989. Optimal Inventory Policies with Service-Level Constraints. Journal of the Operational Research Society, 40, (1) 65-73 available from: ISI:A1989T301400005

Armstrong, D.J. 1985. Sharpening Inventory Management. Harvard Business Review, 63, (6) 42-& available from: WOS:A1985ATS4600005

Arrow, K.J., Harris, T., & Marschak, J. 1951. Optimal Inventory Policy. Econometrica, 19, (3) 250-272 available from: ISI:000204900400002

Badinelli, R.D. 1986. Optimal Safety-Stock Investment Through Subjective Evaluation of Stockout Costs. Decision Sciences, 17, (3) 312-328 available from: ISI:A1986D116200003

Bollapragada, S. & Morton, T.E. 1999. A simple heuristic for computing nonstationary (s, S) policies. Operations Research, 47, (4) 576-584 available from: ISI:000082409900008

Chen, F.Y. & Krass, D. 2001. Inventory models with minimal service level constraints. European Journal of Operational Research, 134, (1) 120-140 available from: ISI:000170149700009

Fogarthy, D.W., Blackstone, J.H., & Hoffmann, T.R. 1991. Production and Inventory Management, Second ed. South-Western Publishing Co.

Knod, E. & Schonberger, R. 2001. Operations Management: Meeting Customer Demands., 7th ed ed. New York, McGraw-Hill.

Silver, E.A., Pyke, D.F., & Peterson, R. 1998. Inventory Management and Production Planning and Scheduling, Third Edition ed. John Wiley & Sons.

Teunter, R.H., Babai, M.Z., & Syntetos, A.A. 2010. ABC Classification: Service Levels and Inventory Costs. Production and Operations Management, 19, (3) 343-352 available from: WOS:000277807200006

Thonemann, U.W., Brown, A.O., & Hausman, W.H. 2002. Easy quantification of improved spare parts inventory policies. Management Science, 48, (9) 1213-1225 available from: WOS:000178515300007

van Houtum, G.J. & Zijm, W.H.M. 2000. On the relation between cost and service models for general inventory systems. Statistica Neerlandica, 54, (2) 127-147 available from: ISI:000090149700003

Vijayan, T. & Kumaran, M. 2008. Inventory models with a mixture of backorders and lost sales under fuzzy cost. European Journal of Operational Research, 189, (1) 105-119 available from: ISI:000254422100008

Zhang, R.Q., Hopp, W.J., & Supatgiat, C. 2001. Spreadsheet implementable inventory control for a distribution center. Journal of Heuristics, 7, (2) 185-203 available from: WOS:000168825900005

Zipkin, P. 2000. Foundations of inventory management McGraw-Hill Higher Education.

249 Analysing the Impact of Consumer Tendency in HORECA Distribution Models

Zarei M, Ponce E

Mohammad Mahdi Zarei (✉ e-mail: m.mahdi_zarei@yahoo.com)
Industrial Engineering, Business Administration, and Statistics Department. EscuelaTécnica Superior de IngenierosIndustriales. Universidad Politécnica de Madrid (UPM).c/ José Gutiérrez Abascal, 2. 28006 - Madrid.

Eva Ponce-Cueto (✉e-mail: eva.ponce@upm.es)
Industrial Engineering, Business Administration, and Statistics Department. EscuelaTécnica Superior de IngenierosIndustriales. Universidad Politécnica de Madrid (UPM). c/ José Gutiérrez Abascal, 2. 28006 - Madrid.

Abstract: With increasing complexity of today's consumer requirements, food industry decision makers should be able to respond to consumer needs much faster than ever before. The preliminary studies showed that for improving the performance and selecting suitable distribution models, decision makers in food industries should classify different types of consumers and based on the classification prepare different distributions flows. By studying the HORECA distribution channel, this paper suggest that, logistics decision makers should investigate the relationship between consumers' characteristics and urban freight distribution strategy in order to respond to the exact needs and in the follow to reduce the logistics cost.

Keywords: HORECA Channel; Distribution Model; Urban/City Logistics; consumer Tendency.

1 Introduction

In last few years, many small cities have been converted to metropolitan's areas and many big cities even turned to mega cities (e.g. Lahore and Kinshasa cities) "Demographia World Urban Areas,10th annual Edition, 2014", which clearly shows tendency of population to leave in urban areas instead of rural areas. Along with that, changes have been occurred with the habit of all around the world's society-life food consumption, especially with foods which have taken place outside of home. Meanwhile, it has been generated many issues and concerns that would be worthy to be investigated, particularly in urban context (with many inhabitants). For instance, some classical logistics problems had become more complex, such as, network design problems, vehicle routing and order fulfillment or returns management.

Most of metropolitans are dealing with the various model of city logistics for delivering freight and to distribute in the urban areas. Thus, this has made researchers such as Russo & Comi (2011) and Suksri & Raicu (2012)to investigate the ways for improving economic efficiency and make sustainable environment in urban distribution. One of the most recently growing interested area in the good distribution is inHORECA (Hotels, Restaurants and Catering) food service sector. This channel has a great impact on the socio Communities consumer, and is established by a complex structure in which a variety types of businesses and activities which are integrated and chain to each other. For instance, HORECA facilities for having direct consumption of food outside the home can be named such as bars, restaurants, fast-food chains, hospitals, schools, etc.

Today's world, in some urban population consumes of their foods (e.g. meals, beverages, breads, etc.) inside HORECA channel are averagely 33% (Ii 2006; Anon 2012), which is one of the major components in urban life. Since, urban are an entity where distribution and consumption activities are located, city logistics maintains as a base relationships within HORECA,(Comi, Donnelly, & Russo, 2014).Thus, some industries were interested and allocated "around 30% of their total distribution, while for others it is less than 10%,"(Ponce-Cueto & Carrasco-Gallego 2009; Ibeas et al. 2012).

Many of the food industries are seeing themselves into this channel as an essential element of the market for their products, which requires a marketing strategy specifically tailored to the characteristics and expectations of this particular way of food consumption. This paper is attempting to classify and define HORECA customers and consumers in order to explain their relationship between them and urban distribution strategy which has chosen by logistics decision makers.

2 Methodology

In this research paper scientific journals, conference proceedings and annually consumption reports by Ministry of Agriculture, Food and Environment have been reviewed as sources for HORECA distribution models, city logistics and consumptions. Following list of keywords (and their combination) are used for search: "urban distribution model", "city logistics", "distribution model and consumption", "city logistics and consumers", and "HORECA distribution". The online databases such as Pro Quest, Emerald, Science Direct, Scopus, Web of Science, and Google Scholar are used for searching HORECA distribution models and city logistics. In addition, Referred conference proceedings from international Conference on Computers & Industrial Engineering have also reviewed.

3 Literature Review

Urban distribution concept was first established and modelled by Ogden 1992 and became starting point for other urban models (Fernandez-Barcelo & Campos-Cacheda, 2012). Since then, many studies have developed a strategy to identify solutions for improving life quality, managing resources efficiently, reducing social and economic costs and protecting social environment (Russo & Comi, 2012)such as reducing traffic congestion, air and noise pollution, and the road accidents (Browne, Allen, Nemoto, Patier, & Visser, 2012). Moreover, Ogden study showed each city logistics have objectives which can be categorized in following groups: 1) Economic 2) Efficiency 3) Road-safety 4) Environment 5) Infrastructure & management 6) Urban structure(Anand, Quak, van Duin, & Tavasszy, 2012).Most popular objectives which researchers have been focusing on these days are, efficiency, environmental and economic objectives(Farahani et al. 2013;Yang et al. 2013; Russo & Comi 2012).

However, according to Gonzalez et al.(2012), it is not easy to compare each model to another "without taking into account fundamental functions differences."(Jesus Gonzalez-Feliu & Routhier, 2012). Thus, models were categorized with their function and divided them into four groups: 1) Estimating demand models, 2) Fixed-demand models, 3) Multi-actor simulation models and 4)Macro-economic and public decision support models(Jesus Gonzalez-Feliu & Routhier, 2012). Nevertheless, the most growing works in city logistics are related to the fix-demand models(Gonzalez-Feliu 2011; Russo & Comi 2011). Although, it can create city logistics model base on high information quality of city logistics problems; but, developing and validating models as well as assessing the final outcomes from applying the model is much more important (Taniguchi, Thompson, & Yamada, 2012).

However, with the all classification, yet there is no official delimitation of what commonly called HORECAis and to which function or channel is related. This uncertainty causes and high consumption which distributed averagely between 30% and 33% by major food industries, made this sector to be important to investigate (Russo & Comi, 2013). It has demonstrated the majority of activities in many worldwide metropolitan, city centers and urban areas (Schoemaker et al., 2006; Comi et al., 2011). Since that small but growing part of researchers in the last few years are focusing and proposing some urban good distribution model in this sector for goods and general merchandise(Ponce-Cueto & Carrasco-Gallego 2009; Arvidsson 2013; Crainic et al. 2004).

In general, this literature reviewing was attempted to introduce the fundamental structure of urban good distribution models. It has defined and identified the objectives and functions in order to prepare a suitable distribution model in this sector for food industries.

4 Description of HORECAChannel

Many articles mainly discussed about urban distribution channel, -logistics strategy and performance evaluation(Wisetjindawat et al. 2012;Suksri & Raicu 2012). Among them, particular important channel has been grown as HORECA which have impact on HOtels, REstaurants and CAterings. In fact, HORECA activities are assumed as the end consumers because of being the final destination of goods. Since, the large amount of loads that are moved and distributed in this sector, the process of their decisions is quite same as retailers (Comi et al., 2014). Therefore, the main actors in this distribution model are: 1- Point of sales (hotels, restaurant, bars, and caterings), 2- Final decision makers (consumers) and 3- Distributors.

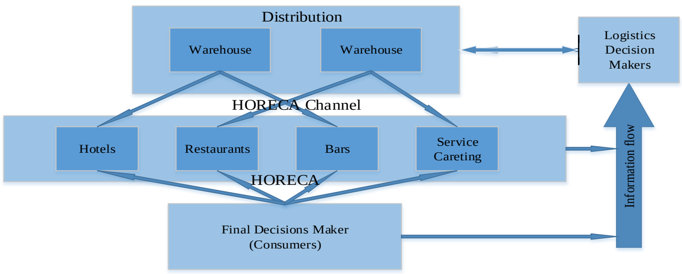


Fig.1 Distribution models in HORECA

Relationship between actors and information sharing flows which are taken place among them, is shown in Figure 1. Logistics decision makers receive information related to service level, quantity (demand) and cost (Jiang et al. 2013;Zhang et al. 2013) which are the three main aspects to take into account to design the distribution logistics network in this context. These items make logistics decision makers toopt and design suitable distribution based on consumer's information and point of sales information to improving customer level and reduce costs. In the following section, main characteristics of point of sales in HORECA channel will be described.

4.1 Sales Characteristics in HORECA Channel

The consumption of food and beverages away from home can be performed by multiple methods and / or types of companies. However, continually new companies will appear. Based on activities carry out by companies, two categories can be proposed:

1. Commercial catering: These types of companies will be preparing directly own food and beverages for individualized consumer choices through local outlets and can be classified as:
   - Traditional companies (Non-organized): retailers like as small bars and restaurants, some hotels and cafeterias.
   - Modern companies (organized): new forms of selling food which are including fast-food chains (fast food), the local take-away (takeaway) or restaurant chains.
2. Service catering: these kind of companies categorized their own members as certain distinct groups by the character and use of service. They will provide central kitchens or similar and prepare the uniformity of the menus offered. For example, companies or institutions which provide their food and beverage for such as hospital chains, schools buffet, aircrafts, trains and ships catering, etc.(Ponce-Cueto & Carrasco-Gallego 2009; Breu et al. 2008).

Table 1 Classification of HORECA companies based on activities

A. Commercial Catering		
Point of sale	Traditional Companies	Modern Companies
Serving Tourist & Public Caterings	•Traditional cafeterias and Restaurants. •Inns, Hotel apartments, and hostel restaurants.	•Restaurants chains and cafes in Hotels chains, Campsites chains, etc.
Specialized-Servicing	•Small and TraditionalFast-food (burger, Pizzeria, etc.)	•Fast-food chains, Vending machines •Take away •Buffet / Self services
Selling Beverage	•Mini-bars, Coffee-bar, Taverns, etc. •Clubs, Halls&Nightlife and other shows, etc.	•Chains of cafes &bars (Starbucks) •Chains breweries, Beverages (milk, etc.)
Selling snacks		•Vending machines •Kiosks, Ice cream stands
B. Service Catering		
• Dining Company (public or private)		
• Catering institutions(central kitchens or similar)		
• Catering visitor (planes, trains, ships, etc.).		
• Catering specializing in events (weddings, parties, banquets, etc.)		
• Catering Home / individualized service		

4.2 Consumer's Characteristics in HORECA Channel

It is significant to identify the consumer's characteristics which are the consumptions of this sector. Thus, some researchers studied consumer movement which travels from their residence to these sectors and called them as the final decision-makers. So, end consumers can be called as the final decision-makers for these kind of movements(Russo & Comi, 2011). This make decision maker in industries to identify and to distinguish their needs and follow their trends.
According to Breu et al. (2008) study, industries decision makers can classify consumer in the following categories:

- The tourism expansion
- The rapid development of immigration.
- The increasing weight in population of older people.(40>)
- The changes in habits and attitudes of young people.(40<)

However, end-consumer consumption, trends consumption and HORECA activities (e.g. advertising, promotion, etc.)have impact on HORECA distribution channel such as delivery size, frequency's characteristics, service level, and cost of delivery (Council, 2008). In fact, the freight distribution flows depend on end-consumer residence location and their attitude and behavior. Furthermore, some consumer's characteristics, such as age, gender, income, family dimension, education background, regions and lifestyle(Comi et al., 2014) affects to demands requirements at point of sale and therefore to HORECA distribution models. Although, companies are trying to be more flexible; but, lacking the proper information flow and decision support systems and feeling the pressure to change and select the proper city logistics model to face with growing populations (Muñuzuri, Cortés, Guadix, & Onieva, 2012) and to respond their consumer's needs.

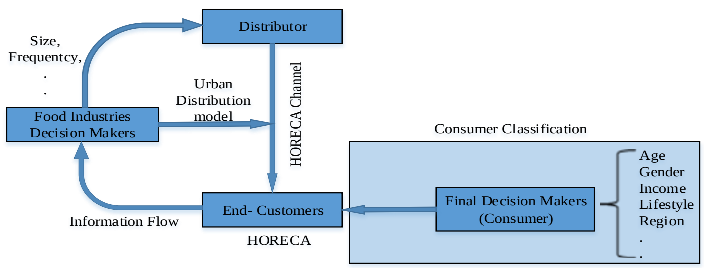


Fig. 2: HORECA Decisions based on consumer's information

In general, logistics decision makers should primarily increase their information about the consumer's characteristic and their trends in order to decision taken process for designing distribution models in HORECA channel, be more efficient. Eventually decision makers can opt suitable distribution model in this sector, from many studies which indicated the distribution model such as " modelling freight transport"(Comi et al., 2014), "distribution models for logistics in HORECA channel"(Ponce-Cueto & Carrasco-Gallego, 2009).

5 Conclusion

Based on this research, a growing importance of around 30% and 35% have been identified in the "food consumption outside the home" in last few years. This has made attention to food industries decision makers for increasing their information about this sector and their consumers. Thus, this paper proposed a first classification and definition for HORECA customers and consumers and explain the relationship between consumers' characteristics and urban freight distribution strategy. Since the strategy and selecting suitable urban distribution model in this channel is depending on delivery size, frequency service level, and cost of delivery among others factors, logistics decision makers should be able to analysis the food consumption inside the HORECA which is based on the diet consumed and consumer tendency and characteristics.

In the further development, it should be study in-depth with real and empirical data to analyze the impact between consumers' characteristics and urban freight distribution strategy in order to reduce logistic cost by opting and preparing suitable distribution in last mile logistics.

6 References

Anand, N., Quak, H., van Duin, R., & Tavasszy, L. (2012). City Logistics Modeling Efforts: Trends and Gaps - A Review. Procedia - Social and Behavioral Sciences, 39, 101–115.

Anon, 2012. Ministerio De Agricutura, Alimentacion y Medio Ambiete, HOGAR EN ESPAÑA 2012.

Arvidsson, N. (2013). The milk run revisited: A load factor paradox with economic and environmental implications for urban freight transport. Transportation Research Part A: Policy and Practice, 51, 56–62.

Breu, F., Guggenbichler, S., & Wollmann, J. (2008). Analisis descriptivo del canal HORECA en la Comunidad de Madrid. Vasa. f.

Browne, M., Allen, J., Nemoto, T., Patier, D., & Visser, J. (2012). Reducing Social and Environmental Impacts of Urban Freight Transport: A Review of Some Major Cities. Procedia - Social and Behavioral Sciences, 39, 19–33.

Comi, A., Donnelly, R., & Russo, F. (2014). Modelling Freight Transport. Modelling Freight Transport (pp. 163–200). Elsevier.

Council, S. (2008). Supply chain operations reference model (pp. 0–23).

Crainic, T. G., Ricciardi, N., & Storchi, G. (2004).Advanced freight transportation systems for congested urban areas.Transportation Research Part C: Emerging Technologies,12(2),119–137.

Demographia World Urban Areas, Edition, A., 2014 (Built-Up Urban Areas or World Agglomerations) 10 th Annual Edition.

Farahani, R. Z., Rezapour, S., Drezner, T., & Fallah, S. (2013). Competitive supply chain network design: An overview of classifications, models, solution techniques and applications. Omega, 45, 92–118.

Fernandez-Barcelo, I., & Campos-Cacheda, J. M. (2012). Estimate of Social and Environmental Costs for the Urban Distribution of Goods. Practical Case for the City of Barcelona. Procedia - Social and Behavioral Sciences, 39, 818–830.

Gonzalez-Feliu, J. (2011). Two-echelon freight transport optimisation: unifying concepts via a systematic review. Working Papers on Operations …, 2, 18–30.

Gonzalez-Feliu, J., & Routhier, J.-L. (2012). Modeling Urban Goods Movement: How to be Oriented with so Many Approaches? Procedia - Social and Behavioral Sciences, 39, 89–100.

Ibeas, A., Moura, J. L., Nuzzolo, A., & Comi, A. (2012). Urban Freight Transport Demand: Transferability of Survey Results Analysis and Models. Procedia - Social and Behavioral Sciences, 54, 1068–1079.

Ii, B. (2006). Quantification of Urban Freight Transport Effects I.

Jiang, L., Wang, H., & Ding, B. (2013). Disruption Management Recovery Model of Distribution Delay with Service Priority. Asian Social Science, 9(2), 170–180.

Muñuzuri, J., Cortés, P., Guadix, J., & Onieva, L. (2012). City logistics in Spain: Why it might never work. Cities, 29(2), 133–141.

Ponce-Cueto, E., & Carrasco-Gallego, R. (2009). Distribution models for logistics in HORECA channel. 2009 International Conference on Computers & Industrial Engineering, 754–759.

Russo, F., & Comi, A. (2011). A model system for the ex-ante assessment of city logistics measures. Research in Transportation Economics, 31(1), 81–87.

Russo, F., & Comi, A. (2012). The Simulation of Shopping Trips at Urban Scale: Attraction Macro-Model. Procedia - Social and Behavioral Sciences, 39, 387–399.

Russo, F., & Comi, A. (2013). A Model For Simulating Urban Goods Transport and Logistics: The integrated Choice of ho.re.ca. Activity Decision-Making and Final Business Consumers. Procedia - Social and Behavioral Sciences, 80(Isttt), 717–728.

Suksri, J., & Raicu, R. (2012). Developing a Conceptual Framework for the Evaluation of Urban Freight Distribution Initiatives. Procedia - Social and Behavioral Sciences, 39, 321–332.

Taniguchi, E., Thompson, R. G., & Yamada, T. (2012). Emerging Techniques for Enhancing the Practical Application of City Logistics Models. Procedia - Social and Behavioral Sciences, 39, 3–18.

Wisetjindawat, W., Yamamoto, K., & Marchal, F. (2012). A Commodity Distribution Model for a Multi-Agent Freight System. Procedia - Social and Behavioral Sciences, 39, 534–542.

Yang, J., Guo, J., & Ma, S. (2013). Low-carbon city logistics distribution network design with resource deployment. Journal of Cleaner Production, 1–6.

Zhang, S., Pang, H., Zhang, M., & Zhang, M. (2013). Research on Optimal Order Quantity of Distribution System with Stochastic Lead-time. Internati*onal Journal of Advancements in Computing Technology*, *5*(9), 623–629.

261 Tackling stakeholders' negative incentives in Air Travel regarding People with Disabilities: Internalizing the externality

Durán A, Solera J

Alfonso Durán Heras (✉ e-mail: alfonso.duran@uc3m.es)
Área de Ingeniería de Organización. Escuela Politécnica Superior. Universidad de Carlos III de Madrid. Avda. de la Universidad 30, 28911 Leganés.

Jorge Solera Camino (✉e-mail: jorge.solera@uc3m.es)
Área de Ingeniería de Organización. Escuela Politécnica Superior. Universidad de Carlos III de Madrid. Avda. de la Universidad 30, 28911 Leganés.

Abstract: The challenge posed by the currently unsatisfactory air transport accessibility for people with disabilities and older persons will become more acute, if not properly dealt with, due to the ageing of the population. The European Commission (EC) consequently funded the research project ICARUS (which encompasses this study) to identify the most promising solutions. Initial findings showed that stakeholders' behavior towards people with disabilities was heterogeneous (more than expected) and sometimes run contrary to the EC's objectives. Further research was then carried out on this counterproductive behavior. The results highlighted the existence of uncorrected negative incentives and suggested that the observed behavior could be explained through the externality theory. Furthermore, it unearthed that this potential issue had already been spotted by the EC while developing the current regulation. The EC, however, tackled this potential issue, depending on the specific instance, with one or the other of the approaches suggested by the externality theory ("internalizing the externality" vs. regulation). The difficulties caused by this divergence led to this paper's recommendations.

Keywords: Incentives, people with reduced mobility, air transport, accessibility, externalities.

1 Introduction

According to the European Commission's European Disability Strategy 2010-2020 (European Commission, 2010), one in six people in the European Union (EU) has a disability that ranges from mild to severe, thus numbering around 80 million citizens, who are often prevented from fully taking part in society and the economy because of environmental and attitudinal barriers. Moreover, the incidence of disability is increasing dramatically as the population ages in most western nations (Eurostat, 2011).

On the other hand, freedom of movement is a right preserved under EU treaties: “Every citizen of the Union shall have the right to move and reside freely within the territory of the Member States, subject to the limitations and conditions laid down in the Treaties and by the measures adopted to give them effect” Art. 45 of the Lisbon Treaty (European Union, 2007).

However, these basic rights are not currently fully realized in the accessibility to air transport for people with disabilities (PWD) and the elderly, thus having a major impact on the lives and life choices of many citizens with reduced mobility (Wilson, 2003; Kwai-Sang Yau, et al., 2004; Leonard Cheshire Disability, 2007; Van Horn, 2007; Poria, et al., 2010). Transport is essential for disabled people and the elderly to access education, employment, health services, social events and leisure pursuits. A lack of accessible means of independent travel creates social exclusion for People with Reduced Mobility (PRM, encompassing people with disabilities and older persons).

Therefore, although society’s awareness and legislation in this regards have come a long way in the past few years, there is still much work to be done regarding accessibility, not just because of legal compliance requirements but also because of the market potential and opportunities it entails.

Within this framework, the European Commission (EC) funded (under FP7) the ICARUS project, which tackles the stumbling blocks that are currently hindering the freedom of movement in order to propose a list of solutions/solution areas with the highest potential to improve the accessibility in the air transport and to propose the future research lines in the EU.

The preliminary result of the first stages of the project was a tentative list of solutions aimed at eliminating/mitigating the barriers users currently find when travelling by air. Furthermore it was observed that the attitude of the various stakeholders’ groups towards accessibility was not uniform; it actually varied depending on their role in the accessibility chain. In some cases this attitude was even contrary to the desired goal: it looked as if certain stakeholders intentionally hindered the travel experience for PRM, instead of being sensitive towards their especial needs. In addition to the inherently negative impact that this may have on the current level of accessibility, it may also obstruct the implementation of the tentative solutions (since they depend on the stakeholders’ willingness to adopt them).

The need to understand, and eventually counteract, this anomalous behavior led to the study described in this paper. Its objectives are:

- Finding the causes of the non-uniform and sometimes counterproductive stakeholders’ behavior.

- Analyzing how this behavior may affect the solutions proposed at the end of the ICARUS project.
- Identifying effective approaches for counteracting or at least mitigating its negative effects.

2 Methodology

This study, developed within the framework of the ICARUS project, analyzes the observed unexpected behavior by some stakeholders (it varies depending on the stakeholders group, e.g., airport management bodies, airlines, service providers…), which sometimes even runs contrary to the EC's objectives.

To accomplish this study's objectives, a dual methodological approach was followed. The basic normative framework, i.e. Regulation (EC) No 1107/2006 was analyzed in detail, along with the deliberations and discussions held to define and justify it, as well as the reports on its functioning (European Commission, 2011; Smith, et al., 2010) and the interpretative guidelines (European Commission, 2012). On the other hand, in-depth interviews were carried out with relevant representatives of the various stakeholders (airlines, airport management bodies, experts on accessibility…).

3 Results

The first results of the analysis highlight that among all the stakeholders that take part in the travel cycle, those who have a higher influence on the choice by the PRM to use their services (mainly airlines) are more likely to exhibit a counterproductive behavior. The airlines' influence on PRM's decisions is notable due the proximity of "substitutive products": PRM can simply switch from one airline to another if the first one does not present accessible procedures/protocols/equipment. On the other hand, PRM can not do the same with airports since the choice of the airport to use depends mainly on the origin and destination of the trip, and there are normally few close substitutes.

In addition, this non-desirable behavior was generally observed in situations in which marginal costs associated with servicing the PRM seem to be higher than the marginal income they produce. Within those stakeholders that can effectively influence the PRM's choice, this behavior was more likely in cases where those marginal costs were higher (e.g., for airlines which minimize their turnaround times in order to reduce their costs, and thus the potential delay caused by PRM boarding/ deplaning could generate significant marginal costs, when compared to airlines that allow for longer turnaround times).

These three key factors (influence on PRM's decisions, marginal costs higher than marginal incomes, and importance of marginal costs in the cost structure) suggest the possible relevance of negative incentives (because of the negative marginal profit associated with the PRM), and, as discussed below, the potential applicability of the economic theory regarding externalities.

According to the Regulation (EC) No 1107/2006, "disabled persons and persons with reduced mobility, whether caused by disability, age or any other factor, should have opportunities for air travel comparable to those of other citizens". Thus, "assistance to meet their particular needs should be provided at the airport as well as on board aircraft, by employing the necessary staff and equipment. In the interests of social inclusion, the persons concerned should receive this assistance without additional charge" (European Commission, 2011).

Requiring relevant stakeholders to provide extra services and to fulfil special requirements and rights by PWD/PRM at no extra charge can easily result in costs associated with providing the service to PWD /PRM exceeding the income generated, particularly, as discussed below, when indirect costs are taken into account.

This potential "non-profitability" can be justified from the standpoint of wider social benefits, e.g. "In the interests of social inclusion". If, however, the specific stakeholder (e.g., airline) providing the service bears the associated costs, a classical "externality" market failure arises, whereby a decision maker (e.g. an airline) is subject to only a subset of the consequences of its decisions (e.g., bears the costs but does not reap the "wider social benefits"), thus creating the wrong incentives for the decision-making process (Lipsey, 1995).

According to conventional economic theory, externalities call for external intervention by the "Authorities" (Government) beyond market mechanisms. These interventions lie in a spectrum ranging from imposing a course of action on the decision maker through a legal requirement ("regulation") to, at the opposite end of the spectrum, "internalizing the externality", i.e. changing the distribution of costs and benefits (e.g., in the case of contamination, through "green taxes" or through tradable permits) so that the decision maker's objectives are better aligned with the wider social objectives.

In the above mentioned case, the EC adopted the regulation approach, thus imposing on the airlines the duty to provide some services, even though that produces negative net revenues for the incumbent companies. However, as the externality theory predicts, the affected stakeholders may then try to minimize their marginal costs (or to increase their marginal incomes) associated to the PRM, while formally satisfying the legal requirements.

Nevertheless, in what might initially seem as contrary to the predictions of the externality theory, it was observed that there was practically no negative attitude related to the main source of marginal costs, the PRM assistance service. This can, however, be explained because, while drafting EC 1107/2006 (instituting the PRM service requirement), the EC was fully aware of this issue, which was discussed at length, for example, in COM(2005) 47 final07/2005 (COD) (European

Commission, 2005) (whose recommendations were basically included in EC 1107/2006), a few selected excerpts of which are included below:

…The Commission … is concerned, however, to ensure that best practice is followed … and that this continues despite the increase in passengers with reduced mobility caused by the ageing of the population and the unrelenting pressure on airlines to reduce costs

…Unless it charged passengers with reduced mobility for the full cost of assistance, which would be quite unacceptable, an airline might be tempted to refuse them carriage in order to save cost. It might also be concerned about potential safety risks or the unjustified reaction of other passengers … An airline or tour operator might refuse either to accept reservations from people with reduced mobility or to embark them once at the airport. The Commission therefore proposes that, in the case of flights departing from airports situated in the territory of a Member State to which the Treaty applies, they should be forbidden to refuse either acceptance of reservations or embarkation of passengers, on the grounds of reduced mobility.

…A second objective should be to avoid giving airlines incentives to reduce the number of persons with reduced mobility that they carry. If an airline were responsible for assistance at each airport served and so were to incur costs roughly proportional to the number of passengers with reduced mobility transported, some might be tempted to carry as few as possible. While they could not directly refuse carriage without violating the fair treatment clause, they might deter people with reduced mobility by providing a poor service or abusing safety rules. If they gained a reputation for doing so, people with reduced mobility would soon start to avoid them. Most carriers would strongly resist such practices but, if a few were to adopt them and make serious cost savings, the others would come under strong pressure to follow.

…This could be avoided if airlines were to pay charges proportional to the number of passengers that it carried to or from the airport, so that they were independent of the number of people with reduced mobility transported. Such an approach would greatly reduce the incentives for airlines to minimise the number carried (it would not eliminate them entirely as airlines would have to provide some assistance on-board the aircraft). It could be realised by establishing a centralised system at each airport and then allowing its organiser to levy a charge on all airlines using the airport in proportion to the number of passengers that it transported to and from it.

Thus, while drafting EC 1107/2006, the EC:

- Based on wider social objectives, prevented relevant stakeholders from "*charging passengers with reduced mobility for the full cost of assistance*", "*which would be quite unacceptable*".
- Clearly identified the associated "externality" risks: "*an airline might be tempted to refuse them carriage*", "*giving airlines incentives to reduce the number of persons with reduced mobility that they carry*".
- Identified trends that would increase that risk: "*increase in passengers with reduced mobility caused by the ageing of the population and the unrelenting pressure on airlines to reduce costs*" (even if it did not explicitly mention the relative surge of "low cost" airlines).
- Implicitly recognized the limitations traditionally associated with the "legal requirement / regulation" approach to externalities: *"...some might be tempted*

> *to carry as few as possible. While they could not directly refuse carriage without violating the fair treatment clause, they might deter people with reduced mobility by providing a poor service or abusing safety rules. If they gained a reputation for doing so, people with reduced mobility would soon start to avoid them. Most carriers would strongly resist such practices but, if a few were to adopt them and make serious cost savings, the others would come under strong pressure to follow".*

Consequently, EC 1107/2006, for the single largest clearly identified cost component leading to that externality (the PRM service, encompassing services described in ANNEX I) imposes what could be characterized as an "internalizing the externality" approach. It settles a "*fierce disagreement over whether airports or airlines should be responsible for the assistance at airports*" by assigning that responsibility to the managing body of the airports (this is also justified by other reasons, e.g. efficiency, economies of scale and seamlessness). The airport may then "*levy a specific charge on airport users for the purpose of funding this assistance*".

The aim is to "*greatly reduce the incentives for airlines to minimise the number carried (it would not eliminate them entirely as airlines would have to provide some assistance on-board the aircraft)*". This should "*avoid these problems as the charge levied on each airline would be proportional to the total quantity of passengers that it embarked and disembarked at an airport. The charge would be independent of the number of passengers with reduced mobility carried, so that the airline would little economic incentive to reduce their numbers*."

It is furthermore argued that, even though it imposes "*one additional cost on the sector, that of extended assistance when people required it*", it basically operates by redistributing costs, eliminating the marginal costs that affect decision making by transforming them into fixed costs (independent of the number of PRM travelling with that airline).

However, for all other cost drivers (besides PRM service) that could give stakeholders, particularly airlines, "*incentives to reduce the number of persons with reduced mobility that they carry*", Regulation (EC) No 1107/2006 resorts to the "legal requirement/ regulation" approach to externalities, in spite of the implicit recognition of its limitations discussed above: "*An air carrier or its agent or a tour operator shall not refuse, on the grounds of disability or of reduced mobility: (a) to accept a reservation for a flight …(b) to embark a disabled person or a person with reduced mobility…*".

That would not be an issue if, after excluding the PRM service, variable costs linked to carrying PRM would not be significant; however, this does not seem to be the case. Article 10 and Annex II of EC 1107/2006 spell out services that air carriers must provide without additional charge, and there are also other indirect costs (e.g., the above mentioned potential costs associated to delays caused by PWD/PRM boarding/deplaning). The results of the analysis pointed out that these direct and indirect costs are relevant (and the affected stakeholders are concerned about them), thus they could explain the stakeholders' negative attitude.

Thus, the externality theory seems to be adequate to explain the stakeholders' negative behavior, and, more important, the EC did take some measures to prevent this situation, but only for one specific case.

Finally, in order to prevent that this "regulation approach" to externalities jeopardizes the future proposed solutions of the ICARUS project (and to generally mitigate its consequences), the following recommendations are made:

- Further analyzing current cost drivers leading to relevant marginal costs for stakeholders (mainly airlines) linked to carrying PRM.
- Including such analysis as a standard element in the evaluation process of proposed changes. This measure aims directly at avoiding the creation of additional externalities as a secondary result of future laws, solutions, etc. Being aware of the indirect implications that hypothetical changes may have in the incentives structure is essential to get effective results.
- Exploring approaches to reduce the disincentive caused by marginal costs for stakeholders linked to carrying PRM exceeding marginal income through a combination of:
  - Reducing associated overall costs.
  - Where feasible, following the example of the PRM service, share the incremental costs of servicing PRM among competing stakeholders (mainly airlines, which are close substitutes of each other, potentially other stakeholders such as airports) according to total number of passengers (rather than each stakeholder bearing the cost of the PRM it services).
  - Promote non-financial incentives to servicing PRM, e.g. through including objective indicators on social inclusion of PWD/PRM in CSR/Sustainability guidelines, or as additional merits for accessing certain publicly funded benefits or scarce resources e.g. finger allocation.
  - Increasing marginal income linked to servicing PRM without resorting to increased ticket price, e.g. either through direct public financial support or through a charge levied on all stakeholders based on the total quantity of passengers served, independently of their being PRM or not.

4 Conclusion

Inadequate accessibility for PRM in air transport is an issue recognized by the EC, leading in the last decade to the issuance of the Regulation (EC) No 1107/2006. In spite of recent significant improvements, it continues to be a stumbling block for PRM, thus other initiatives have been adopted (e.g., the European Disability Strategy 2010-2020). Although specific solutions are necessary (e.g., technological solutions, changes in procedures or protocols, etc.), it is paramount to establish the proper framework to encourage key stakeholders to collaborate proactively in overcoming this challenge.

The results of this study point out that the existing negative incentives associated with servicing PRM (due to marginal costs exceeding the income generated) hinder attaining this framework since they lead the stakeholders to shun these collectives.

Framing the issue, current approaches and observed behaviors in terms of the externality theory sheds light on potentially effective solution. Promoting the internalization of the observed externalities, as the EC did for some aspects of the EC 1107/2006 (e.g. PRM service) but not for others, seems less likely to lead to counterproductive behavior than the regulation approach. This can be achieved through such approaches as implementing redistribution mechanisms in order to transform variable costs into fixed costs (in terms of the number of PRM serviced) and generally reducing the gap between marginal income and cost.

5 References

Leonard Cheshire Disability (2007) Now Boarding: disabled people´s experiences of air travel.

European Commission (2005) Proposal for a regulation of the European parliament and of the council concerning the rights of persons with reduced mobility when travelling by air.

European Commission (2006) Regulation (EC) No 1107/2006 concerning the rights of disabled persons and persons with reduced mobility when travelling by air.

European Commission (2010) European Disability Strategy 2010-2020: A Renewed Commitment to a Barrier-Free Europe.

European Commission (2011) Report from the Commission to the European Parliament and the Council on the functioning and effects of Regulation (EC) No 1107/2006.

European Commission (2012) Interpretative guidelines on the application of the Regulation (EC) Nº 1107/2006, concerning the rights of disabled persons and persons with reduced mobility when travelling by air.

European Union (2007) Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community, signed at Lisbon, 13 December 2007.

Eurostat (2011) Demography report 2010.

Kwai-Sang Yau M, Mckercher B & Packer TL (2004) Traveling with a disability: More than an access issue. Annals of Tourism Research, vol. 31, no. 4, pp. 946-960.

Lipsey RG (1995) An introduction to positive economics. Oxford University Press, Oxford.

PoriaY, Reichel A & Brandt Y (2010) The flight experiences of people with disabilities: An Exploratory Study. Journal of Travel Research, vol. 49, no. 2, pp. 216-227.

Van Horn L (2007) Disability travel in the United States: Recent Research and Findings. 11th International Conference on Mobility and Transport for Elderly and Disabled Persons (TRANSED)-" Benchmarking, Evaluation and Vision for the Future, pp. 18.

Wilson L (2003) An overview of the Literature on Disability and Transport. Disability Rights Commission, London.

273 Competency mapping as a tool to aid organizational learning, and innovation process

Dias R, Souza Cabral A

Raquel Dias (✉e-mail: raqueldias2006@gmail.com).
Mechanical Engineering-Production . ITA - Instituto Tecnológico de Aeronáutica. Praça Mal. do Ar. Eduardo Gomes, 59. São José dos Campos, SP. 12.228-615

Arnoldo Souza Cabral (✉e-mail: cabral@ita.br).
Mechanical Engineering-Production. ITA - Instituto Tecnológico de Aeronáutica

Abstract: This paper presents a literature review of the main models for competency mapping, revealing the importance of these tools to support the organizational learning process. The study is relevant to present the most used methods, highlighting the advantages and disadvantages of each. It provides grants that can be used as guide for the process of choosing the most appropriate technique to the company profile. Identify the specific skills for the innovations development, and make them, hard core in the company is essential to obtain competitive and comparative advantages, in the market.

Keywords: Mapping Skills, Organizational Learning, Management**.**

1 Introduction

Nonaka et al (1997) suggest that innovation originates in the process of tacit knowledge sharing between individuals. The Competency Management Model provides effective tools for human resource management based on the appropriate profile for the achievement of company activities. Competence mapping reveals talents, skills and knowledge that can be improved. The strategic planning can use the competency management tool to promote the targeting of funding, selection, training, career management of employees towards to obtain more competitiveness gains and fulfillment of its mission, and to guide the organization in choosing the most appropriate tool for use. We opted for documentary and bibliographic search, since the analysis of several published studies provides the framework for reflection and understanding of learning and processes, models, mapping and assessment of competences, enabling, in this way the achievement of the desired goal.

2 Theoretical: Mapping Skills

The advantages are obtained with the skills and internal capabilities, assimilated over time, and through path dependence. For Fleury at al (1997) competence means take responsible actions to mobilize, integrate and disseminate knowledge, resources and talents to add value to the organization, and individuals. They suggest a combination of organizational competencies to generate innovations and submit four types of innovation related to the core competencies of the company, as shown in the following table (Fleury et al, 2013).

Table 1 Competences, capabilities and innovation

Competencies	Capability to innovation	Innovations types
Administrative, operations, technology	Business models.	New ways for produce and commercialize
Relationships, design	Products Customization	New products and market share
Technology, marketing	Development demanded	New products for the buyer
Finance, engineering	process Innovations	Costs reduction.

Source: Adapted by author (Fleury at al., 2013).

To Map the skills, it is necessary to relate and compare the talents, skills, and accumulated knowledge of individuals with the required for the exercise of the functions. This mapping can be accomplished through: assessment of organizational performance; evaluation of the customer satisfaction and effect of innovation, learning, individual performance evaluation and identification of learning needs. The Table 2 shows the basic cycle of the competency mapping process and the Table 3 shows the generic mapping process cycle.

Table 2 Basic cycle of the competency mapping process.

Organizational competencies	Get the valid business competence attributes
Skills for positions to Map	Competence attributes name required.
Racing for the performance of duties	Set appropriate profile for positions
Classification and grouping similar attributes.	Classify and aggregate similar attributes
Establishment of skills for positions	Define competencies for all attribute groups

Source: Adapted by author (Amaral, 2008).

Table 3 General model for competency mapping

Procedures	Tools	Issue
Collection of perceptions. • Identify positive and negative characteristics • Identify required characteristics.	Collector perceptions of competence Glossary of	Racing team perceptions. positive characteristics Competence attributes (CHA)

Conversion of perceptions into positive characteristics. Sort the positive features in attributes Develop indicators staff competency: • indicator of importance of attributes; • indicator of the level of domain attributes. Coordinate selection of management attributes	attributes Competencies spread sheet Baseline bookmarks Management Capacity	Staff competence indicators Management attributes

Source: Adapted by author (Amaral, 2008)

2.1 Management Model for Racing

Ienaga suggests the identification of gaps between the skills necessary to achieve the objectives, and available in the organization, as support to the development of actions for recruitment, selection and training of individuals. The phases of the general model of the skills management are shown in Fig.1 (Guimarães et al, 2006).

Fig. 1 Model of the skills management (Brandão, 2001).

There are two paths to reduce the gap: the first one deal with the development and training of personnel with the establishment of partnerships with research institutions, and the implementation of a process of recruitment and selection, externally. The second one suggests the creation of metrics to evaluate the performance of individual's processes to define wages, and undertake comprehensive policies to organizational learning. Based on the results of feedback analyzes of the process, the corrections of distortions should be performed, as well as the reformulation of the goals.

2.2 Data Collection for Mapping Skills

The document analysis is based on the company documents to identify the organizational competencies for career plans, mission, values, goals and objectives that may characterize the professional profiles required for the fulfillment of organizational goals. The questionnaire is based on the documentary research, and preliminary interviews. The direct observation allows perceiving the natural behavior of the persons, without meddling. It requires specialized training, and can cause embarrassment and possible misinterpretation, ensures anonymity, but only allows the observation of small amount of variables. Individual interviews are used when there is no time constraint because it may be long. This type of collection implies reduced time and cost, flexibility in application, suitability for obtaining satisfaction of those involved, and efficiency to obtain information. The process has own weaknesses, such as the requirement for experienced facilitator, not ensures the anonymity, requiring selection of participants, and no possibility of generalization, since it reflects only the group. Regarding the performance evaluation, there are several instruments for its execution. Among them we can mention the traditional assessment, the Balanced Scorecard, 360° evaluation, and self-assessment. The Balanced scorecard focuses on individual and organizational performance by aligning them with strategic objectives, with indicators of short, medium and long term (Kaplan et al, 1997). The 360 ° assessment is based on feedback from several evaluation sources, and Self-assessment. The description of skills should describe metrics for productivity, satisfaction, and the quality, and should to reflect the appropriate professional attributes to the performance of duties. The tests are used to identify potential and professional skills, to generate reliable results, and to provide flexibility and independence from the evaluator. The simulations are performed in the real environment of the company, but in situations created exclusively for testing. They allow the adaptation to company profile and direct observation of the attitudes and reviews before their possible occurrences. The evaluation is based on performance benchmarks, and competency standards describing observable behaviors, skills and desirable attitudes necessary, as shown in Tables 3 and 4 (Edwards et al, 1996).

Table 4 Example description of skills

Competence	Description (performance)
Results Orientation	Implements actions to business growth. Performs cost-benefit analysis. Uses metrics to evaluate results. Sets goals and operational plans.
Teamwork	Shares the challenges. Maintains good interpersonal relationships. Demonstrates optimism and enthusiasm in the search for problem solutions Holds meetings for leveling knowledge.

Source: Adapted by author (Santos, 2001)

The second deals with the competency standards that describe the knowledge, skills and desirable attitudes necessary. (Brandão et al, 2001; Bruno-Faria et al, 2003). Table 4 shows examples of dimensions of competence.

Table 5 Features or dimensions of competence examples.

Dimension of competence	Description
knowledge	Evidence relating to the routine procedures that are evaluating: e.g. finance principles, products, services, etc.
skills	Skills, perceptions, ability to deal with ambiguity.
attitudes	Commitment, involvement, initiative, respect, ethics.

Source: Adapted by author (Guimarães et al, 2006)

2.3 Organizational Learning

Organizational learning is perceived from trend toward improvement with a focus on results, from the individual action, environmental adaptation, and planned learning. The major features of organizational learning are the dissemination of trade, and its consequences, organizational memory, and mechanisms for sharing and updating of their solutions. Nonaka et al (1997) consider four processes of knowledge conversion: socialization (tacit - tacit), externalization (tacit - explicit), combination (explicit - explicit) and internalization (explicit - tacit). Initially there is the socialization of tacit knowledge, followed by externalization, which, internalized, generates fundamental innovations for obtaining competitive advantages. The learning process involves defining behaviors that reflects learning and creating new cognitive maps, to understand the external and internal context (Kiernan, 1998).

Garvin proposes ways for the occurrence of organizational learning as: systematic problem solving, experimentation, past experiences, knowledge circulation; experiences of others (Belfort, 2012;Fleury et al, 1997).

2.3.1 Types of learning

Guns (1998) there are the following types of organizational.

- Learning by doing: Oriented performance of the tasks.
- Systemic learning: deals with the implementation and process improvement.
- Cultural learning: relating to the spread of its values, beliefs and actions.
- Learning leadership: management and leadership of people, groups and units.
- Team learning: oriented to the efficient performance of the group.

- Strategic learning: focused on the strategies of the organization.
- Entrepreneurial learning: focused on the entrepreneurship and management.
- Reflective Learning: Emphasize the questioning of existing models.
- Transformational Learning: Geared for ways to make changes.

2.3.2 Learning and performance

The performance-based organization obtains short-term results, while those based on learning obtain results in long-term. This is because learning-based organization reinvests in learning (Guns, 1998).

3 Results and discussion

Competence mapping should cover the identification and description of the desired organizational competencies and skills of employees. Comparing the results of these two aspects, it is possible to see points that should be adjusted to allow actions that optimize their resources in pursuit of greater productivity. Table 6 shows the main methods used by companies to identify and map skills, revealing the weaknesses and strengths of each.

Table 6 Comparison of the main methods of competency mapping.

Method	Description	Advantages	Disadvantages	Authors
Document analysis	Review of institutional documents to identify skills.	low cost, agility.	Need validation by executives, the data may be outdated	(Guimarães et. al, 2006; Bruno -Faria et al, 2003; Brandão, et al 2001),
Focus group	Group interview. The moderator directs the discussion.	Reduce cost and time reduced, flexibility in application	Requires experience and selection, does not guarantee anonymity.	(Mattar, 2012; Carbone et al , 2005).
Self-evaluation	The people evaluate themselves.	low cost agility	Restricts evaluated perception Subjective	(Edwards et al, 1996)
Performance Evaluation 360º	Circular with all that integrate with the rated with coverage of 360º.	Requires experience, gives context information, not guarantee anonymity	Constrains. Use of inappropriate variables Coordinator trained.	(Chiavenato, 2004; 2014)

Table 6 (continued).

Traditional performance review	Consensus: manager and rated.	Feedback, Agility, trust and Lower cost	Allows bias and generates conflicts.	(Edwards et al, 1996)
Evaluation by Balanced scorecard	Performance evaluation of the firm and the individual.	Alignment of individuals with firms goals.	Objective technique does not use qualitative information.	(Kaplan et al,1997).
Direct observation	Observation of the individual while working.	low cost, complexity and objectivity.	Constrains,restricts the observer perception	(Carbone et al, 2005; Mattar, 2012)
Questionnaire	Questions based on documental analysis, direct observation and interview.	Low cost. Objectivity. Guarantee anonymity	May contain ambiguities and data may be outdated	(Brandão et al, 2001; Guimarães et al, 2006).
Identification of Potential Test	Identifies talents and personal tendencies	Independent of the evaluator, flexible, reliable results	Costly; allows manipulation . Does not allow adjustments	(Nazar, 2013).
interviews	individual interview	Allows direct contact to observe the reaction of people	Expensive. The quality of the result depends on the experience of the evaluator	(Brandão et al, 2001; Lodi, 1991; Carbone et al, 2005).
simulations	Simulation routine of the company, according with desirable skills	Reliable, adaptable. Allows to-stop and people watch.	High cost. Requires facilitator in groups and adequate infrastructure.	(Sauaia, 2006).

Table prepared by the author. * Sources: authors who have treated the subject.

All mentioned instruments have strengths and weaknesses. It is possible to minimize these limitations by combining the most appropriate instruments according to the company profile, allowing the crossing of resulting information.

4 Conclusion

Innovation is the result of the company's ability to articulate their resources and expertise. The management by competence enables the creation of an innovative organization, as it enhances the individual knowledge, aligning them with the needs of the institution to achieve its objectives and goals. The impact of process mapping skills provides conditions to situate the individual within the company, identifying their weaknesses and where exist points to support the professional growth, and allows the organization to be aware of the resources they have, and their real productive capability, allowing you to redefine roles, tasks, and goals, as well as designing performance standards in line with policy staff development.

The objectives of this research were achieved with the presentation of comparative overview of the main tools used for mapping competencies in firms. Certainly, this work will subsidize the selection process of the most appropriate model or combination of models, based on the company profile.

5 References

Amaral, R.M. (2008).*Gestão de pessoas por competências em organizações públicas*, São Paulo. Proceedings of XV Seminário Nacional de Bibliotecas Universitárias, p.10-14.

Belfort, R. M. (2012). Gestão por competências: Um novo modelo de gerenciamento. *UNI Magazine, Imperatriz (MA),* n.2, p.39-53.

Brandão, H. P. et al. (2001).Gestão de competências e gestão de desempenho: tecnologias distintas ou instrumentos de um mesmo constructo. In: *Journal of Business Administration*, São Paulo, v. 41, n.1, P.8-15.

Bruno-Faria, et al. (2003). Competências relevantes a profissionais da área de T&D. *Magazine of Administração Contemporânea de uma organização pública do DF*, v. 7, n. 3,p.35-56.

Carbone, P. P. et al. (2005). *Gestão por competências e gestão do conhecimento*. R.J., FGV.

Chiavenato, I. (2014). *Gestão de Pessoas: o novo papel dos recursos humanos nas organizações*. Sao Paulo, Manole.

Chiavenato, I. (2004). *A dinâmica do sucesso das organizações*. São Paulo, Thomson.

Edwards, M. et al (1996). *360º feedback: the powerful model for employee assessment and performance improvement*. New York: AMACOM.

Fleury, A. et al. (2013). The Brazilian Multinationals' approaches to innovation.*Journal of International Management*, 19, p.26-75.

Guimarães, T..A. et. al. (2006). Aspectos metodológicos do diagnóstico de competências em organização,in:*Training, Development and Education and Labor Organizations*,S.P: Artmed.

Guns, B. A. (1998).*Organização que aprende rápido: seja competitivo utilizando o aprendizado organizacional*. São Paulo: Futura

Kaplan, R. S. et al. (1997). *A estratégia em ação: balanced scorecard*. Rio de Janeiro: Campus.

Kiernan, M. J.(1998). *Os 11 mandamentos da administração do século XXI*. S.P: Makron Books.

Lodi, J. B. (1998) *A entrevista: teoria e prática*. 8ª.edition, Pioneira, São Paulo.

Mattar, Fauze Najib. (2012). *Pesquisa de Marketing*. Rio de Janeiro. Campus.

Nazar, R. (2013). *Guia de RH*. Banco de talentos - estratégia empresarial para a gestão de pessoas.Available at: http://www.guiarh.com.br/PAGINA22J.htm .Accessed on 20 Nov 2013.

Nonaka, I. et al. (1997). *Criação de conhecimento na empresa: como as empresas japonesas geram a dinâmica da inovação*. Rio de Janeiro, Campus.

Santos, A. C.(2001). O uso do método Delphi na criação de um modelo de competências. *Magazine of Administration*, São Paulo, v.36, n.2, abr./jun., 2001.

Sauaia, A. C. A. (2006). *A Lógica econômica, raciocínio estratégico e evolução organizacional: além das regras do jogo de empresas*.Thesis in Business Administration to Associate Professor, University of São Paulo.

277 A Fuzzy Inference System for Decision Making of Players of a Business Game for Teaching Concepts of Production Management, Sales and Business Strategies

Barros Jr D F, Araújo S A

Daniel Ferreira de Barros Jr.(✉e-mail: danielf@uninove.br)
Nove de Julho University (UNINOVE), Industrial Engineering Post-Graduation Program, Av. Francisco Matarazzo, 612, Água Branca, 05001-100, São Paulo, SP – Brazil.

Sidnei Alves de Araújo (✉e-mail: saraujo@uninove.br)
Nove de Julho University (UNINOVE), Industrial Engineering Post-Graduation Program, Av. Francisco Matarazzo, 612, Água Branca, 05001-100, São Paulo, SP – Brazil.

Abstract: Business games can be seen as differentiated pedagogical tools, for directing the focus of the class and the dynamics of student learning. However, a typical problem in these tools is the feedback to the student at runtime of the simulation, mainly due to the number of players involved in the game and the amount of data generated in the simulations. In this scenario, it is desirable the existence of intelligent mechanisms that make inferences on the database of the game and provide, at runtime, information which could assist the players and also the teachers who mediate the game. In this work, we proposed a fuzzy inference system to assist the decision making of players of a game used as a support tool for teaching concepts of production management, sales and business strategies. The proposed system was designed to automatically evaluate student's performance based on their decisions in the game. Experiments comparing the real performance of students with performance inferred by the fuzzy system show that the proposed approach is very useful in a considered business game, since it provides help to the students allowing them to reconsider their decisions, if necessary, before they commit them in the game.

Keywords: Business game, Fuzzy, Production Management, Business Strategies, Computational Intelligence.

1 Introduction

A Business Game can be defined as a simulation in which people actively participate as decision makers within the simulated organizational system (Naylor, 1971). According to Oliveira and Sauaia (2011), business games are educational tools aimed at the learning process, at the strong appeal of experiential learning that assist in the perception of systemic vision and experimentation of the corporate decision making process.

Currently, the use of business games in universities is increasing as an important tool to support teaching and learning (Oliveira, 2009). It is observed that decision-making in business games is required of the students, as well as the recovering of concepts learned during the course, which are often fragmented. The use of the game allows information to enrich themselves through the dynamic employed, the systemic vision needed to solve problems, the collective participation of students and the relationship of cause and effect on the decisions taken.

The content and analysis to be developed in the game, needed for decision-making, vary according to the course or the student's specialty. There are business games focused on topics in the areas of logistics, human resources, business management, management of industrial production, entrepreneurship and information technology, among others (Silva and Lopes, 2012).

Given the amount of the data generated in the simulations, which grows according to the number of players, it becomes almost impractical to perform inferences by the teacher at runtime of the game in order to give a feedback to the students. Such inferences would enable better orientation to the students, who could benefit from these guidelines to achieve greater return on their future decisions.

In this sense, there are several computational intelligence approaches proposed in the literature. Among them, we can cite (Renna and Argoneto, 2010; García et al., 2010; Oderanti and De Wilde, 2010; Oderanti and De Wilde, 2011; Oderanti, Li and Wilde, 2012; Oderanti, 2013; Chun et al., 2013).

This work aims to propose an inference fuzzy system for assisting the decision making of players of a game for teaching concepts of production management, sales and business strategies, described in next section. The inference rules of the system are based on the decision tree presented in a previous work (Barros Jr. et al., 2013), where the authors determined the most relevant decision variables and the rules for classifying players of the same game, according to their decisions.

Experiments comparing the real performance of students with performance inferred by fuzzy system demonstrate that the proposed approach is very useful in the game, once it helps the students by allowing them to reconsider their decisions, if necessary, before they commit them in the game.

2 Material and Methods

2.1 Brief description of the business game considered in this work

The game considered in this work simulates the management of an industry of vacuum cleaners, considering two production lines: "Luxury" and "Standard" (Barros Jr. et al., 2013). It is used as a support tool for teaching concepts of production management, sales and business strategies in the last period of a business administration course from a university in São Paulo, Brazil, which has about 10,000 students enrolled in this course alone. In the simulations, students are asked to ponder and decide on multiple challenges and visions, such as human resources, production, sales and marketing.

The performance of a player is measured according to the fulfilment of predefined goals. Thus, at the end of the game (considering 12 months of simulations), the player receives a score ranging from 0 to 10 points.The decision variables, presented in Table 1 represent the core of the problem and the player must decide on their values (for each month of simulation) to reach his goal in the game. Some of these variables directly influence the quantity of products sold, while others affect the operating costs and financial results.

To determine the final score of each player, the ratio between the measurable goals and the results obtained by the player is considered. Thus, if the player reaches 100% or more of the established goals, he will get full marks.

Table 1 Decision variables of the game

Description	Name
Investments in processes concerning environmental management	IEM
Investment in improvements of manufacturing processes	IMP
Investments in technology and product development	ITP
Investments in Advertising	IAD
Sale price of Luxury product	SPL
Sale price of Standard product	SPS
Hiring of employees for Luxury production line	HEL
Hiring of employeesfor Standard production line	HES
Dismissal of employee for Luxury production line	DEL
Dismissal of employee for Standard production line	DES
Purchase of raw materials for the production of Luxury products	PML
Purchase of raw materials for the production of Standard products	PMS

The names of the variables shown in the second column of Table 1 are used in the experiments conducted in this paper.

2.2 Fuzzy Logic

Fuzzy logic can be seen as a logic that deals with models of uncertain or approximate reasoning. The theory of fuzzy sets was proposed by (Zadeh , 1973) to deal with decision problems that are not easily described by mathematical models. A fuzzy system tries to imitate a human operator taking as a basis a descriptive and experimental representation of a given process (Russel, 1995). In its traditional sense, computing involves the manipulation of numbers and symbols. Humans employ, in general, words in computing and reasoning, reaching the conclusions expressed in words from the premises expressed in natural language or having the form of mental perceptions. In fuzzy theory, this idea is modelled by means of linguistic variables and isknown as "Computing with Words" (Zadeh, 1973; Lee, 1990). Formally, a linguistic variable is characterized by a quintuple (V, T(V), X, L, M), where V is the name of the linguistic variable (e.g. Investments in Advertising), T(V) is the set of linguistic terms of V (e.g. low, medium, high), X is the universe of discourse (e.g. 0 to 100), G is a syntactic rule for generating the terms and M is a semantic rule that defines the meaning of each term (Lee, 1990).

2.3 Experimental Design

The proposed system was implemented using the Fuzzy Logic Toolbox from Matlab software. The inference rules were modeled based on decision tree proposed by (Barros Jr. et al., 2013) to determine the most relevant decision variables and the rules for classifying players of the same game according to their decisions.

In the first step we generated a histogram from the data stored in the database for each variable considered in the mentioned decision tree, in order to determine the distribution of values. In this analysis, the histogram of a variable takes into account the set of values of all players, considering all periods of simulation (12 months). In the second step, we modeled the linguistic variables by setting the membership functions, based on the analysis of histograms. After that, the inference mechanism was employed using Matlab and, finally, a set of experiments comparing the real performance of players with performance inferred by the inference system was conducted based on the decisions taken by 129 players.

3 Proposed Fuzzy Inference System

The decision tree presented in (Barros Jr. et al., 2013) indicates a total of 9 variables from table 1 and a target variable asmost relevant. They are: Investments in processes concerning environmental management (IEM); Investment in improvements of manufacturing processes (IMP); Sale price of Luxury product (SPL); Sale price of Standard product (SPS); Hiring of employees for Luxury production line (HEL); Hiring of employees for Standard production line (HES); Dismissal of employee for Standard production line (DES); Purchase of raw materials for the production of Luxury products (PML); Purchase of raw materials for the production of Standard products (PMS); Profitability (PRO).

For each of these variables, a histogram was generated from all values entered by the 129 players who participated of the simulation. The histograms show the distribution of values and behavior of decision making. For example, the Figure 1 presents, respectively, the histograms of variables PMS and SPL.

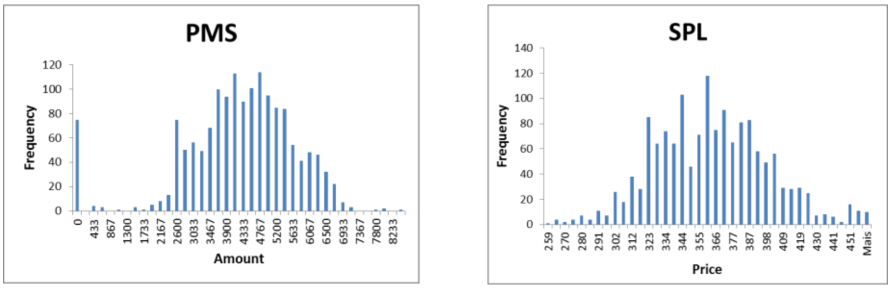


Fig. 1 Histograms of variables PMS and SPL.

Based on the distribution of the histogram of each variable, we divided the universe of values into three intervals. In the next step, these intervals were transformed in pertinence functions (“Low”, “Medium” and “High”) in the fuzzy model. Figure 2 shows the pertinence functions of SPL linguistic variable while the Figure 3 displays the set of linguistic variables (input and output) in the fuzzy model. The output variable is the score representing the performance of a player.

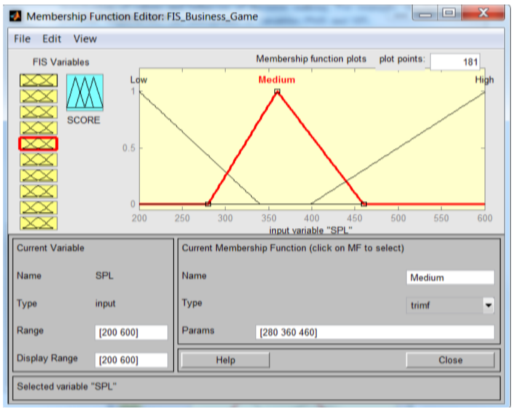


Fig. 2 Pertinence functions of SPL linguistic variable.

In the last step, the configuration of the inference mechanism was performed, according to the association rules obtained by the ID3 algorithm presented in (Barros Jr. et al., 2013). A total of 37 rules in the way of IF ...THEN were set in the model.

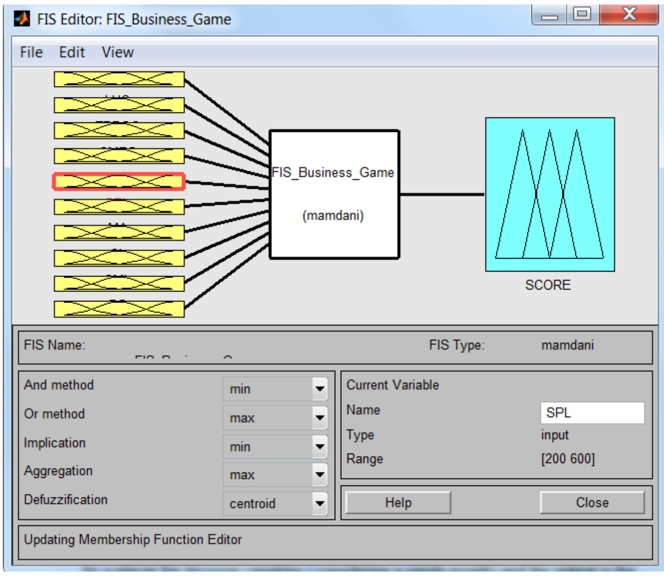


Fig. 3 Set of input/output variables of the proposed fuzzy system.

4 Results

In order to evaluate the fuzzy system, we used it to infer the scores of 129 players and compared the results with the real scores obtained by the same players in the game. In the experiments, the input of the system is the set of values chosen by a player for decision variables (considering a single month) and the output is the score of the player. Figure 4 shows the comparison between the scores inferred by the system and the real score obtained by the players. From this figure, one can see that, in general, the system produced good results. However, it is clear that the model need to be adjusted to produce better results, especially for the cases of low scores, as indicated in Figure 5, which shows the Mean Absolut Error (MAE) and Standard Deviation for each interval of score.

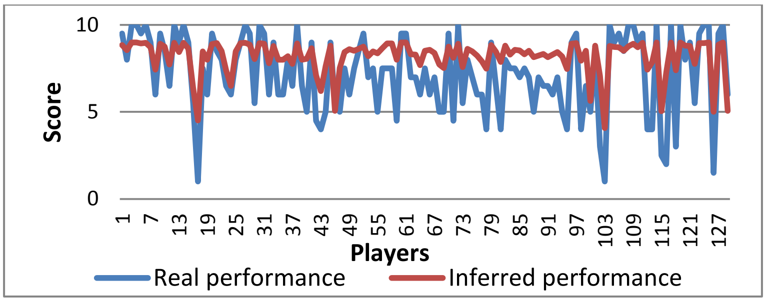


Fig. 4 Comparative results of real performance of students and the performance inferred by proposed fuzzy system.

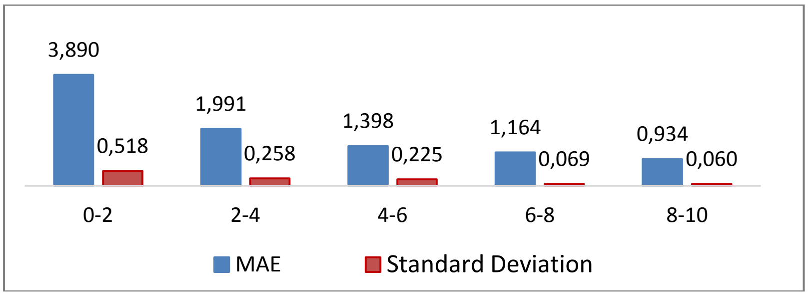


Fig. 5 Errors in fuzzy inferences by intervals of scores.

As can be seen in the graph of Figure 5, the lower the score, the bigger the error of fuzzy inference. Based on the standard deviations shown in the graph, it can still be seen that the model tends to be more accurate in the cases of high scores (9-10). This information is essential for the refinement of the fuzzy model. It is important to remember that the system was not developed to tell the player what needs to be done, but to indicate how good its performance will be if the set of decisions (values of variables) is adopted.

5 Conclusions

In this paper a fuzzy inference system to assist the decision making of players of a game was developed. In the conducted experiments, the proposed system generated good inferences about the score of the students (players) based on their decision making, indicating that it can be used as a help mechanism, at run time of the game. Furthermore, this work may facilitate the development of other mechanisms of inference of decision making applicable to games with similar characteristics. In future works we intend to improve the fuzzy system, integrate it in the considered game and test the game with a high number of students, in order to perform a better evaluation of the proposed approach.

Acknowledgments

The authors would like to thank CAPES – Coordination for the Improvement of Higher Education Personnel (Process AEX 3573/14-1) and UNINOVE by financial support.

6 References

Barros Jr, D F, Araújo S A, Amendola F, Estivalli J D (2013) Analysis and data mining to support teaching of concepts of production management, sales and business strategies. In: XXXIII Encontro Nacional de Engenharia de Produção, Vol.1, p. 1-13.

Chun F, Yu-chu Y, Yu H, Ray I C (2013) Data mining for providing a personalized learning path in creativity: An application of decision trees. Computers & Education, Vol. 68, pp. 199-210.

García J, Borrajo F, Fernández F (2010) Learning Virtual Agents for Decision-Making in Business Simulators, in: Olivier Boissier; Amal El Fallah-Seghrouchni; Salima Hassas & Nicolas Maudet, ed., MALLOW, CEUR-WS.org.

Lee C-C (1990) Fuzzy logic in control systems: fuzzy logic controller. in: IEEE Transactions on Systems, Man, and Cybernetics 20 (2), pp. 404-418.

Naylor T H (1971) Computer simulation experiments with models of economic systems. New York: John Wiley & Sons.

Oderanti F O (2013) Fuzzy inference game approach to uncertainty in business decisions and market competitions, SpringerPlus, v. 2, n. 1, p. 484.

Oderanti F O, Li F, Wilde P D (2012) Application of strategic fuzzy games to wage increase negotiation and decision problems. Expert Syst. Appl. 39 (12), pp. 11103-11114.

Oderanti F O, Wilde P D (2010) Dynamics of business games with management of fuzzy rules for decision making. Int. Journal of Production Economics, Vol. 128, n. 1, pp. 96–109.

Oderanti F O, Wilde P D (2011) Automatic fuzzy decision making system with learning for competing and connected businesses. Expert Syst. Appl. 38 (12), pp. 14574-14584.

Oliveira M A (2009) Deploying lab management: An integrated program in management education and research. FEA/USP, São Paulo. p. 16.

Oliveira M A, Sauaia A C A (2011) Teaching Printing for experiential learning: A study of the benefits of business games. Administração: Ensino e Pesquisa, v.12, n.3, pp. 355-391.

Renna P, Argoneto P (2010) Production planning and automated negotiation for SMEs: An agent based e-procurement application. International Journal of Production Economics, v. 127, n. 1, pp. 73–84.

Russel S, Norvig P (1995) Artificial intelligence a modern approach. New Jersey: Prentice Hall.

Silva I, Lopes R B (2012) Teaching lean thinking with a business game. in: XVIII Int. Conference on Industrial Engineering and Operations Management, pp.1-10.

Zadeh L A (1973) Outline of a New Approach to the Analysis of Complex Systems and Decision Processes. IEEE Transactions on System, Man and Cybemetics, VoI. 3, p. 2844.

281 Describing the APS Systems: a Software Overview

Sousa T B, Camparotti C E S, Guerrini F M, Silva A L, Biondo, T M

Thales Botelho de Sousa (✉ e-mail: thalesbotelho@sc.usp.br).

Carlos Eduardo Soares Camparotti (✉e-mail: carloscamparotti@sc.usp.br).

Fábio Müller Guerrini (✉ e-mail: guerrini@sc.usp.br).

Adauto Lucas da Silva (✉ e-mail: adautols@sc.usp.br).

Thaís Mingolelli Biondo (✉ e-mail: thais.biondo@usp.br)

Departamento de Engenharia de Produção, Escola de Engenharia de São Carlos, Universidade de São Paulo. Avenida Trabalhador São-carlense, 400. CEP 13566-590, São Carlos - SP/Brasil.

Abstract: Within the context of production planning and control systems development, in the 1990s were launched the APS systems, which represent an innovation when compared to their predecessors. This paper intended to provide through a literature review, the concepts, capabilities, implementation process and benefits of using APS systems in the companies production planning and control. The main contribution of this research is to show a strong conceptual understanding regarding APS systems, which can be used as a solid theoretical reference for future researches.

Keywords: Advanced Planning and Scheduling, Production Planning and Control, Literature Review.

1 Introduction

Production Planning and Control systems (PPCs) are the central corporate control mechanisms that relate the production and logistic performance of a company with customer demands. Its main task is to plan, initiate and monitor manufacturing company products delivery, and, in cases of unforeseen deviations, to adjust the progress of orders or production plans (Wiendahl, Von Cieminski and Wiendahl, 2005). PPCs have an important role in the continuous search for improvement in production resources use (Rodriguez, Costa and Do Carmo, 2013) and aim to plan and control production so the company achieves the production requirements with the highest possible efficiency (Fernandes et al., 2007).

According to Steger-Jensen et al. (2011), the computerized PPCs were gradually developed in the last 30 years, since the MRP (Material Requirements Planning), MRP II (Manufacturing Resources Planning), ERP (Enterprise Resources Planning) and APS systems (Advanced Planning and Scheduling). These continuous developments provided substantial improvements in PPC area of companies (Nyhuis and Wiendahl, 2004).

APS systems are a set of applications used for managing three domains of supply chain operations: planning, programming and execution (Setia, Sambamurthy and Closs, 2008). According to Brun et al. (2006), APS systems represent the most relevant innovation in the world of manufacturing since the introduction of MRP systems in the 1970s.

The use of APS systems as support tools for decision making in the production planning and control of enterprises is growing at the global level. Based on these affirmations and its increasing relevance, the aim of this paper is to present a literature review on APS systems in order to provide to the reader a brief understanding of the concepts, integration with other PPCs, implementation process and benefits that their use provide to the companies.

2 Methodological Procedures Used for developing the Research

The methodology used for the development of this work targets a dynamic that aims to get results capable of supporting the construction of a better knowledge on APS systems.

Published papers in scientific journals indexed in databases Current Contents Connect, SCIELO, SCOPUS and Web of Science were analyzed. To select the publications of interest, they were searched by title, abstract, keywords, irrespective of the period of publication, the following terms: Advanced Planning and Scheduling, and Advanced Planning System*. Subsequently proceeded to the reading and analysis of title and abstract of the articles found, by selecting those with relevance to the research objectives.

3 Advanced Planning and Scheduling: an Overview

According to Stadtler (2005), APS systems are based on the principles of hierarchical planning and make extensive use of solution approaches known as mathematical programming and meta-heuristics. The main APS systems ability consists in finding the optimal resource selection for operations, operations sequences, allocation of variable transfer batches, and schedules considering flexible flows, resources status, capacities of plants, precedence constraints, and workload balance (Gen, Lin and Zhang, 2009). Unlike other systems, APS do not assume that capacities are infinite, that all customers, products and materials are of equal importance, and that certain parameters, such as lead times, can be fixed (David, Pierreval and Caux, 2006).

APS systems have improved the integration of materials and capacity planning, bridge the gap between the supply chain complexity and the daily operative decisions (Hvolby and Steger-Jensen, 2010). APS systems are considered as an effective approach for generating an optimized production plan considering a wide range of constraints, including raw materials availability, machines and operator's capability, service level, secure stock level, costs, sales and demand (Chen, Huang and Lai, 2009).

According to Günther and Meyr (2009), APS systems represent successful applications of supply chain management, and are related to support activities and decision making at the strategic, tactical and operational levels. By APS systems companies can optimize their supply chains, reducing costs and inventory levels, improving product margins, and increasing industrial yields (Lee, Jeong and Moon, 2002). APS are based on the principles of hierarchical planning and make extensive use of solution approaches known as mathematical programming and meta-heuristics (Stadtler, 2005). They simulate different planning scenarios before launching a plan (Hvolby and Steger-Jensen, 2010). Furthermore, APS systems can be configured for giving alerts to the appropriate organizational units when something out of the ordinary happens (Wezel, Donk and Gaalman, 2006).

4 APS Systems Integration with Other Production Planning and Control Systems

While APS systems themselves are an advance compared to its predecessors, companies use a combination of systems for guiding the supply chain collaboration and planning (Setia, Sambamurthy and Closs, 2008). APS systems were developed under the combination of MRP with the CRP (Capacity Requirement Planning) for allowing the creation of suitable production plans and planning activities for the supply chain as a whole, providing procedures and methodologies that are able to react quickly to exceptions and variability (Chern and Yang, 2011; Kung and Chern, 2009). Traditional MRP systems does not sufficiently support the planner in settling production planning and control issues, and may create many problems on the shop floor for later production (Chen and Ji, 2007). According to Peng, Lu and Chen (2014), MRP systems generally makes plan according to finite material requirements and infinite capacity requirements, meanwhile the production lead time which is actually depending on production planning is predetermined, whereas in APS systems plans are optimized within the boundaries of material and capacity constraints.

Using sales and inventory data from an MRPII system, it can produce a production plan in seconds or, at worst, a few minutes. APS systems can validate the plans generated by the MRP II system or can carry out planning, eliminating the need for such modules, being the use of MRP II directed toward the acquisition of product information, order and inventory (Chambers, 1996).

APS does not substitute but it supplements existing ERP systems (Steger-Jensen et al., 2011). It is widely known that the strength of ERP systems is not in the area of planning. Thus, APS systems have been developed to fill this gap (Stadtler, 2005). According to Ou-Yang and Hon (2008), APS systems develop an appropriate production scheduling for supporting potential orders, while ERP systems are used for integrating the execution of orders related to business processes, and handling the basic activities and transactions, such as, e.g. customer orders, accounting, etc. (Steger-Jensen et al., 2011). An APS system extracts information from the ERP database through input user interface, makes its calculations and sends the resulting plans back for distribution and execution. The APS sends to the ERP manufactured part needs, purchase part needs and projected order completions. The ERP sends to the APS demands (customers orders, forecasts, MPS, safety stock orders, transformer orders), item information, BOM information, operation information, resource information, resource group information, WIP status, finished and released jobs, scheduled jobs, run parameters, calendar, shifts and holidays. The schedule and utilization results can be saved in the database through the output interface (Chen et al., 2013; Musselman, O'Reilly and Duket, 2002; Rudberg and Cederborg, 2011).

5 APS Systems Implementation

From an APS system implementation perspective, the knowledge of APS and planning, experiences of the processes under investigation and implementation projects, and commitment to the project should be important individual factors (Ivert and Jonsson, 2011).

For Pacheco and Santoro (2001), the main deficiencies that may arise in the evaluation process of an APS system are poor assessment of the opportunities for improving the current system, deficient investigation of alternatives, and poor analysis of the relationship between adherence and quality of the solution. For overcoming these deficiencies, Pacheco and Cândido (2002) proposed the following actions: assessing opportunities for improvement and preliminary selection of alternatives, detailed analysis of adherence and quality of models solution, weighting of results obtained between models, analysis of commercial criteria and implementation strategy.

According to Pedroso and Côrrea (1996), for implementing programming systems with finite capacity (such as APS systems), are investments needed in software, hardware, training, implementation, system maintenance, organizational changes. Investments in software are related to the acquisition the application itself, possible needs for this adaptation and its integration with other information systems of the company. In hardware, the equipment necessary for system management. In training, is related to the training of human resources for the management of new technology. In implementation, encompasses modeling and the availability of other necessary information. In system maintenance the values associated with the management of the system and the maintenance and upgrading of software and hardware. In organizational changes, necessary improvements for effective management of the system in the organization.

APS systems implementations comprise the following phases (Ivert and Jonsson, 2011):

- The chartering phase: comprises decisions leading to funding an APS system. Typical activities comprise current state analysis, ideas of adopting the system, definition of key performance indicators, conducting business case for investment development, identifying project manager, approving a budget and schedule, and the selection of a software package.
- The project phase: phase where activities are comprised in order to get the system up and running. Typical activities include model building, setup of internal data structures and databases, validation/testing, training, and go-live.
- The shakedown phase: Phase is where organizations are coming to grips with the information system. Typical activities include cleaning up data and parameters, providing additional training to users, particularly on business processes, and working with vendors and consultants to resolve bugs in the software.
- The onward and upward phase: phase that continues from normal operation until the system has been replaced with an upgrade or a different system. Typical activities comprise post-implementation audit, continuous business improvement, technical upgrading, additional end-user skill building.

6 Benefits of the APS Systems Use

Based on the results of the literature review, it is possible to claim that several benefits that can be obtained with the APS systems use, such as more efficient management of supply chains (Garcia-Sabater, Maheut and Garcia-Sabater, 2012; Kristianto, Ajmal and Helo, 2011), higher throughput and shorter industrial lead time (Chen, Huang and Lai, 2009; Dayou, Pu and Ji, 2009), integration with ERP systems, other planning modules or process control systems (Chen et al., 2013; Garcia-Sabater, Maheut and Garcia-Sabater, 2012; Öztürk and Ornek, 2014; Steger-Jensen et al., 2011), high processing speed (Giacon and Mesquita, 2011), creation of suitable production plans (Chern and Yang, 2011), consideration of capacity constraints and operating sequences (Hvolby and Steger-Jensen, 2010; Peng, Lu and Chen, 2014; Zhong et al., 2013), increase in operational profits

(Gen, Lin and Zhang, 2009), reduction in inventory levels (Chen, Huang and Lai, 2009), quick reaction to exceptions and variabilities (Kung and Chern, 2009), realistic and feasible delivery promises (Chen et al., 2013), support to the following S&OP process: forecast future demand, prepare preliminary delivery plan, prepare preliminary production plan, adjust and settle delivery plan and production plan Ivert and Jonsson, 2010), possibilities for graphical depiction of the resulting production schedules and quick access to additional information on the schedule elements (Brandenburg and Tölle, 2009), among several others.

7 Conclusions

This paper presented through a literature review key concepts, structure, brief description of its integration with other production planning and control systems, implementation process and key benefits of APS systems for companies.

In recent times, with the great transformations imposed by globalization, companies deal with increasingly demanding markets in relation to cost, schedule, quality, reliability and everything else that represents competitiveness. Their managers are constantly pressured to get progressive gains.

The lack of alignment between the various productive companies resources can cause confusion in production schedules, which entails, among other problems, low productivity, low level of service and loss of customers, with negative impacts on your finances.

Many of the traditional implemented production planning and control systems in companies since the second half of the twentieth century had failures in the operation, because disregard capacity limits of production. APS systems represent a breakthrough for the production planning and control of companies, because consider the various constraints present in production processes.

It is possible for companies, that with the use of APS systems, they achieve improvement in treatment to the delivery deadlines, fines and special freights reduction, raw materials, work in process and finished goods stocks reduction, production lead times reduction, better care of customer requests, improvement in productivity and overall efficiency of productive resources, purchases and hiring of outsourced services rationalization.

This paper did not intend to exhaust the issues raised here. His focus was directed to the conceptual analysis of the theme studied in papers found. In spite of possessing some limitations, this literature review aims to generate new knowledge and information through by rescuing of gaps that have already been addressed in previous research (Mariano, Guerrini and Rebelatto, 2012). More detailed studies can be carried out and contribute to the development of this theme, because according to Gil (2008), exploratory researches constitute the first step of a broader investigation.

8 References

Brandenburg M, Tölle F-J (2009). MILP-based campaign scheduling in a specialty chemicals plant: a case study. OR Spectrum, 31:1:141-166.

Brun A et al (2006). Value and risk assessment of supply chain management improvement projects. International Journal of Production Economics, 99:1/2:186-201.

Chambers N (1996). Beyond MRPII: a new approach to manufacturing planning and simulation. Industrial Management & Data Systems, 96:4:3-5.

Chen C J et al (2013). Advanced planning and scheduling for TFT-LCD color filter fab with multiple lines. The International Journal of Advanced Manufacturing Technology, 67:1/4:101-110.

Chen W-L, Huang C-Y, Lai Y-C (2009). Multi-tier and multi-site collaborative production: illustrated by a case example of TFT-LCD manufacturing. Computers & Industrial Engineering, 57:1:61-72.

Chen K, Ji P (2007). A mixed integer programming model for advanced planning and scheduling (APS). European Journal of Operational Research, 181:1:515-522.

Chern C-C, Yang I-C (2011). A heuristic master planning algorithm for supply chains that consider substitutions and commonalities. Expert Systems with Applications, 38:12:14918-14934.

David F, Pierreval H, Caux C (2006). Advanced planning and scheduling systems in aluminium conversion industry. International Journal of Computer Integrated Manufacturing, 19:7:705-715.

Dayou L, Pu Y, Ji Y (2009). Development of a multiobjective GA for advanced planning and scheduling problem. The International Journal of Advanced Manufacturing Technology, 42:9/10:974-992.

Fernandes F C F et al (2007). Identificação dos principais autores em planejamento e controle da produção por meio de um survey mundial com pesquisadores da área. Gestão & Produção, 14:1:83-95.

Garcia-Sabater J P, Maheut J, Garcia-Sabater J J (2012). A two-stage sequential planning scheme for integrated operations planning and scheduling system using MILP: the case of an engine assembler. Flexible Services and Manufacturing Journal, 24:2:171-209.

Gen M, Lin L, Zhang H (2009). Evolutionary techniques for optimization problems in integrated manufacturing system: State-of-the-art-survey. Computers & Industrial Engineering, 56:3:779-808.

Giacon E, Mesquita M A (2011). Levantamento das práticas de programação detalhada da produção: um survey na indústria paulista. Gestão & Produção, 18:3:487-498.

Gil A C (2008). Métodos e técnicas de pesquisa social. 6ª ed. São Paulo: Atlas.

Günther H-O, Meyr H (2009). Supply chain planning and Advanced Planning Systems. OR Spectrum, 31:1:1-3.

Hvolby H-H, Steger-Jensen K (2010). Technical and industrial issues of Advanced Planning and Scheduling (APS) systems. Computers in Industry, 61:9:845-851.

Ivert L K, Jonsson P (2010). The potential benefits of advanced planning and scheduling systems in sales and operations planning. Industrial Management & Data Systems, 110:5:659-681.

Ivert L K, Jonsson P (2011). Problems in the onward and upward phase of APS system implementation: why do they occur? International Journal of Physical Distribution & Logistics Management, 41:4:343-363.

Kristianto Y, Ajmal M M, Helo P (2011). Advanced planning and scheduling with collaboration processes in agile supply and demand networks. Business Process Management Journal, 17:1:107-126.

Kung L-C, Chern C-C (2009). Heuristic factory planning algorithm for advanced planning and scheduling. Computers & Operations Research, 36:9:2513-2530.

Lee Y H, Jeong C S, Moon C (2002). Advanced planning and scheduling with outsourcing in manufacturing supply chain. Computers & Industrial Engineering, 43:1/2:351-374.

Mariano E B, Guerrini F M, Rebelatto D A N (2012). Análise da relação entre estrutura e desempenho de redes interorganizacionais colaborativas. Gestão & Produção, 19:3:471-479.

Musselman K, O'reilly J, Duket S (2002). The role of simulation in Advanced Planning and Scheduling. In: WINTER SIMULATION CONFERENCE, 34. San Diego, 2002. Proceedings of the 2002 Winter Simulation Conference. San Diego: ACM.

Nyhuis P, Wiendahl H-P (2004). 3-Sigma PPC - a holistic approach for managing the logistic performance of production systems. CIRP Annals - Manufacturing Technology, 53:1:371-376.

Öztürk C, Ornek A M (2014). Operational extended model formulations for Advanced Planning and Scheduling systems. Applied Mathematical Modelling, 38:1:181-195.

Ou-Yang C, Hon S J (2008). Developing an agent-based APS and ERP collaboration framework. The International Journal of Advanced Manufacturing Technology, 35:9/10:943-967.

Pacheco R F, Cândido M A B (2002). Uma metodologia para a seleção de sistemas de programação da produção com capacidade finita. In: ENCONTRO NACIONAL DE ENGENHARIA DE PRODUÇÃO, 22. Curitiba, 2002. Anais... Rio de Janeiro: ABEPRO.

Pacheco R F, Santoro M C (2001). A Adoção de modelos de schedulingno Brasil: deficiências do processo de escolha. Gestão & Produção, 8:2:128-138.

Pedroso M C, Côrrea H L (1996). Sistemas de programação da produção com capacidade finita: uma decisão estratégica? Revista de Administração de Empresas, 36:4:60-73.

Peng Y, Lu D, Chen Y (2014). A Constraint Programming Method for Advanced Planning and Scheduling System with Multilevel Structured Products. Discrete Dynamics in Nature and Society, 2014:1-7.

Rodriguez D S S, Costa H G, Do Carmo L F R R S (2013). Métodos de auxílio multicritério à decisão aplicados a problemas de PCP: Mapeamento da produção em periódicos publicados no Brasil. Gestão & Produção, 20:1:134-146.

Rudberg M, Cederborg O (2011). APS for tactical planning in a steel processing company. Industrial Management & Data Systems, 111:4:608-628.

Setia P, Sambamurthy V, Closs D J (2008). Realizing business value of agile IT applications: antecedents in the supply chain networks. Information Technology and Management, 9:1:5-19.

Stadtler H (2005). Supply chain management and advanced planning - basics, overview and challenges. European Journal of Operational Research, 163:3:575-588.

Steger-Jensen K et al (2011). Advanced Planning and Scheduling technology. Production Planning & Control, 22:8:800-808.

Wezel W V, Donk D P V, Gaalman G (2006). The planning flexibility bottleneck in food processing industries. Journal of Operations Management, 24:3:287-300.

Wiendahl H-H, Von Cieminski G, Wiendahl H-P (2005). Stumbling blocks of PPC: Towards the holistic configuration of PPC systems. Production Planning & Control, 16:7:634-651.

Zhong R Y et al (2013). RFID-enabled real-time advanced planning and scheduling shell for production decision making. International Journal of Computer Integrated Manufacturing, 26:7:649-662.

292 Integrated acquisition, transmission and communication system for information related to airline passengers with reduced mobility

Durán A, Solera J

Alfonso Durán Heras (✉ e-mail: alfonso.duran@uc3m.es)
Área de Ingeniería de Organización. Escuela Politécnica Superior. Universidad de Carlos III de Madrid. Avda. de la Universidad 30, 28911 Leganés.

Jorge Solera Camino (✉e-mail: jorge.solera@uc3m.es)
Área de Ingeniería de Organización. Escuela Politécnica Superior. Universidad de Carlos III de Madrid. Avda. de la Universidad 30, 28911 Leganés.

Abstract: Improving accessibility in the air transport is one of the goals of the European Commission (EC) in its strategy for 2010-2020. Therefore, the EC funded the ICARUS project under the 7th Framework Program in order to identify the main barriers for people with disabilities and older persons in the air transport and to propose solutions with the greatest achievable contribution. This paper, encompassed within that research project, analyzes an issue that emerged from the preliminary list of barriers detected by users: many barriers seemed to be caused by difficulties in the transmission of information on passengers with reduced mobility and their service requirements. This led to a line of research aimed at understanding the underlying issues and how to tackle them. The results of this analysis suggested that pre-notification should be promoted and that the regulation should warrant that the PRM-related information is transmitted as soon as it becomes available. Moreover, this study further reinforced the industry's diagnosis regarding the need to evolve the current information standards to achieve higher flexibility. These results lead to a set of proposals, structured in two timeframes.

Keywords: accessibility, air transport, people with disabilities, transmission of information, ATI information systems.

1 Introduction

Accessibility for people with disabilities (PWD) and older persons (generally referred to as People with Reduced Mobility, PRM) in air transport is currently not as satisfactory as it should be. In spite of the substantial improvement attained in the common legal framework (enshrining the right to non-discrimination on the basis of disability or reduced mobility), current conditions are not yet satisfactory.

The European air transport system plays an essential role in creating links between people and exchanges for business, leisure and culture within Europe and worldwide. In 2010, it transported 750 million passengers through 450 airports.

According to the European Disability Strategy 2010-2020 (European Commission, 2010), one in six people in the European Union (EU) has a disability that ranges from mild to severe, thus numbering around 80 million citizens, who are often prevented from fully taking part in society and the economy because of environmental and attitudinal barriers. Moreover, the incidence of disability is rapidly increasing as the population ages in most western nations (Eurostat, 2011).

This situation led the European Commission (EC) to fund the ICARUS project under the 7th Framework Program in order to study the current situation and to propose solutions. In the earlier stages of the project, relevant bibliography was reviewed (e.g., Calvinato & Cuckovich, 1992; Ray & Ryder, 2003; Eichhorn, et al., 2008; Chang & Chen, 2012a, 2012b) and users were interviewed to identify the existing barriers that hinder their traveling by air.

Besides that, observations in real environments were carried out, involving a sample of PRM (blind, deaf, older persons, etc.) travelling across Europe who had to accomplish some tasks and report the barriers they found.

These barriers were studied using problem trees and causal analysis techniques, which showed that the underlying causes for a number of barriers seem to converge to some difficulties in the transmission of PRM-related information (e.g., some users argued about strictly standardized service which does not allow them to express their specific needs, thus the current information demanded by airlines/PRM service providers seems not to be sufficient, moreover they also suggested that the impossibility of requesting PRM assistance at the check-in counter may be caused by inadequate communication with the service providers).

This issue appears to be relevant because proper acquisition, transmission and communication of information is necessary to achieve a seamless travel experience (a key EC goal) and to improve the services provided to users.

2 Methodology

Stakeholders involved in the accessibility chain (basically airports, air carriers and their subcontractors) provide a wide variety of specific services to PWD, out of which the “standard” PRM service is only the most cited one. These stakeholders are involved in the acceptance or refusal or the PWD’s reservation/boarding, medical clearance / medical support, the identification or allocation of safety assistants / accompanying persons, seating, special luggage provisions including those related to mobility equipment, handling of service/emotional support animals, transfers (potentially between different airports), incident reporting, specific treatment in the event of lost connections, delays or overnight stays, to name a few.

Furthermore, these services may have to be provided, even for one single trip, by a variety of organizations in different locations and subject to time constraints. Thus, the criticality of an effective information system orchestrating their planning and execution is readily apparent. Giving the recurrence of barriers associated to the transmission of information that were identified in the initial stages of the project, a decision was taken to further study their origin and its implications.

Therefore, the goals of the study were:

- Understanding the difficulties that emerge when transmitting the PRM-related information, and their consequences.
- Reconciling the observed difficulties with the fact that a supposedly effective system for the transmission of PRM-related information was already in place.
- Proposing solutions to reduce or eliminate the effects of these difficulties.

The study was performed through in depth interviews with some stakeholders (e.g., airlines and airport management bodies), which are directly involved in all the activities concerning the acquisition of information, its transmission and communication. In addition, the activities carried out by different industry working groups and their results were reviewed. The information provided by the main providers of technology of information in the sector (e.g., SITA) was also analyzed. These activities were complemented with the review of reports on the actual operation of the system commissioned both by the EC (European Commission, 2011; Smith, et al., 2010) and by independent organizations, the interpretative guidelines on the application of the Regulation (European Commission, 2012) and the PRM handling manuals of several airlines.

3 Results

The different interviews with the stakeholders and the revision of the technical documentation shed light on the current operation of the information mechanisms. These mechanisms are summarized below.

The current normative framework succinctly specifies the requirement that information on service requests is collected and transmitted; according to Regulation (EC) No 1107/2006 (Article 6 - Transmission of information):

1. Air carriers, their agents and tour operators shall take all measures necessary for the receipt, at all their points of sale in the territory of the Member States to which the Treaty applies, including sale by telephone and via the Internet, of notifications of the need for assistance made by disabled persons or persons with reduced mobility.

2. When an air carrier or its agent or a tour operator receives a notification of the need for assistance at least 48 hours before the published departure time for the flight, it shall transmit

the information concerned at least 36 hours before the published departure time for the flight: a) to the managing bodies of the airports of departure, arrival and transit, and b) to the operating air carrier...

3. In all cases other than those mentioned in paragraph 2, the air carrier or its agent or tour operator shall transmit the information as soon as possible.

4. As soon as possible after the departure of the flight, an operating air carrier shall inform the managing body of the airport of destination, if situated in the territory of a Member State to which the Treaty applies, of the number of disabled persons and persons with reduced mobility on that flight requiring assistance specified in Annex I.

According to the Evaluation of Regulation 1107/2006. (Smith, et al., 2010):

…Almost all airports and airlines have contracted SITA (a company providing aviation information technology) to provide a telex or email service for the purpose of passing notification of the needs of PRMs (see 4.64). For each series of flights for a given aircraft, any assistance required is communicated via a telex which includes a four letter code describing the category of disability of each PRM on each flight (see 3.4). This message is known as the passenger assistance list (PAL); if requirements change prior to the flight this is updated by a change assistance list, or CAL. Where a request for assistance is made by a PRM at least 48 hours before the published departure time for the flight, the airline is obliged to transmit this information to the relevant airports at least 36 hours before the published departure time.

This information arrives at a telex server in the dispatch office of the airport PRM service provider. The telex describes: the time of the flight, the flight number, the names of passengers on board requiring assistance, and the category of disability of these passengers... Information regarding requests for assistance may also arrive via email.

Airlines and airports may use email for several reasons: some airlines (such as non-EU charter carriers) may not have a SITA terminal; larger groups (such as operators of cruises) may send an off-line message in addition to PAL/CAL messages…

Thus, even though the basic system is in place and operating, it currently falls well short of this ideal role of seamlessly orchestrating the planning and execution of the abovementioned variety of services by various players throughout the accessibility chain, as hinted by the abovementioned report’s references to disparate systems and approaches.

Moreover, SITA (admittedly a potentially biased observer, being a provider of ATI TIC solutions) states (SITA, 2010):

Online booking sites, for example, are inconsistent in asking for PRM information…

But the most glaring challenge – and one that can be most readily addressed – is the communication between airlines and airports…

The two main systems for providing PRM information – the Passenger Assistance List (PAL) and Change Assistance List (CAL) – are effective, but they both also have limitations on how much information they can provide. Some airlines bypass PAL and CAL altogether by using inefficient forms of communication, such as fax and e-mail.

Disparate systems require end-users to enter and receive information manually, often leading to coding mistakes in messages, resulting in inadequate staff and equipment when needed.

Further complicating matters, many check-in staff at the airport still rely on paper-based resources…

The lack of a universal communication system is the biggest obstacle airports face in meeting their regulatory obligations, and in providing a uniform and standardized service for PRMs.

Despite the different channels available to pre-notify the request for assistance, the levels of pre-notification are low and widely varying. This issue implies that, when an user request for assistance in the airplane, the period of notification is reduced to the duration of the flight (instead of the 36 hours established on the Regulation (EC) No 1107/2006), as Smith, et al. (2010) discussed:

…In addition to arriving via PAL or CAL, notification for arriving passengers may arrive by passenger service message (PSM). This is a list of passengers on board the aircraft requiring particular treatment on arrival, dispatched when an aircraft departs.[...]In some circumstances, no PAL or CAL is received for arriving passengers, and the only notification is via PSM; this reduces the period of notification from 36 hours to the duration of the flight. In some cases no notification is received at all.[…]PSM messages are generated automatically on departure from the origin airport, so can be particularly useful for airports in relation to long haul flights, where there is sufficient time to mobilise staff and equipment before the aircraft arrives. Conversely, PRM messages are of less use in relation to short haul flights, as staffing arrangements cannot be so easily amended at short notice.

…The majority of airlines believed that the main issue in terms of pre-notification was that passengers were themselves failing to notify of their assistance needs. Several airlines and airports suggested a possible explanation as being that, although they may not normally consider themselves as being in need of special assistance, some travellers (especially infrequent flyers and the elderly) may find they need this once in the airport and having to walk long distances to reach their flight.[…] However, the majority of airports stated that the most significant problem was failure by airlines to pass on notifications, or erroneous notifications.

- In some cases, strict adherence to the regulated conditions governing the interfacing among stakeholders leads to missing efficiency opportunities. As stated above, although the Regulation establishes “at least 36 hours” for the cases described in paragraph 2. By literally applying these guidelines, air carriers often convey this information to airport management bodies only 36 hours before, even if they have received it well in advance. According to airport management bodies, this foregoes opportunities for more efficient and effective advanced planning, thus lending further support to the desirability of a better integrated communication system across stakeholders.
- Inconsistency in the PRM information requested by the online booking sites has also been identified, corroborating SITA’s claim. Nowadays the service request is present in most booking systems (website, travel agencies, etc.) nonetheless there are no unified procedures to book the PRM assistance.
- A related issue is ensuring that all the relevant information residing in the Information Systems is actually provided to the service personnel so that they can accordingly tailor their services. Some users complained that after giving their personal information when requesting for assistance, the airline staff

behaved as if they did not have it. In contrast, the interviewed airlines affirmed that all their crews have the information about the passengers, their disabilities and where they are seated, through the Passengers Information List, PIL, generated by the Departure Control Systems for the local cabin crew to advise special information about passengers on board. Thus, this point must be further analyzed to find the origin of either the problem or the perception.

Further analysis of the technical procedures and the company-confidential PRM Handling Manuals (made available to the researchers by the involved airlines for the purpose of this project), along with the outcome of the interviews, revealed that many stakeholders (especially those most sensitive to the PRM needs) require more (and more specific) information about the user needs, in order to provide appropriate assistance, than the information supported by the current standard. Thus, they are forced to rely on non-standard, intrinsically less reliable messages and codes (see architectural discussion below; e.g., switching backbones may filter out non-standardized communications) to convey the comprehensive, specific information required to actually provide the service, e.g., as opposed to characterizing a PRM by simply his or her IATA PRM code, transmitting details such as medical support to be provided should a disruption force this particular passenger to spend an unplanned night at a transfer airport.

The limitations of the current standards can be traced back to the messaging systems currently deployed in the Air Transport Industry (ATI). The ATI is a highly integrated industry, requiring millions of messages per day for reservations, passenger processing, and general operations, including the PRM-related messages discussed above. Current and legacy ATI applications operate on message switching backbones based on ATI messaging standards developed decades before current open messaging standards such as those used on the web. Type B message codes and format rules were defined by IATA working groups to efficiently encode ATI data as short strings of ASCII characters.

The industry has, however, recognized the need to move on, by incorporating more flexible, open standards, particularly XML (eXtensible Markup Language), a language capable of describing many different kinds of data that facilitates the sharing of data across different systems, particularly those connected via the Internet. That would enable a much more effective approach for the development of these integrated, seamless systems. IATA's Passenger & Airport Data Interchange Standards (PADIS) Board is leading industry initiatives such as Type X ATI Messaging, aimed at enabling reliable and secure delivery of the XML-encoded messages and rich-data attachments using standard open-technology stacks, while using the same addressing structure as Type B to facilitate bridging between the two technologies. PADIS is also involved in even farther-reaching transformation initiatives, e.g. the Airline Industry Data Model.

While as these transformational initiatives will hopefully eventually provide a much better platform for the systems aimed at the integration of PWD oriented services, they are not PWD specific, and their size, budgets and foreseeable timeframes make it advisable to combine short to medium actions aimed at improving systems based on the current architecture with medium to long term support and exploitation of the opportunities offered by these approaches. Thus, this study leads to the following proposals, organized into these two timeframes:

- Promote medium-term migration to new, architecture-based, XML-based integrated systems:
  - Follow up, and support, current industry's medium/long term efforts aimed at providing an architecture-based, model-driven foundation to overcome the limitations of the current message-by-message approach to standards development (e.g. IATA's Airline Industry Data Model initiative).
  - More specifically, follow up, and support, IATA's PADIS Board medium term advances in the development of Electronic Data Interchange and XML message standards for passenger travel and airport-related passenger service activities, e.g. the evolution from Type B messaging to more flexible and capable XML-based Type X messaging.
  - Analyze how the flexibility provided by these approaches could be exploited to provide seamless and comprehensive acquisition, transmission and communication of all required data on PWD and their requirements.
- In the meantime, improve the existing, Type B messaging - based systems:
  - Promote a wider standardized set of operations and status/condition codes that all stakeholders would recognize, and ensure their collection and transmission through all the system interfacing points.
    - Ensure all required data is collected at the point of the original reservation, providing, if needed, complementary support mechanisms.
  - Promote "advancing" the time at which relevant information is relayed.
    - Promote pre-notifications (current rate is unsatisfactory) by providing passengers and carriers with more incentive to pre-notify.
    - Ensure that information is shared among stakeholders (e.g. airlines and airports) as soon as it is available, as opposed to only when the minimum legally required advanced notice time is reached.
    - Tackle the issues behind destination airports finding about service request only after the aircraft departure (through PSM messages).
  - Address the issues of missing or mistaken requests in the Passenger Name Record (PNR) (currently it is so prevalent that some PRM manuals include a section on "PRM service code Incorrectly or Not Indicated in PNR").
  - Ensure that service planning and service personnel punctually receive the information held in their employer's systems that is required for their tasks.

4 Conclusions

Proper acquisition and transmission of PRM-related information between different stakeholders is a requirement for the scheduling of the service personnel and the tailoring of the service to the specific needs of the PRM. Moreover, certain barriers faced by users suggest that the information flow is not adequate. The analysis described in this paper suggests that existing PRM messages based on the current ATI messaging standards do not provide adequate support to the PRM-related communication needs of the involved stakeholders. This limitation is not confined to the PRM area, thus several industry working groups are working on an architectural evolution that should eventually provide a more capable and flexible infrastructure. The need to support this transition and ensure that it takes into account, and thus fulfils, the PRM-specific requirements is highlighted.

In the meantime, the analysis of the shortcomings in how the existing, Type B messaging - based systems are used leads to another set of recommendations, including promoting pre-notifying the need for assistance, standardizing the codes used for the acquisition and transmission of PRM-related information, tackling the problems related to missing/wrong information, and ensuring that each stakeholder receives the information as soon as it becomes available.

5 References

Cavinato JL, Cuckovich ML (1992) Transportation and tourism for the disabled: an assessment. Transportation Journal, pp. 46-53.

Chang Y, Chen C (2012) Meeting the needs of disabled air passengers: Factors that facilitate help from airlines and airports. Tourism Management, vol. 33, no. 3, pp. 529-536.

Chang Y, Chen C (2012) Overseas travel choice for persons with reduced mobility. Journal of Air Transport Management, vol. 20, no. 0, pp. 43-45.

Eichhorn V, Miller G, Michopoulou E, Buhalis D (2008) Enabling access to tourism through information schemes? Annals of Tourism Research, vol. 35, no. 1, pp. 189-210.

European Commission (2006) Regulation (EC) No 1107/2006 concerning the rights of disabled persons and persons with reduced mobility when travelling by air.

European Commission (2010) European Disability Strategy 2010-2020: A Renewed Commitment to a Barrier-Free Europe.

European Commission (2011) Report from the Commission to the European Parliament and the Council on the functioning and effects of Regulation (EC) No 1107/2006.

European Commission (2012) Interpretative guidelines on the application of the Regulation (EC) Nº 1107/2006, concerning the rights of disabled persons and persons with reduced mobility when travelling by air.

Eurostat 2011 Demography report 2010.

Ray N M & Ryder M E (2003) “Ebilities” tourism: an exploratory discussion of the travel needs and motivations of the mobility-disabled. Tourism Management, vol. 24, no. 1, pp. 57-72.

SITA (2010) Air Transport IT Review Nov. 2010 Special Edition “Passengers with Reduced Mobility".

Smith S, Macnair W, Havenhand M (2010) Evaluation of regulation 1107/2006. Final report.

296 Transfer Of Knowledge By Collaboration: Case Study In Aerospace Application

Ünal V, Solakoğlu E

Verda Özge ÜNAL (✉ e-mail: vounal@tai.com.tr)
Technology Management Department. TAI (Turkish Aerospace Industries Inc.). Fethiye Mah. Havacılık Bulvarı No:17 06980, Kazan- Ankara / TURKEY

Erhan SOLAKOĞLU (✉ e-mail: esolakoglu@tai.com.tr)
Technology Management Department. TAI (Turkish Aerospace Industries Inc.). Dr. Fethiye Mah. Havacılık Bulvarı No:17 06980 Kazan- Ankara / TURKEY

Abstract: As knowledge production is a challenging attribute for companies, the research based nature of universities derives the greatest competitive input as a technology acquisition method. This study aims to propose an efficient tool for technology based university-industry collaboration with a specialized case study on aerospace industry. Since there is a lack of collaboration method in selecting the most suitable university, this paper aims to optimize the necessary metrics that match with firm's technology requirement. The model provides an efficient bridge for knowledge transformation from academic institution to industry. By use of descriptive metrics in Analytical Hierarchy Process (AHP), the model serves two common needs for the actors of collaboration. First, the model is helpful to trigger R&D projects in strong collaboration between companies and candidate universities. Second, the model provides a great input for human resource department of companies in such a way that the graduate researchers participating in the R&D projects are identified and appraised for future positions in the company. Finally, in the case study application, technologically applicable metrics for aerospace industry is used internationally.

Keywords: Knowledge Production, University-Industry Collaboration, Analytical Hierarchy Process, Innovation.

1 Introduction

The aerospace industry is one of the most knowledge-intensive technology areas in national innovation systems. In the last decade, the relative importance of advanced competitiveness reached to the top level for aeronautics as the rule of the game changed with changing technology complexity of the companies.

Accordingly, many of the civil and military aerospace companies shifted their effort to concentrate on their core competitive properties. As a result, firms differentiated their effort for knowledge transfer to qualify their information network. [10] The University-Industry Collaboration Model can be beneficial for the planning and initiation of R&D projects between companies and universities. Here, the model is useful in selecting the proper university for the specific R&D project serving for the purposes of the Company's Technology Roadmap. Talent capital of the university can be spotted by the company through these R&D projects. Thus, the model contributes prospective intellectual capital database to the companies. This study consists of an interface for managers working in aerospace industry to give "Yes/No" decision for collaboration with universities. For the basis of this research, the paper generates a model for Aeronautics Company as its technology characteristics is high-value added. On the other hand, aerospace nature requires Just-In-Time (JIT) production with right time and right quantities. Also, customer profile differs with respect to dynamic geographical requirements. [10] So, sophisticated nature of knowledge production in aerospace requires collaboration with academics as a way of knowledge transfer.

First of all, this research study is constituted to compare different universities within the given methodology. The metrics are identified according to need for robust knowledge flow. To come up with an optimum solution, level of collaborative interactions defined as Collaboration Capability Level (CCL) in this model. Characteristics of given metrics are selected with respect to feasibility of desired universities. As the purpose of this study is to generate a universal model, both national and international performance reports of different universities are embedded.

Next, the relative importance of the performance metrics is set with respect to Delphi Method Analysis (DMA) from different layers of Aerospace Industry professionals. Delphi Method is a structured communication technique that is developed as a systematic and interactive forecast method which relies on a panel of experts. According to Grisham's definition, expert cohort was selected according to work experience in the relevant technology intensive geography. Also, survey questionnaires were selected to provide credible and consistent feedback in CCL model. [5] In this study, the panel of experts has been formed from personnel of Technology Management Department in an aerospace company. This group of individuals answered the questionnaires in a survey by an "e-forum". The questionnaires were individually and separately sent to the experts. Therefore, the anonymous nature of the experts' evaluation has been assured. After the first round, the answers of experts to the survey yielded that those answers converged with each other. Then, monitoring and feedback for a few of survey metrics has been discussed with a couple of participant experts in order to consolidate questionnaire survey results. Then, the descriptive results are embedded into Analytical Hierarchy Process (AHP). Also, the comparative rankings of sub category metrics are constructed with AHP results to obtain a unique scoreboard in CCL table. The given order of parameters in AHP is based on personal experience of technology-intensive professionals.

In conclusion, the CCL scale table defines the current profile of University-Industry Collaboration and forms a proactive roadmap for further actions in collaboration. This study shows gaps between industry and academics in current collaboration system according to eight different zones as it aims to improve these weaknesses with its optimum solution. To criticize the method of this study, the indiscrete results of DMA resources are used in eight parameters zone. In further studies, the number of categories can be enriched to generate more accurate results. The validation of the method presented in this paper is going to be the subject of the further studies. In the prospective studies, the performance of the model will be considered by using data of a set of universities.

2 Literature Survey

As collaborative actions for strategic focus has always been a major concern in history of nations, first formal act of collaboration started in 17th century with Francis Bacon. The first product catalogue was defined for “History of Trades” publication with respect to contacts of manufacturers with center of basic research in scientific community. [3] In 18th the USA Congress intended to propose a law to regulate university-industry relations. In these new standards named “Morill Laws”, public universities were entitled to publish their effort on R&D activities with a new scientific model. [6] In Second World War, USA government promoted its funds to gain military advantage. On the other hand, governmental incentives gave edge to the academic institutes to apply their basic research into real life with healthy cash-flow. [4] In 19thcentury, government mitigated the sources of incentives as a result of depreciation. As economic downturn affected research activities, competition in research projects were boosted rapidly. In 1980, “National System of Innovation” concept was introduced to the market by government. With this new formation in knowledge production, role of universities and firms changed to assure more precious knowledge transfer. Companies initiated to collaborate with universities by means of intellectual capital. Financing research funds were undertaken by companies rather than strict governmental budgets in United States. [1] This long-last relationship provided firms to learn working style of academic institutes as a partner. [8] In 1990, a new “Triple Helix Model” was introduced that diversified the roles to three actors of innovation as university-industry-government. [9] In this model “Market Pull& Technology Push” was enriched with strengthening interactions of government with academic institutes and companies. Government provided various mechanisms for research funds and universities enhanced the quality of their basic research to support entrepreneurial basis. [7] Companies funded the basic research and sustained infrastructure to apply basic research. As universities cannot provide patent within a corporate culture, this model boosts capacity of universities. Firms developed spin-off mechanisms to university as an interface to apply knowledge into real life more quickly. [2]

3 Method of the Study

The method used in this research study is completed with consistency of related universities' faculty of engineering and research institutes since these resources are center of knowledge transfer to companies through R&D projects. To get the whole picture, the model is built upon CCL in order to combine final grade of related university in Figure 1 after all datum are agglomerated.

100-80 %	80-60 %	60-40 %	40-20 %	20-10 %	Final Cumulative Grade	Grade Color
Very Strong	Strong	Medium	Weak	Not Feasible		

Fig. 1 The Cumulative Grade Scale in CCL Model

In given figure CCL model, % 0-20 range represents "Not Feasible" region which means that it is the base level and there is no official university-industry collaboration. In long term, the related index parameters have to be improved to achieve efficient knowledge transfer between university and company. % 20-40 range represents "Weak" region which means that it is the secondary level of the CCL pyramid. At this range, the student clubs of related university are supported. Moreover, various kind of weak interactions are sustained according to personal contacts between university and industry. According to these weak one-to-one relations rather than corporate activities, a small group of teaching staff can give consultancy services within limited technology area. % 40-60 range represents "Medium" region which means that it is the third level of CCL pyramid. At this level, university-industrial collaborations are prosecuted with specific universities and with a range of reputable university professionals such as professors, assistant professors, directors of research institutes etc. There is more option as a mean of advisory for teaching staff that can take over limited role in various projects. % 60-80 range represents "Strong" region which means that it is the fourth level. At this level, university-industry collaborations are conducted with different types of universities according to corporate contacts. Partnership in international projects such as 5th, 6th and 7th framework of European Union projects are constituted with different role sharing mechanism. % 80-100 range represents "Very Strong" region which means that it is the top level of CCL pyramid. At this level, various technology related student clubs are guided, thesis works of the undergraduate, graduate, doctorate and post-doctorate students are formed jointly within the industrial demand. Board of Trustee at related university, and upper managerial levels of the firm come together regularly and discuss further actions to draw a long-term collaborative strategy in technology advisory boards and specifically designed industrial advisory boards. The university-industry collaboration works effectively to trigger new R&D projects and enrich quality of current projects according to firm's technology roadmap.

Through the study, AHP method is used to generate University-Industry Collaboration Model. With this concern, model is defined on eight categories to constitute an international academic matrix in Table 1. These categories are Structure of Students, Project Status of Related Department of University, Publication Status of that Department, Commercial Activity Status of that Department, Structure of Teaching Staff in University, Financial Investment Related to Research Infrastructure, Research Income and Operational Feasibility of the University.

Table 1 AHP Analysis on University-Industry Collaboration Parameters

RESULTS	
	Weight coefficients
Indicator1: Structure of Students	0,05
Indicator2: Project Status of Related Department	0,30
Indicator3: Publication Status of that Department	0,09
Indicator4: Commercial Activity Status of that Department	0,12
Indicator5: Structure of Teaching Staff	0,07
Indicator6: Financial Investment Related to Research Infrastructure	0,09
Indicator7: Research Income	0,10
Indicator8: Operational Feasibility	0,17

As a result, when the real performance data of selected university is embedded into this model, the model fits within the relative ranges and gets (1-5) degraded scale according to its defined interval.

- Theory/Calculations

In the first step, the eight parameters are compared with each other according to DMA. To define comparative importance of each category, surveys are carried out with managers of an aerospace company. For example, according to the results with respect to industrial perspective, the number of doctorate students is the most important metric for indicator 1. According to the application of AHP methodology in each category on its own sub matrices, the result ensures consistency to converge in final grade and color in CCL scale.

In the second part of the methodology, the ranges are defined for each sub-metric to give rank in 0-5 grade zone. For example, in structure of students index, if the number of brain drain is x>0.1, it is ranked by the highest factor (5); for 0.1-0.05 range, ranked (4); for 0.05-0.02 range, ranked (3); for x<0.02, ranked (0).

Similarly, in project status of the department index, if the number of industry funded projects is x>1, it is ranked by the highest factor (5); for 1-0.5 range, ranked (4); for 0.5-0 range, ranked (3); for x=0, ranked (0). Next, the given ranks (0-5) are multiplied with the actual eigenvector of each sub categories when the model is applied on real data agglomerated from universities' performance report.

Then, the cumulative of each sub categories demonstrated the sum of to the main indicators, which are shown in Table 2. Finally, summation of each subcategory is completed and the parameters are converted into 0-100 scale index which brings up the CCL grade of that university overall.

Table 2 Key Performance Metrics on CCL Model in Aerospace Industry

Main Parameters	Sub Category Parameters	Descriptions of Key Performance Metrics
Structure of Students		
	Number of Master Degree Students	Number of Master Degree Students/ Number of Teaching Staff of That Department
	Number of Doctorate Students	Number of Doctorate Students/ Number of Teaching Staff of That Department
	Number of Brain Drain	Number of Labor Works at the Corporation (Transferred with Brain Drain) / Total Number of R&D Engineer
Project Status of Related Department (University)		
	University Funded Research (Internal) / Academic Staff	Net research investment(outflow)/ inflow from operating activities
	Government Funded Research / Academic Staff	Government Research Grant / Total Externally Fund Research
	Industry Funded Projects (Related Aerospace Company) / Academic Staff	Related National Industry Funded Projects/ Total Research Fund
Publication Status of that Department (University)		
	Number of International Publication	Number of International Publication (Report, Conference, Scientific Newspaper) / Number of Teaching Staff of That Department
	Number of International Article (In Referee Publication)	Number of International Article (In Referee Publication) / Number of Teaching Staff of That Department
Commercial Activity Status of that Department (University)		
	Number of Assets (Patent etc.)	Number of Assets / Total Number of Projects of That Department
	Number of Technology Transfer (Commercialized Product/Service)	Number of Technology Transfer / Total Number of Projects of That Department
	Number of training delivered as a result of a paymet (prepared by university for industrial purpose)	Number of training delivered as a result of a paymet (prepared by university for industrial purpose) /Total number of trainings
Structure of Teaching Staff (University)		
	Number of Research Assistant	Number of Research Assistant / Number of Teaching Staff of That Department
	Corporate Advisory Services	Number of Corporate Advisory Services provided by Related Department Of University / Number of Teaching Staff of That Department
	Laboratories	Number of Laboratories used in projects of Teaching Staff / Teaching Staff
Financial Investment Related to Research Infrastructure		
	New Academic Staff Transfer Related to Research Project	New Academic Staff Transfer Investment / Total Investment
	Assistant Scholarships	Assistant Scholarship / Total Investment
	Building and Equipment(Software,Laboratory) Expenditure	Buildings and Equipment / Total Investment
	Training Expenditure	Training Expenditure on Research/ Total Investment
Research Income		
	Research Income Per Academic	Research Income / Total Number of Teaching Staff
	Research Income Per Total Income	Research Income / Total Revenue(Endowment and Academic Fee)
	New Awards Income Received Related to Research Project	Number of new awards / Total Number of Awards
	Commercial Income	Commercial Income / Total Research Income
Operational Feasibility		
	Completed Research Projects	Number of Completed Research Projects / Total Number of Projects of That Department
	Matching Projects on Technology Roadmap of Company	Number of Matching Projects on Technology Road Map / Total Number of Projects on Technology Road Map
	Advanced Research Potential	Number of Available Post Doctorate Students For Research Study / Total Number of Students (MS-PhD-Post Doctorate - Researcher)

4 Conclusion

In this research study, nature of current university-industry collaboration is examined to propose an upgraded alternative plan. To overcome gaps in knowledge transfer, CCL model is proposed as a solution for managers' plan. By means of current study, managers of an Aerospace Company will be able to foresee potential competency of its collaboration partners. Also, the CCL model will improve the quality of universities to boost its innovative activities while competing with other actors for knowledge formation.

On the other hand, the perspective reflected by this study is restricted on faculty of engineering in universities as capability to stimulate R&D projects is main concern in key performance metrics. So, the study is useful for any company to perform research based on its critical technologies on “Technology Roadmap” with suitable university’s research potential. The study will stimulate better empirical models as a qualified reference for other technology intensive industries. By measuring universities’ performances within eight metrics on AHP, the model will give effective feedback about inadequate functions of targeted universities. So universities will be able to evaluate their performances in detail.

Finally, the next study is going to include the validation of the University-Industry Collaboration Model. The expected results of the validation will generate suitable classification of different universities and generate comparison of the grade of collaborations. The real data set of the metrics will be filtered from Annual Business Reports of universities.

5 References

Candemir, B. (2011), “The Role of Intermediary Organizations in Promoting Knowledge Exchange between University and Industry. A Study of the Agricultural Biotechnology Sector in the Netherlands and the UK”, SPRU, University of Sussex, Technology and Economic Development (TED), April 2011, UK.

Coyle, G. (2004), “Practical Strategy-Open Access Material-AHP”, Pearson Education Limited

Erdil, E., Pamukçu, T., Akçomak, S., Erden, Y., “Değişen Üniversite-Sanayii İşbirliğinde Üniversite Örgütlenmesi”, Ankara Üniversitesi SBF Dergisi, Vol. 68, No. 2, 2013, s. 95 - 127.

Geuna, A. (2011) “New Horizons in the Economics of Innovation”, SPRU, University of Sussex, Vol. 14, No.303.483.

Grisham T. (2008), “The Delphi technique: a method for testing complex and multifaceted topics”, Grisham Consulting Inc., St Pete Beach, Florida, USA, Vol. 2, No. 1, 2009, pp. 112-130

Kiper, M. (2010), “Dünyada ve Türkiye’de Üniversite-Sanayi İşbirliği”, TTGV Report, No.1, pp. 17-22.

Leydesdorff, L. (2012), “The Triple Helix of University-Industry-Government Relations”, University of Amsterdam, Amsterdam School of Communication Research (ASCoR), Netherlands.

Marceau, J. (2002), “Divining directions for development: a cooperative industry government-public sector research approach to establishing R&D priorities”, Blackwell Pub., University of Western Sydney, Australian Expert Group in Industry Studies (AEGIS), Sydney, Australia.

Martin, Ben R. (2000), Etzkowitz, H. “The origin and evolution of the university species”, SPRU, Science Policy Institute, presented at Organization of Mode 2/Triple Helix Knowledge Production Workshop, Goteborg University.

Niosi, J. & Zhegu, M. (2005), “Aerospace Cluster: Local or Global Knowledge Spillovers?”, Industry and Innovation (The Charlesworth Group, Wakefield), Vol. 12, No. 1, 1-25, March

298 Utilización del mapa de la cadena de valor en un entorno sanitario: un caso de estudio

Value Stream Map utilization in healthcare environment: a case study

Garcia-Sabater J J, Maheut J, Vidal-Carreras P I

Julio J. Garcia-Sabater (✉ e-mail:jugarsa@omp.upv.es)
ROGLE. Dpto. de Organización de Empresas.. Universidad Politécnica de Valencia. Camino de Vera s/n 46022 Valencia

Julien Maheut (✉e-mail: juma2@upv.es)
ROGLE. Dpto. de Organización de Empresas.. Universidad Politécnica de Valencia. Camino de Vera s/n 46022 Valencia.

Pilar I. Vidal-Carreras (✉ e-mail: pivicar@omp.upv.es)
ROGLE. Dpto. de Organización de Empresas.. Universidad Politécnica de Valencia. Camino de Vera s/n 46022 Valencia

Abstract: The value stream mapping (VSM) is one of the main tools in order to plan the implementation of lean tools in any environment. It can be found a lot of literature on its use in industrial environments and even in office environments "office" (lean office), even though the growing extension of lean in healthcare tool has not yet been widely used there. This paper is intended to address an adaptation of the tool to be displayed on a single map information and patientflow that allow sanitary staff to understand the functioning of a process in its current state, and from there, plan improvements.

Resumen: El mapa de de la cadena de valor es una de las herramientas fundamentales para poder planificar la implantación de herramientas lean en cualquier entorno. Existe abundante literatura sobre su utilización en entornos industriales incluso y en entornos de "oficina" (lean office), incluso a pesar de la creciente extensión del lean en el sector sanitario la herramienta todavía no se ha usado extensamente. En el presente artículo se pretende abordar una adaptación de la herramienta que permita visualizar en un único mapa los movimientos de información y los movimientos de pacientes que permitan poder entender el funcionamiento de un proceso asistencia en su estado actual, y a partir de ahí, planificar las mejoras.

Keywords: Value Stream map, healthcare, lean manufacturing, improvement, hospital;

Palabras clave: Mapa de la cadena de valor, cuidado de la saludo, producción ajustada, mejoras, hospital

1 El mapa de la cadena de valor

1.1 Introducción

El mapa de la cadena de valor es una herramienta de mejora de las organización que ayuda a visualizar los procesos en su totalidad, representando tanto los flujos de material como los flujos de información (Singh, Garg et al. 2011). Se define cadena de valor como el conjunto de todas las actividades que aportan valor añadido, así como aquellas que no lo aportan, que se utilizan para convertir una familia de productos o servicios desde la materia prima o estados iniciales del servicio hasta el cliente final (Rother, Shook 1999). La parte fundamental del mapa de la cadena de valor es documentar la relación entre los procesos de fabricación y los controles usados para gestionar estos procesos, así como la información sobre los programas de producción. A diferencia de la mayor parte de las técnicas de mapeado de procesos, el VSM representa los flujos de información en el sistema, los puntos de almacenamiento y las decisiones que activan los movimientos de material de un proceso a otro (Singh, Garg et al. 2011). La herramienta empieza a ser nombrada a finales de los años 90 por diferentes autores, pero no es hasta la aparición del libro "learning to see" (Rother, Shook 1999) en el año 1999 hasta que su uso se estandariza tal y como se usa habitualmente en la actualidad.

La herramienta se ha demostrado útil en entornos de producción y ha sido extrapolada a entornos de oficina, aunque habitualmente se suele encontrar en proceso repetitivos como creación de facturas o gestión de documentación (Tapping, Shuker 2003).

La manera habitual de trabajar con los mapas de la cadena de valor es representar la situación actual, tal y como existe en la realidad con todos los indicadores básicos necesarios para poder establecer un diagnóstico adecuado de la situación. Una vez la "foto" ha sido tomada, el equipo debe crear el mapa futuro y trazar el plan de acción para poder llegar a él en un tiempo determinado (Rother, Shook 1999).

1.2 El mapa de la cadena de valor en entornos sanitarios

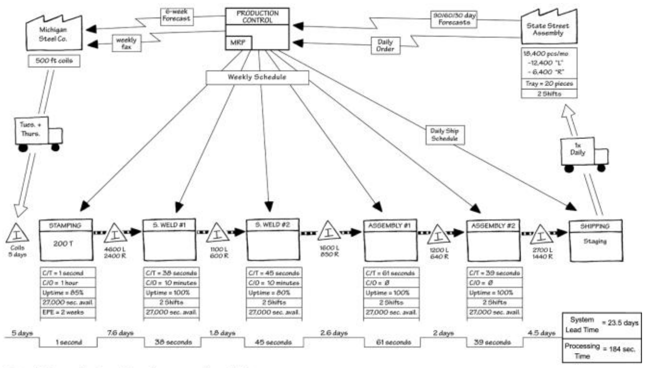
El objetivo de la implantación del la filosofía lean en entornos sanitarios es fácilmente trasladable desde un entorno de la producción al entorno sanitario. El objetivo de lean manufacturing en entornos industriales es conseguir un producto de máxima calidad al mínimo coste y en el menor tiempo posible (Marchwinski, Shook 2003). En el caso de implantación del lean en un entorno sanitario es conseguir un paciente sano, en el menor tiempo posible y al mínimo coste. El mapa de la cadena de valor nos puede ayudar a minimizar el tiempo que el paciente necesita en su paso por el hospital y a minimizar costes derivados de la gestión tradicional (Jackson 2013). Siempre teniendo en cuenta que la parte fundamental de calidad de atención y costes de atención deben ser abordados por médicos con procedimientos médicos que no son abordados (ni deben serlo) con herramientas de gestión. Existe ya literatura que aborda los mapas de la cadena de valor en entornos sanitarios (Lummus, Vokurka et al. 2006, Kim, Spahlinger et al. 2006). El problema de estos trabajos es que siguiendo su metodología no se consigue trazar un mapa fácilmente comprensible, ya que no separa flujos de pacientes de flujos de personal sanitario, que ocurren en paralelo y cuya sincronía (o no) es fundamental para que el paciente fluya y se pueda tener la foto adecuada del proceso.

2 Problemas del uso del mapa de la cadena de valor en el entorno sanitario

Siguiendo la teoría del VSM para poder representar un mapa se debe escoger una pieza perteneciente a la familia seleccionada y seguirla desde que entra en forma de materia prima hasta que sale de la fábrica en forma de producto acabado (si bien esta tarea debe ser seguida en dirección contraria al flujo) (Rother, Shook 1999). En el caso de mapas en el entorno sanitarios el seguimiento se debe hacer a un paciente, que forma parte de una familia (función de la patología) y seguirlo hasta que sale “curado” del hospital.

La representación de la realidad en un entorno industrial lleva a que los mapas presenten el mismo esquema (en forma de U con flujos de información centrales tal y como se ve en la imagen siguiente) y la pieza pasa desde que empieza el primer proceso por 7 u 8 procesos secuenciales hasta que se obtiene el producto acabado[4] .

[4]Si fuera necesario para entender el proceso de creación de la pieza, se pueden insertar líneas de valor adicionales al flujo principal, aunque no se aconseja porque complica el mapa y por tanto su comprensión.



Note: C/T = cycle time; C/O = change-over time; EPE = every part every ____
Source: Womack (2003)

Fig. 1 Vista típica de un mapa de la cadena de valor (Rother, Shook 1999)

El problema que se presenta a la hora de representar una cadena de valor en un entorno sanitario es que habitualmente el paciente pasa por muy pocos procesos. Por ejemplo: un paciente que va la consulta del cardiólogo únicamente debe pasar por un proceso técnico que le mide el funcionamiento del corazón y luego por el especialista que diagnóstica y presenta el tratamiento. Si únicamente se representa esta realidad el mapa sería insuficiente. No se abordaría el problema de la información. Cuando pasas a abordar este problema se observa que la información puede pasar por 7 u 8 procesos diferentes antes de que el paciente aparezca por primera vez en el centro de especialidades.

La solución que se propone es crear un mapa con dos vías, por un lado con una manera de trabajar similar al "value stream office" (Tapping, Shuker 2003) que sigue a los "papeles" y pruebas que va generando el paciente y por otro lado simultáneamente seguir al paciente que es el "producto" que está esperando los procesos que le aporten valor. Se debe tener en cuenta que se presentan dos problemas de clasificación similar (esperas) pero de realidades muy diferentes. Por un lado están los problemas de listas de espera (días, semanas o meses) y por otro lado la espera del paciente una vez ya está en el hospital o centro de salud.

3 Casos de estudio: servicio de urgencias y servicio de consultas externas

El caso de estudio está basado en un mapa elaborado en un Hospital de la Comunidad Valenciana. Se van a representar dos mapas, por un lado el proceso de urgencias en una de sus patologías identificadas como críticas, rotura de huesos y necesidad de asistencia por parte de un traumatólogo. Por otro lado el servicio de consultas externas, en la primera visita, y partiendo de la información que llega desde atención primaria a un centro de especialidades.

Para representar los mapas se van a utilizar dos técnicas diferentes, por un lado una representación con la ayuda de plantillas dibujando sobre el papel y el otro mapa representados con post-it. El objetivo es utilizar las dos técnicas para observar la utilidad y la facilidad de representación para decidir que técnica es mejor para poder formar a los trabajadores del hospital.

3.1 Caso de urgencias

El proceso de urgencias es, desde el punto de vista del paciente, similar a cualquier proceso de urgencias de otro hospital. A grandes trazos se puede describir como sigue: 1º el paciente al llegar al hospital espera, poco tiempo, hasta que se le tomen los datos básicos (nombre, dirección….) y avanza hasta la zona de espera de *triaje* 2º Se le clasifica en función de su gravedad (*triaje)* y de ahí pasa a esperar en la sala de espera 3º El médico le atiende y en función de su patología lo envía a realizar una técnica u otra y acude a esperar a la sala de espera de la técnica 4º Se le realiza la técnica y va a esperar de nuevo a que le atienda el médico y 5º el médico le atiende y en función del resultado, o bien se le cura y se le envía a casa, o bien se va directamente a casa.

El proceso se representa en un mapa de la cadena de valor como se muestra a continuación en la figura 2.

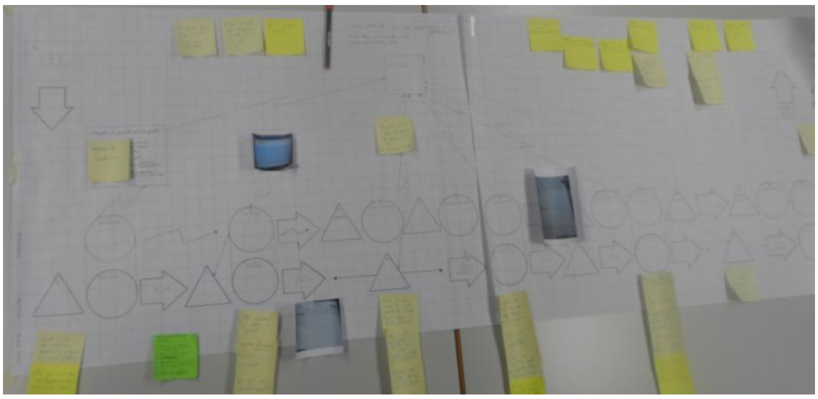


Fig. 2 Vista del mapa de la cadena de valor del proceso de urgencias

La línea horizontal inferior del mapa es la que corresponde a las actividades del paciente, mientras que la superior es la que corresponde a los procesos del personal del hospital. En la imagen se puede observar que existen muchas actividades que se producen en paralelo a las esperas del paciente y que son críticos para el correcto funcionamiento del proceso de urgencias. La mayor parte de estos últimos procesos corresponde a movimientos de información y decisiones, pero que si se representaran según la notación clásica del Lean Enterprise Institute (Rother, Shook 1999) perderíamos información tanto a nivel de proceso interno como visión de sincronización con el paciente. Perder estos paralelismos de tiempo significaría que el mapa no tendría validez.

Los movimientos de información representados en el lugar clásico (interior del mapa) únicamente representan las grabaciones de datos que se realizan a los servidores y la información del paciente que necesitan los médicos para ir tomando decisiones médicas, en ningún caso tienen que ver con el flujo del paciente o la toma de decisiones acerca del proceso que se está representando.

Se disponen de todos los indicadores básicos (tiempos de espera, tiempos de ciclo, capacidades de médicos…) ya sea porque se pueden medir, ya sea porque se puede disponer de ellos ya que el ordenador dispone de un sistema de indicadores muy desarrollado.

Destacar como mejora más fácilmente implantables técnicas de factoría visual. Estas técnicas ayudarían a mover mejor a los pacientes por las zonas de urgencias, a visualizar mucho más claramente la gravedad de los pacientes (las hojas con los datos) y permitiría poder priorizar los pacientes con mucha más facilidad. Actualmente los papeles de las fichas de pacientes se amontonan en pilas y se pierde completamente la visibilidad de la gravedad y de la hora a la que han acudido al hospital.

Como mejoras de más largo alcance existen dos importantes. Por un lado la secuenciación de pacientes a través de algoritmos matemáticos. Las reticencias a este último tipo de mejora radica en que “no es lo mismo una pieza que un paciente”, pero la verdad es que el proceso de *triaje* realizado al inicio de la atención al paciente consiste en hacer objetiva a través de unas cuestiones la gravedad del paciente y habitualmente los médicos se fían de estos datos para secuenciar manualmente. La solución pasaría por la presentación de una solución inicial (matemática) dándole autorización al médico a cambiar la secuencia si lo considerara. La no eliminación del papel tiene que ver con el miedo a que caigan los servidores.

El otro cambio propuesto tiene que ver con la creación de dobles rutas (físicas) para separar paciente de atención rápida del resto, lo que bajaría sustancialmente, como se ha demostrado en otros hospitales, los tiempos medios de espera (Ben-Tovim, Bassham et al. 2007)

3.2 *Proceso de consultas externas*

La familia de pacientes que se ha elegido para representar el proceso de consultas externas es el paciente que acude a primera consulta del especialista enviado por el médico de primaria u otros hospitales. El proceso a modo de resumen se podría representar como sigue: 1º llega la hoja de solicitud de cita con toda la información médica ya realizada, 2º se procesan las hojas y se guardan en servidores los datos básicos (nombres, dirección…) y se almacenan para trasladarlo a la especialidad correspondiente 3º Se trasladan a la especialidad y allí se le asigna fecha, hora y médico, 4º se traslada dicha información (en papel) de nuevo a la sala inicial, 5º Se comunica la información al paciente, 6º el paciente acude en fecha y hora, 7º espera hasta la realización de la técnica correspondiente y espera al médico, 8º el médico atiende al paciente. El mapa, sin movimiento de información médica a servidores se representa como sigue:

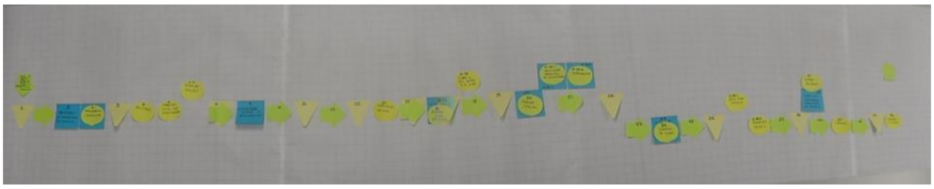


Fig. 3 Vista del mapa de la cadena de valor del proceso de consultas externas

El mapa sigue la misma manera de trabajar que en el caso anterior. La línea inferior horizontal corresponde al paciente y el resto al proceso de gestión de documentación por parte del personal sanitario. Se observa de un simple vistazo que el paciente interviene en muy poca parte del proceso, que es amplio y con abundantes puntos de espera y transportes que son, sin dudar, desperdicio.

Las mejoras más importantes a realizar son la eliminación de desperdicio debido a transportes innecesarios de documentación, que además lleva a que los papeles se pierdan o se acumulen en el fondo de pilas de papel con más frecuencia de la deseada. La siguiente mejora a realizar sería una correcta nivelación de las cargas de trabajo (primeras y segundas citas) que eliminaría tiempos de espera de los pacientes y una secuenciación de citas que siguiera criterios distintos a simplemente la prioridad. Las reprogramaciones son también fuente de distorsiones importantes en el sistema, el problema fundamental es que se cree que es un problema, sin datos objetivos que lo demuestre. Lo primero sería objetivar la importancia de esta distorsión y después ponerle remedio si es necesario, si bien la eliminación de estas requiere de un cambio cultural importante.

4 Conclusiones

Después de presentar el mapa a los profesionales implicados en las dos secciones se pueden extraer las siguientes conclusiones:

- El mapa se entiende por profesionales que lo han visto por primera vez que hacen notar que “obviamente” el flujo de paciente y el de personal sanitario deben ser representados de forma diferente e incluso en mapas diferentes. Si bien esto último es inviable porque se perdería visibilidad.

- Los movimientos de información hacia los servidores no son bien entendidos al estar en el punto central del organigrama. Por esto motivo el segundo mapa se hace sin ellos. De cualquier modo esta representación queda pendiente de futuros estudios ya que los autores consideran que a pesar de que el mapa actual representa bien la realidad y es comprensible, habría que diferenciar los puntos de decisión (secuencia) de los procesos en los que se trabaja sobre el paciente.
- El método de representar con post-its se ha demostrado mucho más ágil para trabajos con grupos de 6 o7 personas.
- Para implantar las mejoras hay que incluir a todo tipo de personal en los grupos de mejora, y se necesita un cambio cultural importante ya que no abundan este tipo de grupos en la organización.

Este artículo ha contado con la financiación del proyecto "Path Dependence y toma de decisiones para la selección de herramientas y prácticas de Lean Manufacturing" (PAID-06-12-SP20120717) de la Universitat Politècnica de València

5 References

Ben-Tovim, D.I., Bassham, J.E., Bolch, D., Margin, M.A., Dougherty, M. and Szwarcbord, M., 2007. Lean thinking across a hospital: redesigning care at the Flinders Medical Centre. Australian Health Review, 31(1), pp. 10-15.

Jackson, T.L., 2013. Mapping Clinical Value Streams. CRC Press.

Kim, C.S., Spahlinger, D.A., Kin, J.M. and Billi, J.E., 2006. Lean health care: What can hospitals learn from a world-class automaker? Journal of Hospital Medicine, 1(3), pp. 191-199.

Lummus, R.R., Vokurka, R.J. and Rodeguiero, B., 2006. Improving quality through value stream mapping: a case study of a physician's clinic. Total Quality Management, 17(8), pp. 1063-1075.

Marchwinski, C. and Shook, J., 2003. Lean lexicon: a graphical glossary for lean thinkers. Lean Enterprise Institute.

Rother, M. and Shook, J., 1999. Learning to see. Lean Enterprise Institute, Boston, MA, .

Singh, B., Garg, S.K. and Sharma, S.K., 2011. Value stream mapping: literature review and implications for Indian industry. The International Journal of Advanced Manufacturing Technology, 53(5-8), pp. 799-809.

Tapping, D. and Shuker, T., 2003. Value Stream Management for the Lean Office: Eight Steps to Planning, Mapping, & Sustaining Lean Improvements in Administrative Areas. Productivity Press.

299 Identification of key areas and levels to define Maturity Models applied to Reverse Logistics

Cortés P, Cuenca L, Alarcón F, Alemany MME

Pascual Cortés Pellicer (✉ e-mail: pascorpe@omp.upv.es) Dpto. de Organización de Empresas. Universitat Politècnica de València, Camí de Vera S/N, 46022 Valencia.

Llanos Cuenca González (✉ e-mail: llcuenca@cigip.upv.es); Faustino Alarcón Valero (✉ e-mail: faualva@omp.upv.es); Mª del Mar Eva Alemany Díaz (✉ e-mail: mareva@omp.upv.es)Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). Universitat Politècnica de València, Camí de Vera S/N, 46022 Valencia.

Abstract: The environmental awareness of society, policy and legislation on recycling, sustainable development, shortage of raw materials and the desired "green" image of business are some of the issues that are forcing companies to incorporate the area of Reverse Logistics as a critical area to maintain the level of competitiveness. To achieve this, it is necessary to achieve the integration of new logistics processes with other existing operations. And it is essential to develop an appropriate level of efficiency, so that the Reverse Logistics can increase the overall level of business efficiency. In this regard, note the usefulness of Maturity Models as clear and simple tools that can serve both companies and supply chains, in benchmarking the maturity of their operations in general and Reverse Logistics particular. Using Maturity Models, you can have a full view of the path to excellence in Reverse Logistics. The purpose of this article is to identify the key areas and levels that must contain a maturity model in the field of reverse logistics. The key areas identified are: satisfaction, participation and customer relations; compliance with environmental regulations and corporate social responsibility; effectiveness and efficiency on the reclassification of products; flexibility of attention on products and coordination between the different factors. The maturity levels are identified: intra - organizational, inter - organizational, extended inter - organizational, multi -chain and societal.

Keywords: Reverse Logistic, Maturity Model, Supply Chain maturity, Performance Measurement, Reverse Supply Chain.

1 Introduction

Nowadays, environmental issues have become a major concern for companies, most of which integrate a focus on sustainability in their activities and strategies. The process of Reverse Logistics (RL) reduces the social, environmental and economic impact, by the use of raw materials, through the definition of new reverse product recovery flows that link suppliers, manufacturers and end users.

Many companies already consider reverse logistics as a critical area to maintain the level of competitiveness and, therefore, to the success of the business. Once built this new area and integrated with other existing operations will be essential in the business evolve to the proper level of efficiency, so that the RL can increase, or at least not undermine, the overall level of business efficiency. In this regard it is important to consider the usefulness of Maturity Models (MM), in their simplicity to assess the degree of evolution and development of the modeling aspects, according to a common scale for a group of companies or sector. To determine a MM reference must initially establish the areas to assess and the different levels at which to place each of the areas of the company, defining the features to meet each area to be at a certain level (Cuenca et al. 2013).

Applying the MM, you can easily determine what level you are and what follows it will be, becoming aware of the path to be followed towards efficiency and ultimately operational excellence. In this way and according to the particular interests and objectives established, the MM helps achieve the appropriate level of development or desired (Fraser, Moultrie & Gregory 2002).

Despite of the proven usefulness of MM in different areas and in particular in the area of processes (III, McCormack 2004), there seems to be a gap in the literature regarding MM process applied to RL (Battista, Schiraldi 2013). In this paper aims to begin to cover this gap by proposing key areas and levels of MM for the RL process, which would serve for the further development of a complete MM in the above context.

To achieve that objective, we select articles that referred to performance indicators of RL with the intention of shelling the main characteristics that define the RL and identify those aspects to consider for efficient management. Once extracted from the literature, are grouped by similarities in global areas that allow us to mark them as activities that cover the main features of the RL.

Subsequently MM literature is reviewed to identify the levels that should be considered in the field of RL, trying to reach a consensus among existing which may be more decisive in its application to the object of study. The proposed key areas and levels for MM applied to the RL is performed in section 4, and finally conclusions and paragraphs bibliography are included.

2 Reverse Logistics: key areas

Reverse Supply Chain (RSC) comprises a series of necessary activities to recover the used products and either dispose of them, or reuse. RSC management is defined as the field that studies how to manage these recovery activities effectively and efficiently (Guide Jr, V Daniel R, Van Wassenhove 2002).

The reverse logistics processes to help companies fulfill their social responsibility and improve their reputation for providing a more respectful disposal of the products and components, either for repair, reuse or disposal. In general, companies are focused on creating a RSC, either due to environmental regulations or to reduce its operating costs by reusing products or components.

For companies that use RSC strategic issues included the following two important issues: (i) how to obtain the products used by consumers, and (ii) the issue of recovery, i.e., when handling products returned. Due to the uncertainty as to time, quantity and quality of the returned products, RSC management becomes very complex.

The process of collecting waste products or "return" in the SC is collected in a standardized high-level operations model that aims to provide a structured procedure approach to improve the SC. This standardized operating model is called Supply Chain Operations Reference Model (SCOR) (Stewart 1997). The SCOR model includes the planning, source, manufacturing (make) delivery, in addition to the process of return, and is used to guide companies in their process modeling and benchmarking performance against other SC. At the same time, it has contributed to the development and evaluation of different MM of SC (Cohen, Roussel 2005).

The SCOR model defines the return process as the process associated with the reverse flow of products, in which the activities of identifying the need to return, programming, loading and reception are included, specifying the collaboration between different entities system for optimum performance.

So RL processes require collaboration between different organizations, start from the idea that the models that best fit our purpose we are those who analyze the maturity of SC, supported mainly in the SCOR model. Therefore, the process of Return will be analyzed to draw a MM that can be applied, when this phase which corresponds to the reverse logistics process.

The revised articles to identify key process for RL that should be included in the MM areas. Areas are considered key aspects or characteristics of the RL process that should be taken into account to assess the level of progress or development of this process.

3 Maturity Models: levels of a measurement

A MM aims to help companies in benchmarking the maturity of their areas, factors or operations in relation to best practice (Netland, Alfnes 2011). The fact of being in a certain level, indicating what remains to be done to achieve the highest degree of excellence, symbolized at the highest level.

The main idea of MM is that "describes in a few sentences, the typical behavior exhibited by a company in a number of maturity levels for each of several aspects of the study area. Also (Cuenca et al. 2013) indicate that all MMs have common characteristics such as: define key areas or activity to be assessed and specify different levels of maturity for each key area or activity.

The MM usually can communicate in two-dimensional form, so that one axis corresponds to the practices to measure the maturity and the other indicates the maturity level of each. Changes to a maturity level to another higher are usually associated with the implementation of best practices.

The ability to integrate best management practices SC is a way to define maturity levels. Higher levels of maturity in any business process result in: Better control of results; Improving the prognosis of the objectives, costs and performance; Greater efficiency in achieving defined objectives and improved manageability of the fight propose new and higher goals for performance (III, McCormack 2004).

The Maturity Model best known from the approach of improving business performance is the Capability Maturity Model Integration (CMMI), which has been developed by the Software Engineering Institute (SEI) with the aim of improving the efficiency and effectiveness of activities product maintenance and development services (Estampe et al. 2013).

In the CMMI model, there are five maturity levels:

- Level 1: Initial. The processes are neither defined nor standardized and performance is not evaluated regularly.
- Level 2: Managed. The processes being implemented are planned, executed, supervised, controlled, reviewed and assessed.
- Level 3: Defined. The processes are standardized, improved and used by the whole of the organization, whose own objectives will also be defined.
- Level 4: Quantitatively managed. The organization sets the performance objectives for the processes. The objectives are linked to organizational, but also customer demands. The results are measured quantitatively.
- Level 5: Optimization. The processes are continuously improved through an analysis of the causes of variations in performance.

These levels have been taken as a basis to draw other MM, being adapted to the needs of other areas, as is the case of SC (Cuenca et al. 2013).

The maturity classification proposed in the SCOR model refers to the ability of companies to manage the full scope of a supply chain (Cohen, Roussel 2005).

Paché & Spalanzani (2007) have proposed five levels of maturity built around inter-organizational supply chain relationships, including any relevant societal aspects.

- Level 1: Intra-organizational maturity. The objective is to manage performance, bringing together different corporate functions.
- Level 2: Inter-organizational maturity. The performance is managed at a more global level through the integration of any and all actors operating in the proximity of the company (suppliers, service providers, direct customers, etc.)
- Level 3: Extended inter-organizational maturity. Find a better performance with all actors involved in a chain.
- Level 4: Multi-chain maturity. The company is part of a complex network of relationships, where each member company can be the "pilot" or "fulcrum" of a relationship.
- Level 5: Societal maturity. Companies belonging to a global network incorporate sustainability-associated performance dimensions (environment, society) and looking for a kind of performance that will be valuable in a broader social context.

Definitely, the CMMI model is principally oriented on the processes and do not specify the collaboration aspects in an inter-organizational context. The maturity model proposed by an SCOR is limited to inter-organizational aspect of a specific chain and does not specify multi-chain aspects such as the collaboration processes or resource sharing, neither the social dimension and the necessary collaboration with territories, in which the channels will be stakeholders, including environmental and societal aspects. The model proposed by Paché & Spalanzani (2007) includes both societal and multi-chain perspectives (Estampe et al. 2013).

4 Proposed Levels and Key Areas for Maturity Model

Once the analysis of the articles and taking into account the need to identify key areas to be assessed to locate an organization in maturity levels, are determined as the main areas for RL the following process:

- **Satisfaction, participation and customer relations.** Designing network of RL has a key part to their good performance, customer relations, because in this type of process the client has a role of fundamental stakeholder since we can serve as input to the system other than as the receptor of our products (Pokharel , Mutha 2009).

- **Compliance with environmental legislation and corporate social responsibility**. The RL is closely related to the respect of the company towards the environment and their social image in relation to society, as the reverse logistics processes to help companies fulfill their social responsibility and improve their reputation (Azevedo, Carvalho & Cruz Machado 2011).
- **Effectiveness and efficiency on the reclassification of products.** The products recovered in our RSC may arrive by different paths, so it is very important the correct assignment of the itinerary for each of them (Olugu Wong & Shaharoun 2011).
- **Flexibility for classification and utilization of recovered products.** The key to managing the logistics network focuses on the flexibility of care versus the uncertainty of inputs to the system (Srivastava 2008).
- **Coordination between different factors.** As a key factor for all SC, coordination between the various participants will be key for optimal performance. In this regard, note the timing and coordination of the RL as the main concerns of the RSC (Xueqi Xu, Xue Wu & Wen Guo 2011).

Moreover, because the processes of RL have extensive operational complexity, require an inter-organizational coordination and have a direct relationship with the social environment around them, the model of maturity levels proposed by Paché and Spalanzani (2007) we find the most appropriate starting point for defining levels in the MM process applied to RL. Based on this model, it is proposed Maturity Model levels applied to the Reverse Logistics processes:

- **Level 1: Intra-organizational maturity of Reverse Logistics**. The objective is to manage the performance of the Reverse Logistics, bringing together different corporate functions.
- **Level 2: Inter-organizational maturity of Reverse Logistics.** The performance of the Reverse Logistics is managed at a more global level through the integration of all stakeholders of the company.
- **Level 3: Extended inter-organizational maturity of Reverse Logistics**. Find a better performance with all stakeholders in a RSC.
- **Level 4: Multi-chain maturity in Reverse Logistics.** The company is part of a complex network of relationships in RL. The "multi-company" level enables each company to progress by offering a number of inter-sectorial approaches.
- **Level 5: Societal Maturity for Reverse Logistics.** Companies that belong to a global network incorporating performance dimensions associated sustainability and seeking a more social type of performance.

Once the key areas have been identified and have been selected different levels of maturity in which they could put each of them, our MM could be shown as two-dimensional scheme, so that one axis corresponds to the key areas to measure the maturity, and the other axis indicates the different levels of maturity in which you can find each one.

5 Conclusions

As demonstrated, the RL is a vital aspect for businesses to where they are focusing their efforts in recent years. In this regard, it is important to know the current situation in which they find themselves (maturity), and what would be the way to go to improve several key areas within the RL. The MM are presented as a solution to achieve this goal, however have not been found to date, MM to assess the maturity of reverse logistics . So, in this paper we have identified the key areas and different levels of maturity to evaluate the process of RL, covering the gap identified in the literature.

Knowing the diversity of processes that can be given for the reverse logistics process, this proposal is the starting point for defining best practices that should be carried out to achieve the highest level of maturity in key areas to identify the RL process. It is proposed as a future line of research, complete these best practices and their validation on a case study.

6 Acknowledgments

This research has been carried out in the framework of the project funded by the Spanish Ministry of Economy and Competitiveness (Ref. DPI2011-23597) and the Polytechnic University of Valencia (Ref. PAID-06-11/1840) entitled “Methods and models for operations planning and order management in supply chains characterized by uncertainty in production due to the lack of product uniformity” (PLANGES-FHP) and the ADENPRO-PJP project (ref. SP20120703) funded by the Vicerrectorat d’Investigació de la Universitat Politècnica de València.

7 References

Azevedo, S.G., Carvalho, H. & Cruz Machado, V. 2011, "The influence of green practices on supply chain performance: A case study approach", Transportation Research Part E: Logistics and Transportation Review, vol. 47, no. 6, pp. 850-871.

Battista, C. & Schiraldi, M.M. 2013, "The logistic maturity model: Application to a fashion company", International Journal of Engineering Business Management, vol. 5, no. SPL.ISSUE.

Cohen, S. & Roussel, J. 2005, Strategic supply chain management: the five disciplines for top performance, McGraw-Hill Companies.

Cuenca, L., Boza, A., Alemany, M.M.E. & Trienekens, J.J.M. 2013, "Structural elements of coordination mechanisms in collaborative planning processes and their assessment through maturity models: Application to a ceramic tile company", Computers in Industry, vol. 64, no. 8, pp. 898-911.

Estampe, D., Lamouri, S., Paris, J. & Brahim-Djelloul, S. 2013, "A framework for analysing supply chain performance evaluation models", International Journal of Production Economics, vol. 142, no. 2, pp. 247-258.

Fraser, P., Moultrie, J. & Gregory, M. 2002, "The use of maturity models/grids as a tool in assessing product development capability", Engineering Management Conference, 2002. IEMC '02. 2002 IEEE International, pp. 244.

Guide Jr, V Daniel R & Van Wassenhove, L.N. 2002, "The reverse supply chain", Harvard business review, vol. 80, no. 2, pp. 25-26.

III, A.L. & McCormack, K. 2004, "The development of a supply chain management process maturity model using the concepts of business process orientation", Supply Chain Management: An International Journal, vol. 9, no. 4, pp. 272-278.

Netland, T.H. & Alfnes, E. 2011, "Proposing a quick best practice maturity test for supply chain operations", Measuring Business Excellence, vol. 15, no. 1, pp. 66-76.

Pache, G. & Spalanzani, A. (eds) 2007, "La gestion des chaines logistiques multi-acteurs : perspectives stratégiques, PUG.

Stewart, G. 1997, "Supply-chain operations reference model (SCOR): the first cross-industry framework for integrated supply-chain management", Logistics information management, vol. 10, no. 2, pp. 62-67.

Xueqi Xu, Xue Wu & Wen Guo 2011, "Applications of IoT to Reverse Supply Chain", Wireless Communications, Networking and Mobile Computing (WiCOM), 2011 7th International Conference on, pp. 1.

306 Transport logistics supporting the development of high added value supply chains: an analysis of the cellular phones industry in Brazil

Oliveira Fabiana L, Oliveira Aristides R

Fabiana Lucena Oliveira (✉ e-mail:flucenaoliveira@gmail.com)
Escola Superior de Ciencias Sociais, Universidade do Estado Amazonas (UEA), Manaus, Brasil.

Aristides da Rocha Oliveira Junior (✉e-mail: aristides.jr@homail.com)
Faculdade de EstudosSociais, Universidade Federal do Amazonas (UFAM), Manaus, Brasil.

Abstract: This article presents a discussion about air transport importance for agile supply chains development at Manaus Industrial Pole. Good development of agile supply chains, according Uncertainty Supply Chain Model (Lee, 2002), is important to keep updated industrial park on emergent economies, in order to keep attractiveness for products of technological frontier. Air transport is fundamental for supply logistics because considers agility which is necessary for products of technological frontier. The results obtained on this discussion and analysis confirms the necessity of good development on air transport infrastructure as attractiveness and competitive factor on Manaus Industrial Park, Manaus Industrial Pole (PIM), as case study.

Keywords: air Transport, Uncertainty Supply chain Model, Agile supply chain; Manaus industrial pole; logistics.

1 Introduction

Business Logistics, as a set of techniques and activities-means (or support) for the productive operations of companies, represents an area of technical-professional research and intervention with increasing relevance to the systemic competitiveness of countries, regions, economic blocks, sectors or individual companies. This growing relevance of Business Logistics has been especially significant over the course of the last thirty years. It is justified by a global context marked by at least four major phenomena: (I) the commercial and productive internationalization of companies, (II) the forming of regional trade blocks and the acceleration of the process for economic, political and cultural integration; (III) the radical and swift technological change brought about by the advent of the new Communication and Information Technologies (CIT's), the frontline products of which are the Internet, mobile telephony and the transition to the platform of digital convergence between computing and telecommunications apparatus and equipment which, in conjunction, change the way in which people and companies live, work and produce, and (IV) in the quest for competitiveness in the CITs, trans-national companies have sought out the emerging economies to house their factories, in the attempt to ensure cheaper labor, lower taxes and other attractive advantages offered by the governments of each emerging economy. For this reason, the question is: transport logistics is a factor of attractiveness and development to supply chains with high added value in particular mobile telephony in Brazil? This paper presents an analysis of the state of the art Model Uncertainty with their supply chains categorized, methodology and case study, the model of clusters used as a source of research-Industrial Pole of Manaus(PIM) and Supply Chain agile used for sampling, as well as the results obtained for the answer to the question asked.

2 Strategic Management of the Supply Chain: The Supply Chain Uncertainty Model (SCUM)

The Supply Chain Uncertainty Model (SCUM) was presented to the academic community for the first time in 2002, and its uncertainty matrix was used to characterize the processes for the supply of raw materials and of demand (consumer market), via certain intrinsic characteristics of each product. Figure 1 reproduces the Uncertainty Matrix published in the article entitled Aligning Supply Chain Strategies with Product Uncertainties, in the California Management Review for the Year of 2002. This study considered the supply chains of the products considered to be functional and those considered to be innovative, in other words, products on the cutting edge of technology. For each one of these products, a different management proposal was presented, making it clear that products on the cutting edge of technology have unstable processes from the point of view of demand (consumer market) and supply (raw material), thereby giving rise to the Uncertainty Model.

		Uncertainty of Demand	
		Low (Functional Products)	High (Innovative Products)
Uncertainty of Supply	Low (Stable Process)	Candies, basics, common apparel, foodstuffs, oil and gas	Fashion apparel, computers, audio, video
	High (Development Process)	Hydroelectric apparatus, some food segments	Telecom, high-end computers, semi-conductors

Fig. 1 The Uncertainty Matrix. *Source: Aligning Supply Chain Strategies with Product Uncertainties: Lee, 2002

This being so, the products considered to present low uncertainty of supply and low uncertainty of demand are those that aggregate little technology in their production, in other words, the life cycles of these products are usually longer and their manufacture depends on to a low degree on technological evolution. Whereas those with low uncertainty of supply and high uncertainty of demand are the audio and video, telecommunications and computer products that follow the tendencies of a market characterized by the consumption of novelties that aggregate new technologies, in the expectation of keeping up with technological evolution. These products already usually present a short life cycle and require agility in the management of their supply chains, since the tendencies in technological evolution can be very fast. Those products with high degrees of uncertainty in supply and low degrees of uncertainty in demand are represented by hydroelectric apparatus (electrical power generating equipment, equipment for hydroelectric power stations, cables and connections and mining equipment, for example) and some food segments that aggregate specific raw materials. Goods with a high degree of uncertainty in demand and a high degree of uncertainty in supply are represented by telecommunications products, high-end computers and semi-conductors. These products have sources of even scarcer supply and that are sometimes monopolized by a handful of companies. From the point of view of demand, telecommunications products, largely represented by mobile telephony, have a short life cycle, high competitiveness and a high degree of uncertainty regarding the consumer desire to buy. Agility in the management of this supply chain is vital to the survival of the product´s manufacture. Any economic agglomeration (cluster, industrial district, technopolis) that wishes to include companies classified in the lower quadrants of the Uncertainty Model, needs to consider agility as one of its pillars of development. The strategies for the uncertainty models are classified according to four types: (1) Efficient Supply Chains, (2) Supply Chains with risk coverage, (3) Sensitive Supply Chains and (4) Agile Supply Chains. Fig 2Presents a summary of the supply chain classifications:

		Low (Functional Products)	High(Innovative Products)
Uncertainty of Supply	Low (Stable Process)	Efficient Supply Chains	Sensitive Supply Chains
	High (Development Process)	Supply Chains with Risk Coverage	Agile Supply Chains

Fig. 2 Supply Chain Strategies. *Source: Aligning Supply Chain Strategies with Product Uncertainties: Lee, 2002

3 Supply Chain Uncertainty Model and its main variables

According to Grieger (2002), the most important variables to be analyzed for the Supply Chains in the SCUMs are: a) Fast Product Life Cycle; b) Just in Time Production; c) Cost leadership; and d) Global Competition. The matrix for the uncertainty model classifies the products as being innovative or traditional. The object of this study is the innovative products), which are those with a short life cycle, high degree of technological innovation and fashion contents, in other words, fashion related characteristics and/or components that represent unpredictable demand. (LEE, 2002).A functional product may be represented by a color TV, for example. A traditional color TV, in other words, with a conventional image tube, does not suffer major oscillations in demand, classifying it as more predictable. An innovative product may be represented by the mobile telephone. This product has an unstable consumer market (demand), a very short life cycle (from six to eight months) and a high level of obsolescence, since it aggregates new technologies very quickly. The profit margins are high, since this product has high aggregated value, and this fact represents a high value for the inventory to be managed. Agility is understood as being the speed with which a process can be concluded. Table 1, below, demonstrates, very simply, how the variables discussed here are encountered in the different models of agglomerations between countries:

Table 1 Variables for the Uncertainty Model inIndustrial Agglomerations

	Brazil	Mexico	China
Cost	High	Medium	Low
Agility	Low	High	High
Obsolescence	High	High	Low

*Source: Multinational mobile telephony companies present in Brazil, Mexico and China. Drawn up by the authors.

Based on the behavior of the variables exposed above, it is possible to understand why Brazil has been facing difficulties in managing the Uncertainty Chain, in comparison with its global competitors, for example.

The high level of obsolescence among these companies in Brazil is largely justified by the low agility in responding to this logistic chain, either to receive (import) raw materials, or re-export those raw materials unused in the productive process, which explains the high cost involved in a slow and overly bureaucratic supply chain.

5 Methodology

With regard to the purposes, this survey was explanatory and applied, because it aimed not only to clear up the factors involved, but also to contribute to the making of decisions and propose concrete solutions to concrete and immediate problems. The universe for study refers to the group directly involved in the formulation of the problem, the companies in the Manaus Industrial Center (MIC). All of the variables involved in the process for defining a consigned stock model for the MIC were an integral part of this universe: a) reduction of inventory cost; b) agility in the processes for importing raw materials and exporting finished goods, c) reduction in international transit time, agility in attending to the uncertainty models and d) identification of the different logistics strategies for the companies installed in the MIC so as to categorize this model of agglomerations. The sample of the companies surveyed used the parameters of their participation in the global indicators for the MIC in terms of revenues, exports, imports and direct jobs and by their classification according to the categories of the SCUM, these being stable processes and innovative processes in the supply chains for functional and innovative products. The data was collected via: a) Bibliographical research in books; b) Interviews with the people involved in the supply chain management processes; c) Direct analysis of real times, based on the measuring of processes involved in the logistics management chain. Analysis of the data included: a) tabulation of the real times obtained in the companies analyzed, especially those working with Telecommunications based on the need for adapting the MICS and in such a way that this data could be compared with that for the other companies; b) Comparison between the times obtained within the companies analyzed and the concept described in the supply chain management strategies, available in the literature analyzed, in such a way as to demonstrate whether the practice is in accordance with the concepts; c) Adaptation of the models suggested by the literature, and also by the governing legislation in Brazil, to the supply chain management models existing in the companies studied, in the aim of seeing the improvements based on the development models available and approved by the Brazilian regulatory agencies. The results obtained here, therefore, are restricted to the industrial units with extreme uncertainty regarding their supply chains, following the guidance of Brazilian customs legislation, and improving the processes already identified as being promising by the case study for the Brazilian customs authorities: The Manaus Industrial Center (MIC).

6 Case Study: The Manaus Industrial Center (MIC)

The Manaus Industrial Center (MIC) is the result of the Model Free Trade Zone of Manaus (ZFM), created by the Federal Government and made effective in 1967, with a geopolitical focus based on fiscal incentives for production, and supervising three sectors: Industrial, Commercial and Farming, based on the reduction of the logistical disadvantages inherent to the Western Amazonian region. Its tax benefits (IPI industrialized products tax, Import Tax and the ICMS goods and services tax) extend, according to different regimes, to the States of Amazonas, Acre, Roraima, Rondônia and the Free Trade Zones of Macapá and Santana, in the State of Amapá. This model, administered by the Superintendence of the Manaus Free Trade Zone (SUFRAMA) for the last 40 years, attracted more than 450 industries to the MIC, many of which are internationally known brands which jointly represent around US$ 4.0 billion in accumulated fixed investments to date, and cover a number of sub-sectors, the foremost of which are electro-electronics, information technology, two wheeled vehicles (bicycles and motorcycles), chemistry, thermoplastics and watch making. The recent performance of the MIC:

Table 2 Recent performance indicators for the Manaus Industrial Center (MIC)

	INDICATOR	PERFORMANCE IN 2007
1.	GLOBAL REVENUES OF THE COMPANIES	US$ 11.5 billion
2.	DIRECT JOBS GENERATED	115 thousand jobs
3.	ESTIMATE INDIRECT JOBS	510 thousand jobs
4.	EXPORTS	US$ 0.855 million
5.	TOTAL TAX GENERATED	US$ 2.8 billion
6.	COMPANIES CERTIFIED VIA ISO 9000	251

* SUFRAMA / Drawn up by the authors

Table 3, presents a real example of the absolute costs involved in the management of a logistic chain for Mobile Telephony in the MIC, with similar models of strategic management in Brazil, Mexico and China. The amounts presented are a proportional average designed to guarantee the secrecy of the sources involved.

Table 3 Costs of Managing the Logistics Chain for an Uncertainty Model

Annual Costs for Infrastructure (millions of dollars)			
	Brazil	Mexico	China
Storage/Handling	6.99	0.84	3.57
Building infrastructure	0.21	0.31	-
Personnel	0.19	-	-
Insurance	0.75	1.05	1.50
Provider Management Logistics	2.85	4.54	1.89
Total	10.99	6.74	6.96

* Multinational mobile telephony companies. Drawn up by the authors

This represents, therefore, the obtaining of costs relating to the same operation in different countries and under different conditions of legislation and procedures.

Figure 3 demonstrates the times involved in management of one of the supply chains included in the uncertainty model, present in the MIC. The supply chain in question uses the consigned stock model, which means that, according to current Brazilian legislation, in the use of a dry port, such as a customs warehouse, for storing the imported raw material before starting the process to nationalize the imported components. The stock model has been widely used by the supply chains in the uncertainty model, because it substantially reduces inventory costs. Given the characteristic of the products involved (high technological aggregation), the inventories represent a major point of concern for this type of management.

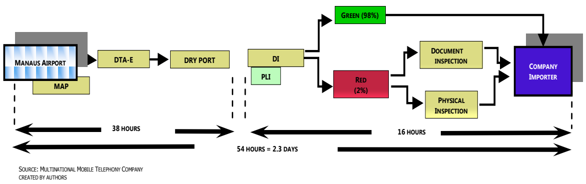


Fig. 3 Flow of supply chain managements with consigned stock in the MIC

Implantation of the Consigned Stock Model in the Manaus Industrial Center complied with the following directives: a) Bonded Warehouse under the EIZOF regime (International Bonded Warehouse for the Manaus Free Trade Zone): the consigned stock model stipulates that merchandize is remain in the country in a secondary zone, under the EIZOF regime and under the responsibility of the Federal Tax Office, available to the consigning company for a maximum period of five years, with suspension of taxes. The material remains in the country as property of the supplier, and therefore, with the issue foreign currency suspended by the Brazilian Central Bank; b) Agile customs clearance process: the complete clearance of an import process in the MIC, must comply with four independent inspection agencies: The Federal Tax Department, the Superintendence for the Free Trade Zone of Manaus (SUFRAMA), the Ministry of Agriculture (MA) and the State Treasury Department (SEFAZ). Inspection time for each one of these agencies takes several hours, and all of them together often represent a slow process from the point of view of the company; and c) The process of agile movement and storage: the process of bonded warehouse management, in other words, the process of storage and movement needs to be agile to meet the needs of agility for the manufacturing processes within the environment of uncertainty. Transportation from the warehouse to the productive unit, for example, needs to be very fast to avoid undermining the raw material supply process.

Reconciling the current customs legislation with the process for making procedures more agile has been the greatest difficulty faced in effectively implementing this Consigned Stock Model in the MIC. While the agile management model predicts just a few hours for the unloading of international merchandize, the MIC works with a number of working days for the complete transportation and unloading of imported merchandize, if it uses the consigned stock model.

7 Conclusions and Recommendations

The difficulty in supply chain management for the representatives in the Uncertainty Model was the reason for this article, which sought to identify what possible improvements could be made to achieve the agility required for the good performance of this industrial model, along with discussion of the best possible factors of attractiveness for the Uncertainty Model.

In this sense, air transport is a fundamental pre-requisite for attending the supply chains in the uncertainty model. For this, it needs to have an improved infrastructure and guarantee the agility and attractiveness of this model of high aggregated technology also in the Manaus Industrial Center (MIC).

With the MIC being one of the foremost export centers in Brazil, there is a need to improve the services and infrastructure for air transport as a fundamental support for developing high technology production and, consequently, products on the cutting edge of technology, which could contribute greatly to the level of Brazilian exports, given their high aggregated value.

8 References

FIGUEIREDO (2003), Kleber F., et al. Logística e Gerenciamento da Cadeia de Suprimentos. São Paulo: Atlas.

FLEURY (2000), Paulo Fernando et al. Logística Empresarial: uma perspectiva brasileira. São Paulo: Atlas.

GRIEGER (2000), Martin. In: Electronic Marketplaces: a literature review and a call for supply chain management research. European Journal of Research.

LEE, L. Hau. (2002) In: Aligning Supply Chain Strategies with Product uncertainties. California Management Review, vol.44. nr.3.

SEGeT (2007), Simpósio de Excelência em Gestão e Tecnologia

314 Internet de las cosas en el ámbito de la Logística Inversa

Internet of things in the field of Reverse Logistics

Cortés P, Boza A, Alarcón F, Cuenca L

Pascual Cortés Pellicer (✉ e-mail: pascorpe@omp.upv.es)
Dpto. de Organización de Empresas. Universitat Politècnica de València, Camí de Vera S/N, 46022 Valencia.

Andrés Boza García (✉ e-mail: aboza@cigip.upv.es)
Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). Universitat Politècnica de València, Camí de Vera S/N, 46022 Valencia.

Faustino Alarcón Valero (✉ e-mail: faualva@omp.upv.es)
Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). Universitat Politècnica de València, Camí de Vera S/N, 46022 Valencia.

Llanos Cuenca González (✉ e-mail: llcuenca@cigip.upv.es)
Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). Universitat Politècnica de València, Camí de Vera S/N, 46022 Valencia.

Abstract: The concept of Internet of Things (IoT) refers to a network of everyday objects connected through internet. This new concept is producing significant changes in the use that is given to certain everyday objects and is having a significant impact on the activities performed in organizations. So, something can be a generator of information, being more immediately available at the occurrence of events. This can be exploited by businesses for faster and better performance of your business and its environment. IoT may be, therefore, a tool of special relevance in Reverse Supply Chain scenarios, which is essential to quickly know the event that triggers the recovery of proceeds to initiate and coordinate its inverse flux. The aim of this paper is to analyze the usefulness of IoT in a context of Reverse Supply Chain.

Resumen: El concepto de Internet de las cosas (Internet of Things – IoT) hace alusión a una red de objetos cotidianos conectados mediante internet. Este nuevo concepto está produciendo importantes cambios en el uso que se le da a ciertos objetos cotidianos y está teniendo un impacto considerable en las actividades que se realizan en las organizaciones. Así pues, cualquier objeto puede convertirse en un generador de información, estando disponible con mayor inmediatez a la ocurrencia de eventos. Esto puede ser aprovechado por las empresas para conocer más rápidamente y mejor el funcionamiento de su negocio y su entorno. IoT podrá ser, por lo tanto, una herramienta de especial relevancia en escenarios de Cadenas de Suministro Inversas, en la que es fundamental conocer rápidamente el evento que activa la recuperación del producto para iniciar y coordinar su flujo inverso. El objetivo del presente artículo es analizar la utilidad de IoT en un contexto de Cadenas de Suministro Inversas.

Keywords: Reverse Supply Chain, Internet of Things (IoT), RFID, Reverse Logistic, Green Manufacturing.

Palabras Clave: Cadena de Suministro Inversa, Internet de las Cosas (IoT), RFID, Logística Inversa, Fabricación verde.

1 Introducción

Debido al alarmante incremento en el abuso de los recursos naturales y la escasez de reposición de estos hacía la que nos dirigimos, se han causado muchos problemas medioambientales que han dado lugar a varias regulaciones gubernamentales que mantienen a los fabricantes responsables de sus productos una vez lleguen al final de su uso. Es por ello que las empresas están tratando de reutilizar, volver a fabricar y reciclar sus productos con el fin de reducir el impacto negativo sobre el medio ambiente.

El concepto de Cadena de Suministro Inversa (CdSI) se entiende como el opuesto a la cadena de suministro hacia delante, ya que representa todas las actividades necesarias para tratar los productos entregados, de vuelta, por parte de los clientes**.** Además, se necesita un sistema de procesamiento de la información avanzada y eficaz para gestionar las entidades del sistema, los procesos de logística y sistemas de inventario.

En este sentido, hay que tener en cuenta el imparable avance de las Tecnologías de la Información y la Comunicación, gracias al cual se abre un amplio abanico de posibilidades para mejorar el funcionamiento de los negocios. En este marco de las Tecnologías de la Información y la Comunicación es digno de mención el concepto de Internet de las Cosas (IoT) por las posibilidades que está ofreciendo ya y puede llegar a ofrecer en los próximos años a las empresas en general, y a CdSI en particular. Por ello, hemos creído conveniente analizar los artículos referentes a la aplicación de IoT sobre la Logística Inversa y así extrapolar las principales utilidades que se le puede dar.

A continuación, en el apartado 2, se revisa el concepto de IoT para entender mejor todo su alcance e identificar las tecnologías que lo sustentan y sus posibles aplicaciones en el ámbito de la LI. Después se revisa el concepto de LI, así como las principales utilidades encontradas referentes a la aplicación de la tecnología

RFID en el campo de la logística inversa. Finalizaremos el artículo destacando las principales conclusiones extraídas al respecto e indicando las posibles líneas futuras de investigación a realizar.

2 Internet de las Cosas

El concepto revolucionario de Internet de las Cosas (IoT) se fundamenta en aportar información en tiempo real a través de conexiones inalámbricas entre objetos (Qiaolun, Tiegang 2011).

Internet de las Cosas (IoT) es un Internet global emergente que se basa en la arquitectura de la información facilitando el intercambio de bienes y servicios en las redes globales de la cadena de suministro. Desde un punto de vista técnico, la arquitectura se basa en las herramientas de comunicación de datos, principalmente de artículos con etiquetas RFID (Radio-Frequency Identification). La IoT tiene el propósito de proporcionar una infraestructura de TI que facilita los intercambios de información entre “cosas" de una manera segura y confiable, las cuales están teniendo aplicaciones industriales que nos permiten estrechar la distancia entre los sistemas de información empresariales (ERP – Enterprise Information Systems) y la situación real de la organización, a través de la aportación de información más precisa de la misma (Boza et al. 2014 A).

La tecnología de identificación por RFID ha sido ampliamente adoptada en la gestión de la cadena de suministro para un mejor seguimiento y rastreo del movimiento del producto. Esta tecnología de identificación automática y captura de datos se compone de tres elementos: una etiqueta formada por un chip conectado con una antena, un lector que emite señales de radio y recibe las respuestas de las etiquetas, y finalmente un middleware que comunica el hardware RFID con aplicaciones empresariales (Sarac, Absi & Dauzère-Pérès 2010).

Las etiquetas adheridas a los objetos físicos tales como productos, cajas o contenedores de transporte, proporcionan información de estos objetos físicos que pueden ser utilizadas por los sistemas de información para una mejor gestión de los mismos. Dicha tecnología permite el seguimiento preciso y monitoreo en tiempo real de cada artículo etiquetado con el mínimo esfuerzo, proporcionando una comunicación en tiempo real con numerosos objetos al mismo tiempo, a distancia, sin contacto ni línea de visión directa (Trappey et al 2010). Fundamentalmente, nos ofrece una trazabilidad completa de los productos desde los puntos de recogida hasta los puntos de tratamiento.

La tecnología RFID no es una tecnología nueva, pero sí recientemente es cuando ha cogido mayor protagonismo, gracias sobretodo a los avances tecnológicos y a la reducción de costes de fabricación de los componentes electrónicos.

3 Logística inversa

De acuerdo con Guide Jr, V Daniel R, Van Wassenhove (2002), una cadena de suministro inversa es una serie de actividades necesarias para recuperar los productos usados de los clientes y reutilizarlos, reciclarlos o desecharlos. La gestión de la cadena de suministro se define como el campo que estudia la forma de gestionar esas actividades de manera eficaz y eficiente.

Los procesos logísticos inversos ayudan a las empresas a cumplir con su responsabilidad social y a mejorar su reputación por ofrecer una salida más respetuosa para los productos y componentes, ya sea para su reparación, reutilización o su correcta eliminación. En general, las empresas crean CDSI, ya sea debido a las regulaciones ambientales o para reducir sus costos de operación mediante la reutilización de los productos o componentes (Gu, Liu 2013).

Las CdS's modernas que incluyen la reparación, reciclaje y eliminación responsable de residuos deben adaptarse a los flujos bidireccionales, mediante los cuales se revierten los flujos logísticos tradicionales (Trappey, Trappey & Wu 2010). En este sentido, para gestionar la CdSI de manera eficiente, el diseño de las redes es un tema crítico. El problema de diseño de la red consiste en determinar el número y ubicación de las instalaciones y el establecimiento de los flujos de materiales entre las instalaciones (Alumur et al. 2012).

Una CdSI puede ser, bien un sistema de circuito cerrado, o bien un sistema de bucle abierto. En una CDSI de bucle cerrado, productos o materiales a menudo son devueltos a los productores originales. Sin embargo, en una CDSI de bucle abierto, los productos no se devuelven a los productores originales, puesto que son recuperados por empresas. Para Gou et al. (2008) varios estudios abordan la problemática de la recuperación de productos para una CdS, analizando si deben utilizarse los centros de distribución propios o utilizar centros devoluciones centralizados externos. Cuando se utilizan centros de distribución propios, los servicios de distribución inversa se combinan con los de la logística hacia delante (lazo cerrado), mientras que para el caso de centros de devoluciones centralizados externos, a menudo son independientes (lazo abierto).

Las actividades basadas en las cadenas de suministro inversa se están convirtiendo en esenciales para un número creciente de empresas, según Guide Jr, V Daniel R, Van Wassenhove (2002), y hay cada vez más incentivos para apoyar a las empresas que emplean una CdSI.

Debido a las incertidumbres en el tiempo de la devolución, la cantidad y calidad de los productos utilizados, las gestión de la Cadena de Suministro de R/M (Remanufacturing & manufacturing) se vuelve muy compleja. Así pues, el capturar cuanto antes información que proporcione algo de certidumbre sobre la complejidad indicada, es un elemento fundamental para mejorar la gestión de la CdSI. En este sentido, nuevas tecnologías que faciliten la captura de dicha información pueden proporcionar grandes ventajas competitivas y permiten la creación de nuevas herramientas para la monitorización y gestión de las incidencias que pueden aparecer (Boza et al, 2014 B).

4 IoT en el ámbito de la Logística Inversa

En la CdSI, la cantidad de productos utilizados recogidos es el factor crucial de funcionamiento de la misma, siendo mayoritariamente incierto. Esta incertidumbre es el principal inconveniente que dificulta la gestión en la LI, afectando básicamente a los inventarios, al nivel de servicio y a los beneficios de los miembros de la CdSI.

La fuente de esta incertidumbre es la ausencia de una adecuada planificación que ha hecho que sea difícil de estandarizar las actividades dentro de la LI (Fleischmann et al. 1997). El uso de la tecnología RFID pretende reducir parte de la incertidumbre, tratando de aportar tres grandes beneficios a la gestión de la CDSI: **automatización de operaciones, seguimiento en bucle cerrado y mayor visibilidad conjunta de la Cadena de Suministro.**

Existen diferentes tipos de incertidumbre que afectan a la Logística Inversa, sobre las que la tecnología RFID les aporta una serie de utilidades: Cantidad, control de inventarios y planificación, variedad, calidad, tiempo de ciclo y tendencia del mercado (Asif 2011).

El principal motivo por el que la tecnología RFID no se encuentre globalmente implantada es su coste, puesto que las etiquetas RFID siguen siendo mucho más caras que las etiquetas impresas Con respecto a la logística, la tecnología RFID se implanta sobretodo en el control de inventario, así como en la gestión de los elementos de transporte, siendo solo una cuestión de tiempo, antes de que los costos de los componentes caigan lo suficiente, para convertirla en una propuesta tecnológica atractiva y económica para su uso generalizado (Want 2006).

En el caso en el que el producto en cuestión sea de un coste relativamente bajo, como por ejemplo los alimentos, se hace muy difícil pensar en su aplicación tecnológica basada en RFID. En cambio, productos de elevado coste en los que nos interesa llevar un control exhaustivo de su uso, como por ejemplo prótesis médicas, el uso de la tecnología RFID comienza a ser una realidad cada vez más generalizada.

Cuando aplicamos la tecnología IOT a la CdSI, básicamente podemos obtener las siguientes mejoras: (Qiao-lun, Tie-gang 2011)

- Información en Tiempo Real
- Facilitar la gestión del Ciclo de Vida del Producto.

La aplicación de la IoT sobre la Logística Inversa se caracteriza por aportar información en tiempo real a todas las partes interesadas, ayudando así a prever el mercado, optimizar rutas de distribución, tomar las decisiones respecto a precios, controlar los inventarios y seguir los productos. También IoT facilita el flujo de información relativa a un producto a través de la CdS. Gracias a IoT tendríamos mayor conocimiento de todo lo relativo al ciclo de vida del producto.

La principal utilidad que aporta IoT a la LI se centra en la reducción de incertidumbre, así cabe destacar como puede ser utilizada según las diferentes estructuras de la Cadena de Suministro Inversa.

Para el caso de una CdSI de lazo cerrado, la aportación principal que nos puede hacer el uso de la tecnología RFID, se centra en el control y seguimiento de la mercancía, proporcionando reducción de inventario, así como ayuda a la planificación de la producción, sobretodo en el caso de que la entrada del producto sea por una devolución del cliente y que el estado del mismo sea bueno como para poder volver a introducirlo en el mercado.

Para aquellos casos en los que el producto de entrada no se encuentre en buen estado, el control de las mermas de la mercancía nos facilita su recolección y posterior tratamiento al poder ser recogido por las mismas unidades repartidoras, pudiendo ser entregado en algún punto intermedio o a su punto de venta. Con esto, aumentamos notablemente la rentabilidad del negocio y el transporte.

Por lo tanto, el principal objetivo que perseguimos a la hora de implantar este tipo de tecnologías en una CdS cerrada, se centra en gestionar de manera íntegra toda la información referente a todos los productos y servicios de la compañía.

Si contamos con una CdSI de lazo abierto, el disponer de la tecnología RFID nos permite anticiparnos en la previsión de la demanda y reducir la incertidumbre acerca de la planificación del inventario, aunque sea más difícil de gestionar por la seguridad de los datos generados y la gestión de los derechos de la misma.

Para los colectores de residuos, un sistema basado en RFID les permite recoger con facilidad y exactitud una gran cantidad de información (identificación de contenedores, fechas de recogida, peso, rutas y trazabilidad del producto…) toda ella necesaria para realizar su trabajo de manera óptima.

Basándonos en la tecnología RFID, podemos desarrollar sistemas de recogida de “residuos” que nos permita conocer la trazabilidad real del residuo, evitando así errores derivados de manipulación de datos por parte de los usuarios que puedan dañar nuestra imagen o reputación.

El hecho de disponer de toda la información relativa al ciclo de vida del producto, nos permite hacer predicciones más precisas sobre los datos de flujo de retorno, y por lo tanto aumentar la iniciativa de gestión de la logística y mejorar el nivel de gestión de cada producto. Pero esta tecnología también cuenta con limitaciones. Gu y Liu (2013) apuntan cuatro limitaciones principales:

- Restricciones de gestión. Desconfianza de la información proporcionada.
- Restricciones económicas. Coste de implantar estas tecnologías
- Restricciones TI y Hardware. Acceso a la tecnología necesaria.
- Restricciones en cuanto a seguridad de datos y gestión de los derechos

5 Conclusiones

Aunque tradicionalmente las CdS's siempre se han mostrado sin procesos de retorno, como estructuras lineales desde los primeros proveedores hasta los clientes finales, debemos adoptar plena conciencia sobre la importancia de entender y sobretodo gestionar el posible flujo inverso tanto de productos como de información que proviene desde los clientes finales.

El hecho de disponer de herramientas tecnológicas que nos aporten mayor y mejor información sobre el ciclo de vida del producto en tiempo real, favorece el manejo de todo el flujo de información y materiales. Al facilitar la recogida de datos durante el uso del producto, estos sensores integrados ayudan a predecir los fallos del producto y estimar la vida útil restante de los componentes, antes de que lleguen al fin de su vida. La determinación inmediata de la vida útil restante permite tomar decisiones óptimas de recuperación para garantizar un nivel mínimo de calidad en los productos de recuperación al tiempo que satisface diversos criterios del sistema.

Si nuestro propósito es el retorno al cliente (por reparación), el hecho de contar con una mayor y mejor información sobre el ciclo de vida del producto, nos permite garantizar una fecha de entrega más exacta. Si la salida que le pretendemos dar al producto se basa en el remanufacturing o reciclado, nos permite tener toda la información a lo largo de toda la vida útil del producto, mostrándonos información clave sobre la eficiencia de la producción y de sus distintos componentes. El simple hecho de utilizar RFID en los productos, mejora el control y seguimiento de los flujos de LI conociendo su perfecta trazabilidad, disponiendo de información en tiempo real, permitiéndonos así mejorar el control de los procesos con proveedores, para una mejora continua y dar un mejor servicio al cliente. El IoT, nos aporta mayor información sobre el estado del producto, por lo que nos facilita la elección de la salida o uso próximo para el producto, tratando de obtener el máximo provecho del mismo.

6 Agradecimientos

Esta investigación se ha llevado a cabo en el marco del proyecto financiado por el Ministerio Español de Economía y Competitividad (Ref. DPI2011-23597) y el proyecto ADENPRO-PJP (SP20120703 ref.), financiado por la Vicerrectorat d'Investigació de la Universitat Politècnica de València

7 Referencias

Alumur, S.A., Nickel, S., Saldanha-Da-Gama, F. & Verter, V. 2012, "Multi-period reverse logistics network design", European Journal of Operational Research, vol. 220, no. 1, pp. 67-78.

Asif, R. 2011, "Reverse Logistics: RFID the key to optimality", Journal of Industrial Engineering and Management, vol. 4, no. 2, pp. 281-300.

Boza, A., Cuenca, L., Poler, R. & Michaelides, Z. (2014 A), "The interoperability force in the ERP field", Enterprise Information Systems, , no. ahead-of-print, pp. 1-22.

Boza A, Alemany MME, Vicens E, Cuenca L (2014 B) Event Management in Decision-Making processes with Decision Support Systems. Paper accepted for ICCCC2014

Fleischmann, M., Bloemhof-Ruwaard, J.M., Dekker, R., van der Laan, E., van Nunen, J.A.E.E. & Van Wassenhove, L.N. 1997, "Quantitative models for reverse logistics: A review", European Journal of Operational Research, vol. 103, no. 1, pp. 1-17.

Gou, Q., Liang, L., Huang, Z. & Xu, C. 2008, "A joint inventory model for an open-loop reverse supply chain", International Journal of Production Economics, vol. 116, no. 1, pp. 28-42.

Gu, Y. & Liu, Q. 2013, "Research on the application of the internet of things in reverse logistics information management", Journal of Industrial Engineering and Management, vol. 6, no. 4, pp. 963-973.

Guide Jr, V Daniel R & Van Wassenhove, L.N. 2002, "The reverse supply chain", Harvard business review, vol. 80, no. 2, pp. 25-26.

Qiaolun, G. & Tiegang, G. 2011, "Impacts of RFID/EPC on Optimal Decisions of Reverse Supply Chain", Business Computing and Global Informatization (BCGIN), 2011 International Conference onIEEE, , pp. 512.

Qiao-lun, G. & Tie-gang, G. 2011, "System dynamics analysis of RFID-EPC's impact on reverse supply chain", Management Science and Engineering (ICMSE), 2011 International Conference onIEEE, , pp. 250.

Sarac, A., Absi, N. & Dauzère-Pérès, S. 2010, "A literature review on the impact of RFID technologies on supply chain management", International Journal of Production Economics, vol. 128, no. 1, pp. 77-95.

Trappey, A.J., Trappey, C.V. & Wu, C. 2010, "Genetic algorithm dynamic performance evaluation for RFID reverse logistic management", Expert Systems with Applications, vol. 37, no. 11, pp. 7329-7335.

Want, R. 2006, "An introduction to RFID technology", Pervasive Computing, IEEE, vol. 5, no. 1, pp. 25-33.

317 Cointegration and Asymmetry between Gasoline and Crude Oil Prices

Salles, A

Andre Salles (✉ e-mail: as@ufrj.br)
Industrial Engineering Department. Polytechnic School. Federal University of Rio de Janeiro. Centro de Tecnologia, bloco F - sala F101, Cidade Universitária, Ilha do Fundão, Riode Janeiro, Brazil.

Abstract: The objective of this work is to study the gasoline prices evolution and its relationship between crude oil prices in the international market through cointegration tests and by asymmetric models, specifically stochastic models with heteroskedasticity and error correction mechanisms when it is mandatory. To achieve the purpose of this work, the gasoline prices were collected in Brazil, the USA and in a selected sample of six European countries namely Belgium, France, Germany, Italy, the Netherlands and the United Kingdom markets. All results are compared among the markets selected to observe country similarities. All prices information collected were converted into U.S. dollars per liter. The data covers the period from June 2006 to April 2013.

Keywords: Cointegration; Asymmetry; Gasoline Price; Oil Price.

1 Introduction

The evolution and association of crude oil and its byproduct prices are important for firms and economic policy makers. Therefore the studies of the relationship between gasoline and crude oil prices should allow to obtain fair gasoline prices in a particular market once petroleum product prices differ among regions and countries. This difference among oil product prices, in particular gasoline prices, occurs for three possible reasons: (i) production or prospection costs and oil transportation to refineries are different; (ii) refining cost or margin profit of byproducts production varies; and (iii) fees and taxes differ among regions or countries.

Several studies have been developed in recent years in national markets to verify: the cointegration between crude oil and gasoline prices; crude oil predictive power to estimate gasoline prices; the crack spread or profit margin determination that differs among markets; and the relationship between gasoline and oil prices as they occur in each market, highlighting the asymmetry amongst these prices or returns. Among studies that verify the asymmetry this hypothesis was sometimes rejected. In a pioneer work Bacon (1991) studies the rockets and feathers effect in the United Kingdom gasoline market from 1982 to 1989, finding evidence that the response to positive changes in crude oil prices fluctuations on gasoline prices occur more rapidly than negative variations. The same evidence was presented by Karrenbock (1991) and Borenstein et al. (1997) in the North American market. Brown and Yücel (2000) observe the same asymmetric effect in the U.S. market. On the other hand Galeoti et al. (2003) revisit the rockets and feathers effect pointed out by Bacon (1991) and did not find similarities among asymmetric effects shown by Bacon (1991). The study developed by Galeoti et al. (2003) used monthly data from 1985 to 2000 for the European gasoline markets namely: Germany, France, the United Kingdom, Italy and Spain. This work differs from other studies. It must be highlighted that Radchenko (2005) work that studies the effect of crude oil prices volatility on the asymmetry degree in the gasoline prices response. In this study Radchenko (2005) used several time series models to indicate an evidence of asymmetry degree in gasoline prices that decreases when crude oil prices volatility increases. In another relevant work Honovar (2009) used cointegration techniques and error correction models, suggested by Granger and Yoon's (2002), to study the gasoline price behavior using monthly data from 1981 to 2007. Among other inferences, Honovar (2009) indicates that the gasoline price behavior presents an asymmetry related with the crude oil prices variations. Liu et al. (2010) used asymmetric error correction models to examine how the gasoline and diesel prices were affected by crude oil price variations The data used for this work was petroleum weekly data from 2004 to 2009 in New Zealand. Unlike results obtained with diesel Liu et al. (2010) found no evidence of asymmetry in gasoline prices. Valadkhani (2010) studied gasoline prices traded on the Australian market and demonstrated evidence of the existence of asymmetry reported by Bacon (1991) in four Australian cities. In another study Valadkhani (2013) studied gasoline prices negotiated in the Australian market, with data from 2007 to 2012. In this other study Valadkhani (2013) accepted the hypothesis of asymmetric effect shown by Bacon (1991) in 28 locations and the existence of an opposite effect contrary to that obtained by Bacon (1991) in 31 Australian locations.

The objective of this work is to study the gasoline prices evolution and their relationship between crude oil prices in the international market through cointegration test and asymmetric regression models. This work specifically uses asymmetric models with heteroskedasticity and error correction mechanisms when mandatory. To achieve the purpose of this work, gasoline prices were collected in Brazil, the USA and a selected sample of six European countries namely Belgium, France, Germany, Italy, the Netherlands and the United Kingdom markets. All results are compared among the selected markets to observe country similarities.

This work is structured as follows. Next section presents the sample used in this work. The methodological approach is explained in Section 3 while the results obtained are presented in Section 4. Finally Section 5 shows the final remarks of this work.

2 The Data Used

To reach the objectives of this study crude oil such as Brent type traded in the international market and gasoline weekly prices time series were collected from selected country markets. Primary data were obtained in the Brazilian Oil and Gas Government Agency (ANP) and the Energy Information Administration (EIA), official statistics energy agency from the US government. All price information collected were converted into U.S. dollars per liter. The data covers the period from June 2006 to April 2013. This information adds up to time series with 358 observations.

The Jarque-Bera (JB) and the Augmented Dickey Fuller (ADF) tests were used to verify respectively the normality and stationarity hypothesis of the time series studied. Regarding the statistical summary of the gasoline price time series used in this work it was observed that the averages and medians present small differences. Considering the means obtained the lowest average price among gasoline price time series in the studied period occurs in Brazil followed by the US and the biggest price occurs in Italy followed by the Netherlands. The standard deviations were between 0.0889 and 0.2575 which shows that the Brazilian market presents the lowest price variability while the United Kingdom presents the biggest. It must be highlighted that in the Brazilian and American markets the gasoline price variability was smaller than the other markets studied. In these other markets the variability presents similarities in general. All skewness coefficients differ from the normal distribution coefficient. Other than Italy and the Netherlands all skewness coefficients were negative. Apart from the United Kingdom the kurtosis coefficients of all gasoline price time series were around two, which indicates a lower kurtosis than the normal distribution. This way the values obtained for skewness and kurtosis coefficients differ from the normal distribution values. Moreover the Jarque-Bera test demonstrates that the normality assumption of all returns time series analyzed could not be accepted once the p value of this test was close to zero. The unit root test, ADF test, showed a negative t statistic but with small values for every gasoline price time series analyzed. Hence all returns time series studied here could not be considered stationarity as shown by p-values, excluding the Netherlands whose the stationarity hypothesis could be accepted in a significance level near 5%. Brent type crude oil prices average in US $ per liter in the studied period was close to 0.56 for the Brent. The skewness and kurtosis coefficients obtained from the crude oil prices time series differs from the normal distribution coefficients which highlights that the crude oil price distribution differ from the normal distribution which is confirmed by the Jarque-Bera test.

Besides crude oil and gasoline prices, the returns of these prices were used in this work for asymmetric models implementation. This way the price return time series were calculated from the weekly prices presented above using the following formula:

$$R_t = Ln\left(\frac{P_t}{P_{t-1}}\right),$$

where R_t represents the return in the period t and P_t represents the price in period t.

The lowest price return among gasoline price return time series in the studied period occurs in Brazil followed by the US while the biggest price occurs in Italy followed by the Netherlands. The standard deviations were between 0.0187 and 0.0260 which shows that the Italian market presents the lowest price return variability while Belgium presents the biggest. It must be highlighted that in Italy, the United Kingdom and France gasoline price return variability was smaller than the other markets studied. In other markets the variability presents similarities in general. All skewness coefficients differ from the normal distribution coefficient. All skewness coefficients were negative while all gasoline price return time series indicate kurtosis higher than the normal distribution. This way the values obtained for skewness and kurtosis coefficients differ from the normal distribution values. Moreover the Jarque-Bera test demonstrates that the normality assumption of all returns time series analyzed could not be accepted once the p value of this test was close to zero. The unit root test ADF showed a negative *t* statistic with high values for every price time series analyzed. Hence all returns time series studied here could be considered stationarity as shown by p-values that the stationarity hypothesis could be accepted in a significance level lower than 1%.

3 The Methodological Approach

In order to investigate the asymmetric relationship between crude oil price returns or variation and the gasoline price variation of selected countries their cointegration was first tested. Therefore the cointegration among all the gasoline price time series and crude oil price time series were tested. Brent crude oil prices were used in this work. Two variables are cointegrated if their linear combination is stationarity, and as a consequence there is a long term relationship between these variables. There are some alternatives to cointegration tests between two variables and in order to do so the Engle-Granger test which was presented in Engle and Granger (1987) was used in this work. The cointegration had relevant implications. If the variables involved are cointegrated it is possible to search for a model to explain or forecast one of these variables using the other as a regressor. Besides that, the knowledge of variables cointegration allows for the behavior study of these variables using an error correction mechanism in stochastic models. In other words, if the cointegration between two variables hypothesis can be accepted, the introduction of an error correction mechanism will be crucial for the estimation of a stochastic model.

To achieve the main objective of this work, stochastic models for gasoline price returns were used having two variables: the crude oil prices positive and negative returns. These models demonstrated below take into consideration the time series problems: the no normality observed in the weekly time series of returns that present heavier tails than the normal distribution; and the heteroskedasticity of returns time series. The t of Student distribution was chosen as an alternative to the normal distribution, in other words to accommodate abnormal observations. The t distribution has been widely used as a methodological approach which uses daily and weekly returns of financial assets due to the attractiveness presented in the form variations given by the degree of freedom numbers. To estimate the variance several Autoregressive Conditional Heteroskedasticity (ARCH) family models are proposed. In this work, besides the ARCH model, first proposed by Engle (1982), the following models were tested: the GARCH model, a straightforward generalization of the ARCH process which also takes into account past lags of the conditional variance, first proposed by Bollerslev (1986); Exponential GARCH, proposed by Nelson (1991), which considers asymmetric shocks in the price returns; and IGARCH, proposed by Engle and Bollerslev (1986), a particular case of the GARCH model that is quite similar to the exponentially weighted moving average (EWMA) model. The following stochastic model was used in this work, an asymmetric model with error correction mechanism:

$$
\begin{aligned}
&(R_t | I_{t-1}) \sim Student(\mu_t; \sigma_t^2; \nu) \\
&\mu_t = \beta_1 ROil_t^- + \beta_2 ROil_t^+ + \beta_3 (GP - \beta_4 BP) \\
&\sigma_t^2 = ARCH
\end{aligned}
$$

where R_t represents the gasoline price return in the period t, $Roil_t$ the negative and positive crude oil price variations while β_3 (GP_t - $\beta_3 BP_t$) is error correction mechanism, where GP_t represents the gasoline price in the period t and BP_t represents the crude oil price in the period *t*. This representation refers to the mean part of the regression but it is also important to put foward consistent processes to estimate the variance, or the volatility of the price returns.

In the next section the results obtained using this methodology are presented.

4 The Results Obtained

Table 1 covers the gasoline price of each country selected and the Brent type crude oil prices cointegration. These results were obtained using the Brent type crude oil prices as a dependent variable and an independent variable in the Engle-Granger cointegration test used here. This test null hypothesis specifies the non cointegration among selected gasoline prices and Brent type crude oil prices. Apart from the Brazilian gasoline market, as shown in Table 1, the results of the cointegration test, that is, the tau statistic and their p value, indicates that the null hypothesis cannot be rejected for all the analyzed tests. Therefore when the Brent type crude oil price or returns are regressors in models to explain the gasoline prices or returns, the error correction mechanism must be introduced in the models as suggested by these results, excluding the Brazilian gasoline prices or returns.

Table 1 Results of Cointegration Tests - Brent

Independent Variable	τ statistics	p-value	Dependent Variable	τ statistics	p-value
Brazil	-1.9856	0.5363	Brazil	-2.4680	0.2954
USA	-4.4529	0.0017	USA	-4.3151	0.0028
Belgium	-6.6949	0,0000	Belgium	-6.9236	0,0000
France	-5.2583	0.0001	France	-5.3709	0.0000
Germany	-4.6041	0.0010	Germany	-4.8726	0.0003
Italy	-4.8441	0.0004	Italy	-4.8119	0.0004
Netherlands	-4.6398	0,0008	Netherlands	-4.7812	0,0005
United Kindom	-4.2991	0,0029	United Kindom	-4.2789	0,0032

For each gasoline market one model was selected for analysis. The model selection has been done initially observing the significance of conditional heteroskedastic model, or the ARCH model used in the estimation of gasoline price return variation from each selected markets. From this stage the following criteria for model selection was taken into consideration in the following order: the Akaike criteria, the Schwarz criteria and the standard error of the model. Among the selected models where the Brent crude oil is an explanatory variable, statistically significant coefficients of the variable that represents the negative variations of crude oil prices can be observed while the coefficients of the variable that represents the positive variations of crude oil prices are not in general statistically significant as shown in Table 2. This is an indication that the asymmetry could not be rejected. Besides that the similarities were observed. Apart from Italy and the Netherlands the ECM does not present statistical significance. This way the asymmetric model was also estimated without the ECM and the results obtained indicate the same inference of Table 2.

Table 2 Results of Asymmetric Models

Country	β_1 *(p-value)*	β_2 *(p-value)*	β_3 *(p-value)*	β_4 *(p-value)*	*AIC*	*g.l.* *(p-value)*
Brazil	0229 (0.000)	0.055 (0.133)	0.0174 (0.000)	1.124 (0.000)	-5.37	5.42 (0.00)

USA	0.035 (0.000)	-0.024 (0.552)	-0.060 (0.047)	1.108 (0.000)	-5.32	5.95 (0.00)
Belgium	0.326 (0.000)	-0.028 (0.593)	2.640 (0.034)	2.993 (0.007)	-4.55	16.72 (0.11)
France	0.247 (0.000)	0.048 (0.217)	0.006 (0.102)	2.285 (0,000)	-5.13	9.00 (0.02)
Germany	0.327 (0.000)	0.0724 (0.116)	0.008 (0.039)	2.546 (0.000)	-4.66	8.42 (0.01)
Italy	0.215 (0.000)	0.103 (0.004)	0.000 (0.998)	609.64 (0.998)	-5.32	9.40 (0.04)
Netherlands	0.242 (0.000)	0.165 (0.000)	-0.000 (0.100)	3803.0 (0.999)	-5.25	8.22 (0.00)
UK	0.226 (0.000)	0.053 (0.112)	0.004 (0.100)	2.156 (0.001)	-5.46	7.06 (0.00)

5 Final Remarks

It can be stated that all objectives were achieved, as it was possible to establish coherent and consistent criteria to verify cointegration and asymmetry between each gasoline market selected and crude oil prices. It should be emphasized, though, that the results were taken for a specific time period and there may be significant differences when other data is taken into account. Besides, it is worth noting that other statistical inference methodologies may be proposed to investigate the relationship between the involved markets here studied, and the selection of the most appropriate econometric tests and asymmetric models.

The results obtained in this work allow a comparison analysis of the evolution of gasoline prices in selected countries. Thus the relevant results obtained here suggest that other work on this topic with other samples and other statistical inference methods must be done to obtain other results which will help the economic agents dealing in the petroleum products to determine a fair price and crude oil price forecasts. Thereby it is possible to obtain estimates for gasoline and other petroleum products fair prices among different regions or countries. Petroleum product and oil prices unlinked in certain periods turn the petroleum byproduct fair price determination difficult which is harmful to the oil sector and consequently for national economies.

6 References

Bacon R, (1991) Rockets and Feathers: The Asymmetric Speed of Adjustment of UK Retail Gasoline Prices to Cost Changes. Energy Economics 13 (July): 211-18.

Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroskedasticity, Journal of Econometrics, v. 31, 307-327.

Borenstein S, Cameron A, Gilbert, R. (1997) Do gasoline prices respond symmetrically to crude oil price changes? Quarterly Journal of Economics 112: 305–339.

Brown S, Yücel K. (2000) Gasoline and Crude Oil Prices: Why the Asymmetry? Economic and Financial Review, Third Quarter: 23–29.

Engle, R. (1982). Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of U.K. Inflation. Econometrica, v. 50, 987-1008.

Engle, R., Bollerslev, T. (1986). Modelling the persistence of conditional variances. Econometric Reviews, v. 5, n. 1, 1-50.

Engle, R., Granger, C. (1987). Cointegration and error correction: representation, estimation and testing. Econometrica, v. 55, 251-276.

Galeotti M, Lanza A, Manera M. (2003) Rockets and feathers revisited: an international comparison on European gasoline market. Energy Economics 25: 175–190.

Granger C, Yoon G.(2002) Hidden cointegration. Department of EconomicsWorking Paper. University of California, San Diego.

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. Econometrica, v. 37, n. 3, 424-438.

Honarvar A. (2009) Asymmetry in retail gasoline and crude oil price movements in the United States: An application of hidden cointegration technique. Energy Economics 31: 395–402.

Karrenbock J (1991) The Behavior of Retail Gasoline Prices: Symmetric or Not? Federal Reserve Bank of St. Louis Review. July/August: 19–29.

Liu M, Margaritis D, Tourani-Rad, A, (2010) Is there an asymmetry in the response of diesel and petrol prices to crude oil price changes? Evidence from New Zealand. Energy Economics 32: 926–932.

Nelson, D. (1991). Conditional Heteroskedasticity in Asset Returns: A New Approach. Econometrica, v. 59, 347-370.

Radchenko S. (2005) Oil price volatility and the asymmetric response of gasoline prices to oil price increases and decreases. Energy Economics 27: 708–730.

Valadkhani A. (2010) Modelling the price of unleaded petrol in Australia's capital cities. Australas. Accounting Business Finance Journal 4 (2): 19–38.

Valadkhani A. (2013) Do petrol prices rise faster than they fall when the market shows significant disequilibria? Energy Economics 39: 66–80.

321 Alignment of Balanced Scorecard Perspectives with Supply Chain Management Objectives: a Literature Review

Sousa T B, Camparotti C E S, Esposto K F, Guerrini F M, Stefanutti R

Thales Botelho de Sousa (✉ e-mail: thalesbotelho@sc.usp.br).
Carlos Eduardo Soares Camparotti (✉e-mail: carloscamparotti@sc.usp.br).
Kleber Francisco Esposto (✉ e-mail: kleber@sc.usp.br).
Fábio Müller Guerrini (✉ e-mail: guerrini@sc.usp.br).
Renan Stefanutti (✉ e-mail: renan.stefanutti@usp.br).

Departamento de Engenharia de Produção, Escola de Engenharia de São Carlos, Universidade de São Paulo. Avenida Trabalhador São-carlense, 400. CEP 13566-590, São Carlos - SP/Brasil.

Abstract: Having in view the fast diffusion of the Balanced Scorecard since its development in the 1990s, this paper aims to present a literature review on the alignment of this performance measurement system with the Supply Chain Management. This research was motivated by the finding of an increase in the annual number of articles published over the years. Through a literature review 43 papers were localized in databases SCIELO, SCOPUS and Web of Science. A brief description of the performed papers with the theme is presented. The main contribution of this research focuses on condense into a single material, an overview of the assessment methods of Supply Chain Management based on the Balanced Scorecard perspectives.

Keywords: Balanced Scorecard. Supply Chain Management. Literature Review, Performance Measurement System.

1 Introduction

Performance management of supply chains has become an activity of recognized importance, especially due to complex nature of business processes, usually involving multiple decision criteria. According to Singhal and Singhal (2012), the area of Operations Management (OM) and Supply Chain (SC) currently has an excessive offer of models and a lack of theories.

The Balanced Scorecard (BSC) is a vehicle that reflects the mission and strategy of an organization into a set of objective and quantifiable measures organized into four different perspectives: financial, customer, internal processes and learning and growth (Kaplan and Norton, 1996; Tsang, Jardine and Kolodny, 1999). According to several authors, the BSC, with its four perspectives, is appropriate for overcoming the problems related to performance evaluation in SCs.

This paper aims to present a brief literature review on the alignment of the BSC with the SCM. The literature survey was conducted in journals indexed in the databases SCIELO, SCOPUS and Web of Science, involving specific objectives that allow a critical analysis of data collected and exposition of the main results.

This paper aims to answer the following questions: What are the main contributions mentioned in the literature? What research procedures most commonly used for the development of papers? What are the main limitations for application of this performance measurement system?

2 Methodological Procedures used for developing the Research

In this review, only papers published in journals were analyzed, because have more careful selection and evaluation than articles of conferences and symposiums (Carnevalli and Miguel, 2008), and are considered researches of highest level, both for gathering information, and for dissemination of new results and discoveries (Ngai et al., 2008).

To select the publications of interest, they were searched by title, abstract, keywords, irrespective of the period of publication, the following terms, combined: Balanced Scorecard and Supply Chain. Subsequently proceeded to the reading and analysis of title and abstract of the articles found, by selecting those with relevance to the research objectives. With refinements, 43 papers on the subject were obtained in the three bibliographical databases. Importantly, the papers obtained in 2014 include only the publications produced until the month of April.

3 Results of the Literature Review

3.1 Use of the Balanced Scorecard for assessing Supply Chain Performance

According to Zimmermann and Seuring (2009), the BSC has gained increasing acceptance as an instrument for the implementation of business strategies, and transforms them into related performance measures, which can be extended to the evaluation of SC performance.

The BSC is capable of combining objectives, quantitative data, and subjective judgments, and includes the long-term trend monitoring and forecasting facilities required to support strategic planning (Chang et al., 2013). According to Kleijnen and Smits (2003), the performance problem becomes simpler when the BSC metrics are shared by all stakeholders (managers, employees, customers, suppliers, banks, etc), all business units within a company's division, all divisions within a company, and all companies in the SC.

The prioritization of different perspectives for a firm is an issue which needs to be addressed (Bhagwat and Sharma, 2007b). According to Verdecho, Alfaro and Rodriguez-Rodriguez (2009), alignment of SC BCS and performance measurement system of the individual companies should include other collaborative elements measurement such as equity, trust and commitment in the SC, as well as levels of collaboration within the processes (strategic, tactical and operational). Already for Park, Lee and Yoo (2005) to take SCM into account, the notion of the BSC needs to expand the internal business process perspective to include the inter-organizational process for the communication and collaboration of SCM between suppliers and customers, and the customer perspective should to consider the demand chain process.

In order to put the BSC to work, companies should articulate goals for time, quality, performance and service and then translate these goals into specific measures (Bhagwat and Sharma, 2007a). According to Chang (2009), the BSC has been utilized for assessing SCM performance in the dimensions customer integration, internal process integration, supplier services and material integration, technology and planning integration, measurement integration, and relationship integration. By combining these different perspectives, BSC helps managers to understand the inter-relationships and tradeoffs between alternative performance dimensions, thus leading to improved decision making and problem solving (Rajesh et al. 2012). In the SC, upstream companies attach more importance to customer integration, and downstream companies attach more importance to supplier integration (Chang et al., 2013).

According to Rajesh et al. (2012), the BSC it is still out of reach for most of the small and medium-sized organizations, because its development requires a lot of skill and expertise of the management, time and expenditure of money. For Barber (2008), criticisms of the BSC and its many applications and various developments state that people and suppliers are excluded, regulations and competitive environments are ignored as well as the environmental and social aspects of industry. According to Reefke and Trocchi (2013), environmental and social aspects can be integrated in the four perspectives by establishing strategic priorities that influence the formulation of targets, measures, and respective indicators, representing strategically important factors which may otherwise not be sufficiently represented through integration into the four standard BSC perspectives.

3.2 Identified Limitations in Literature for the Performance Measurement System

Naini, Aliahmadi and Jafari-Eskandari (2011) claim that there are some limitations to the BSC for SCM such as does not take into account the relation of cause and effect over time, does not provide mechanisms for selecting best measures of performance, does not define value chains in strategic operations, and is not dynamic enough for online control.

The literature review of Agami, Saleh and Rasmy (2012) reveal that most of the already existing SCs performance measurement systems are inflexible and lack continual improvement. In an attempt to bridge this gap, they propose a dynamic, continuous and hybrid system framework that integrates systems thinking, strategic planning, BSCs, SCOR model, Theory Of Constraints Thinking Processes (TOCTP), optimization and eigen structure analysis into a cohesive approach for improving SC performance. For Thakkar, Kanda and Deshmukh (2009) the integration between SCOR and BSC ensure the greater effectiveness of performance measurement system, because the BSC doesn't provide a mechanism for maintaining the relevance of defined measures, fails to integrate top level, strategic scorecard, and operational level measures potentially making execution of strategy problematic, and fails to specify a user-centered development process. The SCOR model overcomes these shortcomings by adopting a building block approach and offers complete traceability, by defining the type of process (planning, execution and enabling) and configuring them to suit the SC requirements, and generating sufficient information to even develop tailor-made software system.

According to Xian, Qiu and Zhang (2013), although the performance measurement of SCM can be studied as a BSC, such approach is not effective for corporate-level evaluation in that many measures can also be influenced by other business activities. For the authors, the index of SC performance evaluation with BSC in existing literature is not fully measurable and the SCM measures are used only for constructing the theoretical framework of SC performance evaluation index system, but the evaluation model or algorithm is scarce. Based in this, they propose a Fuzzy Hierarchy Evaluation Model (FHEM) with the Balanced Supply Chain Scorecard (BSCS) based on the Fuzzy Principal Component Analysis (FPCA), that overcomes the multicollinearity in the index system of BSC and yields better performance evaluation accuracy than the other methods.

Discussion of the complex issues of a balanced system of performance assessment is not simple. BSC performance is subjective, cause-effect relationships are not clear, and it is necessary to assign non-equal priorities to perspectives and performance indicators within each perspective (De Felice and Petrillo, 2013). For De Felice and Petrillo (2013) and Bhagwat and Sharma (2009), Analytic Hierarchy Process (AHP) represents one of the methods that can address the complex issues of a balanced system of performance assessment. The application of this method along with BSC consider several relevant dimensions of organizational performance and formally explain how to weight their importance within a comprehensive framework.

3.3 Technical Procedures Used for the Development of Papers and Industrial Sectors Analyzed

Table 1 shows the classification and annual distribution of papers according to the technical procedure used for the development, according to what the classification used in the area of operations management. Although the literature review to be an essential part of the preparation of any academic paper (Lakatos and Marconi, 2007), in classification used in this article were considered theoretical nature the articles that used only the conceptual approach in its design.

Table 1 Classification and annual distribution of articles according to the technical procedure used for its development

Technical procedure	Year												
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Case study		1	1	2		2		4	1	2	5	3	1
Literature Review	1						1	2	2	1		2	
Modeling												2	
Simulation		1								1		1	
Survey					1	1	1	2			2		

According to the data in Table 1 it can be seen that of the technical procedures used the case study showed a higher incidence, which is explained by maturation of thematic research over the years and need for thorough analysis of the application of the performance measurement system in organizational practices.

Table 1 shows that although with some fluctuations, there was growth in studies that address the alignment of the BSC with SCM over the years, considering that in 2002 only 1 article was published and there was a peak of 8 posts in 2009 and 2013. The use of quantitative techniques has been growing lately, due to the use of quantitative techniques such as fuzzy logic, AHP, ANP, among others, used for reducing the subjectivity of the analysis and validating adjustments made in methodologies already established or new techniques developed.

The industrial sectors in which the methods were applied are diverse, encompassing industry of machinery (1 paper), electronics (3 papers), steel manufacturer (1 paper), water and sewage service companies (1 paper), automotive (4 papers), chemical (1 paper), food SC (4 papers), mass merchandiser market (1 paper), cosmetics and healthcare products (1 paper), services (3 papers), naval (1 paper), consumable goods SCs (1 paper), hospitals (1 paper), carpet-manufacturing (1 paper), leading logistics company (1 paper), high tech engineering (2 papers), packaging and distribution (2 papers), fashion industry (1 paper), beverage (2 papers), petroleum SC (1 paper), third party logistics service provider (1 paper), sportswear (1 paper), leading welding consumable manufacturer (1 paper), leading manufacturer of brakes and clutches (1 paper), iron handicraft manufacturing (1 paper), green SCM (1 paper), among others unidentified (6 papers).

Chang (2009), Naini, Aliahmadi and Jafari-Eskandari (2011), and Chang et al. (2013) claim that the alignment of conceptual BSC frameworks with the SCM objectives ensure integration of different company operations, discussion of company relationships with it external business environment, consistent monitoring approaches for all organizational partners, companies connection with the general organizational strategies, employees engagement with operational objectives in measuring performance, check of only a few measures or performance indicators at any one time, bridge between financial and non-financial fields, and improved management of information in organizations. Furthermore, for De Felice and Petrillo (2013), using the BSC allows for stakeholders to determine the health of short-, medium- and long-term objectives at a glance.

4 Conclusions

The performance measurement is an essential element of effective planning and control as well as decision-making. The measurement results show the effects of the strategies and potential opportunities in the SCM.

This paper presented a literature review on the BSC alignment with the SCM, seeking to characterize the state of art on the theme, some reasons for using measurement system for such evaluations, as well as the advantages of use. Based on several papers, the use of BSC for measuring SC performance is useful not only for firms and managers but also provides clear direction to researchers for accurate measurement of each performance.

The fact that the case study to be the technical procedure most used in researches corroborates the studies of Berto and Nakano (2000), Miguel (2007) and Walter and Tubino (2013), which point the case study as the methodological approach most commonly used in the area of industrial engineering and operations management.

Several research gaps were proposed in literature, such as design of a simulation model that explains how the SC's performance metrics react to environmental and managerial control factors, perform sensitivity analysis, optimization, and robustness analysis of the SC simulation model, application of methods such as AHP, ANP and other mathematical tools in assessment.

It is important to highlight as limitations of this study the focus on aspects mentioned by the author, since the qualitative approach is based on subjectivism, which may neglect many important aspects of the studies analyzed. Another limitation resides in the fact that the bibliographical researches have the possibility to present secondary data collected or processed in error, and thus spread or expand the errors (Gil, 2008). In order to minimize these limitations of the proposed research were analyzed just articles published in journals. Another point to stress is that the amount of analyzed papers, the number of content and approaches present in its structure, as well as space limitations inherent in a scientific paper to be published in this conference, prevented deeper analysis of the results obtained in each production. Due to the page limit imposed, for this literature review, were not presented the main contributions of all 43 papers. Future papers may be developed, increasing the size of the sample analyzed, and deepening the analyzes initiated here.

Importantly, despite all the limitations inherent in the type of work proposed, the results contributed to characterize the profile of academic papers on the BSC with SCM. As conclusions of this paper can be stated that the use of the BSC as a performance measurement system for SCs chain encourages cooperation among members and creation of other evaluation metrics and has a broader focus, with greater concern with SC effectively, addressing the need for joint efforts among its members, to improve the performance of the whole chain.

5 References

Agami N, Saleh M, Rasmy M (2012). A Hybrid Dynamic Framework for Supply Chain Performance Improvement. *IEEE Systems Journal*, 6:3:469-478.

Barber E (2008). How to measure the "value" in value chains. *International Journal of Physical Distribution & Logistics Management*, 38:9:685-698.

Berto R M V S, Nakano D N (2000). A produção científica nos anais do Encontro Nacional de Engenharia de Produção: um levantamento de métodos e tipos de pesquisa. *Produção*, 9:2:65-76.

Bhagwat R, Sharma M K (2007a). Performance measurement of supply chain management: a balanced scorecard approach. *Computers & Industrial Engineering*, 53:1:43-62.

Bhagwat R, Sharma M K (2007b). Performance measurement of supply chain management using the analytical hierarchy process. *Production Planning & Control*, 18:8:666-680.

Bhagwat R, Sharma M K (2009). An application of the integrated AHP-PGP model for performance measurement of supply chain management. *Production Planning & Control*, 20:8:678-690.

Carnevalli J A, Miguel P A C (2008). Review, analysis and classification of the literature on QFD - types of research, difficulties and benefits. *International Journal of Production Economics*, 114:2:737-754.

Chang H H (2009). An empirical study of evaluating supply chain management integration using the balanced scorecard in Taiwan. *The Service Industrial Journal*, 29:2:185-202.

Chang H H et al (2013). Using the balanced scorecard on supply chain integration performance - a case study of service businesses. *Service Business*, 7:4:539-561.

De Felice F, Petrillo A (2013). Key success factors for organizational innovation in the fashion industry. *International Journal of Engineering Business Management*, 5:Especial Issue:1-11.

Gil A C (2008). *Métodos e técnicas de pesquisa social*. 6ª ed. São Paulo: Atlas.

Kaplan R S, Norton D P (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review*, Jan-Feb:75-85.

Kleijnen J P C, Smits M T (2003). Performance metrics in supply chain management. *Journal of the Operational Research Society*, 54:5:507-514.

Lakatos E M, Marconi M A (2007). *Metodologia do trabalho científico*: procedimentos básicos, pesquisa bibliográfica, projeto e relatório, publicações e trabalhos científicos. 7. ed. São Paulo: Atlas.

Miguel P A C (2007). Estudo de caso na engenharia de produção: estruturação e recomendações para sua condução. *Produção*, 17:1:216-229.

Naini S G J, Aliahmadi A R, Jafari-Eskandari M (2011). Designing a mixed performance measurement system for environmental supply chain management using evolutionary game theory and balanced scorecard: A case study of an auto industry supply chain. *Resources, Conservation and Recycling*, 55:6:593-603.

Ngai E W T et al (2008). RFID research: an academic literature review (1995-2005) and future research directions. *International Journal of Production Economics*, 112:1:510-520.

Park J H, Lee J K, Yoo J S (2005). A framework for designing the balanced supply chain scorecard. *European Journal of Information Systems*, 14:4:335-346.

Rajesh R et al (2012). Generic balanced scorecard framework for third party logistics service provider. *International Journal of Production Economics*. 140:1:269-282.

Reefke H, Trocchi M (2013). Balanced scorecard for sustainable supply chains: design and development guidelines. *International Journal of Productivity and Performance Management*, 62:8:805-826.

Singhal K, Singhal J (2012). Opportunities for developing the science of operations and supply-chain management. *Journal of Operations Management*, 30:3:245-252.

Thakkar J, Kanda A, Deshmukh S G (2009). Supply chain performance measurement framework for small and medium scale enterprises. *Benchmarking*, 16:5:702-723.

Tsang A H C, Jardine A K S, Kolodny H (1999). Measuring maintenance performance: a holistic approach. *International Journal of Operations & Production Management*, 19:7:691-715.

Verdecho M J, Alfaro J J, Rodriguez-Rodriguez R (2009). Foundations for collaborative performance measurement. *Production Planning & Control*, 20:3:193-205.

Walter O M F C, Tubino D F (2013). Métodos de avaliação da implantação da manufatura enxuta: Uma revisão da literatura e classificação. *Gestão & Produção*, 20:1:23-45.

Xian S, Qiu D, Zhang S (2013). A fuzzy principal component analysis approach to hierarchical evaluation model for balanced supply chain scorecard grading. *Journal of Optimization Theory and Applications*, 159:2:518-535.

Zimmermann K, Seuring S (2009). Two case studies on developing, implementing and evaluating a balanced scorecard in distribution channel dyads. *International Journal of Logistics Research and Applications*, 12:1:63-81.

327 Exploration and production of oil and natural gas in marginal fields

Yabiko R, Antunes J, Bone R

Raíssa Fernandes Yabiko (✉ e-mail: rayabiko@poli.ufrj.br)
Petroleum Engineering, Polytechnic School of Federal University of Rio de Janeiro, Brazil.

Jéssica Matar Antunes
Petroleum Engineering, Polytechnic School of Federal University of Rio de Janeiro, Brazil.

Rosemarie Bröker Bone (✉ e-mail: rosebone@poli.ufrj.br)
Department of Industrial Engineering - DIE, Polytechnic School of the Federal University of Rio de Janeiro.

Abstract: The objective of this article is to analyze the economic and social impact of oil and gas (O&G) exploration and production (E&P) activities at Alagoinhas (Bahia – Brazil) and Vera Cruz (Bahia – Brazil), where the marginal fields of Bom Lugar and Morro do Barro are located. After initial exploration by Petrobras in the 1990s, these fields were returned to ANP at the Round Zero, and were bided in 2006, during the 7th Round. The production resumption took place only in 2008. Due to the increased hydrocarbons output in both fields, a change in economic conditions of the region happened. Indicators such as the Gross Domestic Product - Added Value (PIBVA) increased; municipalities' tax revenues were boosted due to O&G royalties. E&P activities stimulated the presence of direct and indirect services providers to the petroleum sector. This scenario made a positive change in the number of people employed, fostering local income and savings possibly. However, investment in social infrastructure is still weak, as health facilities and the number of schools showed no such significant growth.

Keywords: Alagoinhas. Bom Lugar. Vera Cruz. Morro do Barro. Exploration and Production of oil and natural gas.

1 Introduction

Before 1997 the exploration and production of oil and natural gas in Brazil was a monopoly of Petrobras, a Brazilian state-owned company. In that year a new petroleum law took effect; it allowed to private companies to enter in exploration and oil production activities, creating competition in the sector. In the transition period between the establishment of this new legislation and the start of public bidding organized by the National Petroleum Agency (ANP), it took place the "Round Zero". Round Zero was the signing of concession contracts between Petrobras and ANP where it was defined which fields would continue granted to Petrobras, and those that would be put available to ANP place them at auction subsequently.

Some of the areas that were not claimed by Petrobras, already in the production stage or advanced development, became known as "marginal fields" and were bid during the Seventh and Eighth Rounds, with the support of a government policy aimed to encourage the introduction of small companies in oil sector and to develop more remote areas of the country with assets from oil.

The purpose of this article is to verify the economic and social development of a region under the influence of marginal fields. Here we focus on two specific areas; however, the approach employed in this study could be easily extended to a broader research (e.g. in national scale). As study object, we focused in the marginal accumulation of Bom Lugar and its principal municipality adjacent, Alagoinhas, which was chosen because it is the first in oil production marginal field. We also investigated the accumulation of Morro do Barro (adjacent municipality of Vera Cruz), which presents the higher natural gas production among the marginal fields.

This research employed data from: National Petroleum Agency (ANP), Brazilian Institute of Geography and Statistics (IBGE) and United Nations Development Programme (PNUD). The methodology used these official data to describe the scenario in these regions in order to make possible the comparison between economic and social sector.

2 Marginal Accumulation Fields and Adjacent Counties

Bom Lugar, a marginal accumulation area, is located in the Reconcavo/Bahia Basin. The former field of Bom Lugar started to produce in 1968 and produced until 1997 when it was deactivated and returned to ANP during Round Zero. This area was acquired in 2005, in the 7th Round. Currently the company operating the area is Alvopetro SA Extraction of Oil, and its production was restarted in 2008. Since the beginning of 2012 it is the largest oil producer among the marginal fields. The municipality of Alagoinhas is the main town in the vicinity of Bom Lugar and is located east of the state of Bahia (figure 1). The city houses the Sauipe Industrial Center, and it has the second largest Gross domestic product (GDP) of Bahia and the tenth largest population.

The Morro do Barro area is located in Itaparica Island/Bahia (figure 1). It was active under Petrobras control within the period 1964 – 1988, this premature closure occurred because the main hydrocarbon present was the natural gas, which was not economically attractive inasmuch as there were not enough transmission networks to supply the main consumer centers and its low market price. In 1997 it was returned to ANP during Round Zero and sold in October 2005, in 7th Round to PANERGY Oil and Gas Ltd Company. The production started in 2008, and since the beginning of 2012 it was rated by ANP as the marginal field that produces more natural gas. The municipality of Vera Cruz is also located in the Itaparica Island. Nowadays the basis of city economy is tourism, and it occupies the 68th place in the state's GDP ranking.

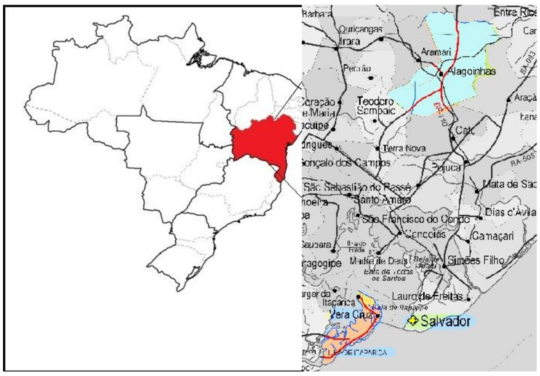


Fig. 1 Location of Alagoinhas and Vera Cruz (Bahia-Brazil). Source: Google MapLink (2014)

In order to establish a relationship between economic and social development of the municipalities with the E&P of oil and natural gas in their territories, we analyzed a set of economic and social variables after the period of reactivation of the fields.

3 Economic Variables

In the economic context, the following variables were examined: royalties collection by municipalities between 2008 and 2012 according to the ANP (charts 1 and 2); Gross Domestic Product - Added Value (PIBVA) (charts 3 and 4), which is the contribution to the gross domestic product by various economic activities, according to IBGE data for the period between 2008 and 2010; net budget of municipalities, using as source IBGE data within years 2006-2010; and private savings and employed people (charts 5 and 6), both data provided by IBGE in the period between 2008 and 2011. Right below the charts analyzing some of these variables is shown.

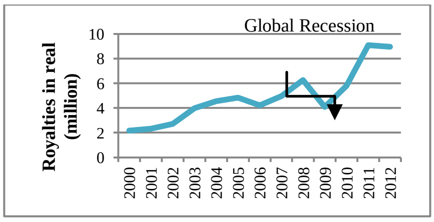


Chart 1 Royalties in real (million) – Alagoinhas. Source: ANP (2013)

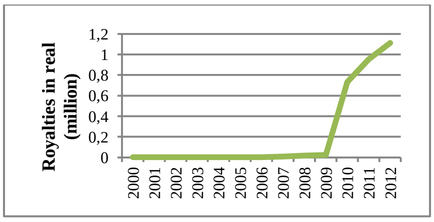


Chart 2 Royalties in real (million) – Vera Cruz. Source: ANP (2013)

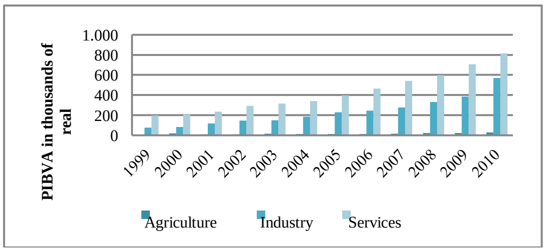


Chart 3 PIBVA - Alagoinhas (BA). Source: IBGE (2013)

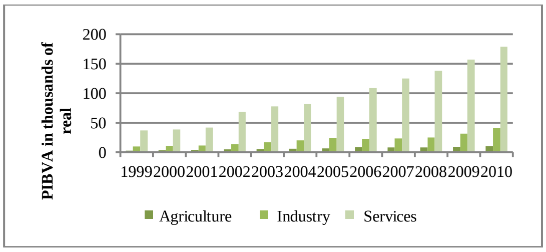


Chart 4PIBVA – Vera Cruz (BA). Source: IBGE (2013)

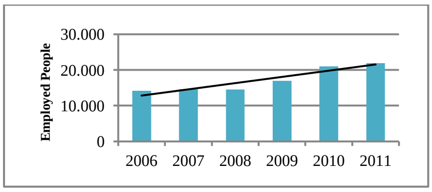


Chart 5 Employed People – Alagoinhas (BA). Source: IBGE (2013)

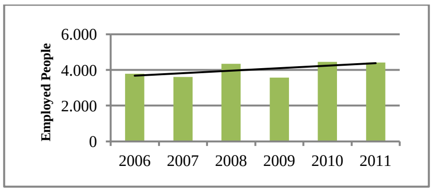


Chart 6 Employed People – Vera Cruz (BA). Source: IBGE (2013)

First analyzing the municipality of Alagoinhas, it can be concluded that under the economic perspective every variable showed improvements. The collection of royalties increased 43% during the production period, yielding an increase in revenues collected by the city that changed its cash flow from a deficit to a surplus condition; this positive situation induced a rise in PIBVA values of all sectors, mainly in the industrial and service. This scenario is a result of the stimuli to the presence of oil industry in the region, which brought companies providing direct and indirect services in the oil sector. It had an immediate effect of positive change in salaried staff, which grew 51%, and as a further proof of enrichment at Alagoinhas, saving of the population increased 204%, causing the opening of a new bank branch.

In the municipality of Vera Cruz it was not different. With respect to royalties, Vera Cruz had an increase of about 6000%. Although this value is pretty significant, it is necessary to consider that the municipality had no previous relevant oil economy, and thus, any minimum gain influence the rate significantly. The evolution of the PIBVA followed the trend of Alagoinhas, also showing positive growth, the only contrast is that in Vera Cruz the industry sector is not much important which make sense in view of the main economy in this county is the tourism and the natural gas production does not require a strong industrial sector around. Furthermore the net city budge became surplus in 2010 which was followed by the population enrichment that can be seen by analyzing the private savings which also got a boost of 308% associated with the favorable economic moment. On the other hand, employment rates and listed companies have not followed the same pace. This is due to the fact that the biggest promotion of the oil industry is in the production chain. Once that Morro do Barro's main hydrocarbon is natural gas, no significant hiring of qualified local workforce occurred.

4 Social Variables

In the social sphere, the following variables were analyzed: Gini index, which measures the degree of inequality in the distribution of individuals according to per capita household income; the City Development Index (CDI), a parameter that analyzes how education, income and health have evolved over the years; the infant mortality rate; and the City Development Index in the Education Perspective, which is a composite of indicators of schooling of the adult population and school flow of young population and assesses the literacy rate and frequency of the student. These data were made available in the Atlas of Human Development in Brazil by UNDP between 1991 and 2010. Using as a research tool also IBGE, other variables were also analyzed: health facilities and available beds in the counties between 2005 and 2009; and school units and students enrolled during the period between 2005 and 2012.

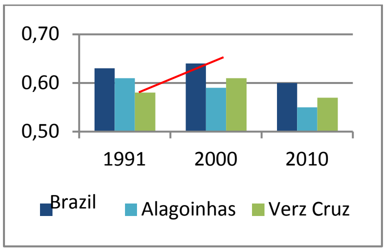


Chart 7 Gini Index - Brazil vs. Alagoinhas and Vera Cruz. Source: PNUD (2013)

There are several indices that show the human development of a locality. The first index considered is the Gini index, which measures the degree of inequality in the distribution of individuals according to per capita household income. Its value ranges from 0, when there is no inequality, to 1, where the maximum inequality is (one individual has all the income). The universe of individuals is limited to those living in permanent private households. The chart 7 shows the data obtained.

Both counties have a Gini coefficient lower than the national average, which is a positive aspect. Alagoinhas presents a progressive improvement in income inequality in the region. The municipality of Vera Cruz during the years 1991 and 2000, when the field of Morro de Barro was closed, income inequality among residents increased and subsequent years, when the E&P of oil and natural gas was reactivated, there was a decrease the Gini index.

Up to here, the data was related more to the economic situation of the counties. Now, is going to be analyzed how the surplus funds that goes into the coffers of the municipalities is being spent and whether it is reversed in benefits to the population through public spending on education and health in order to promote the development and improvement of life.

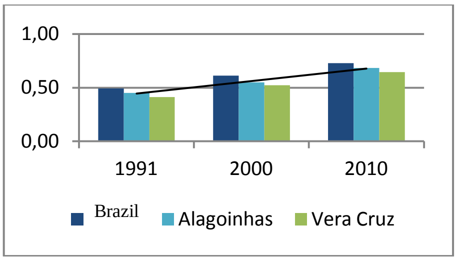


Chart 8 CDI - Brazil vs. Alagoinhas and Vera Cruz (BA). Source: PNUD – 2013

The City Development Index is the most important variable that looks at how education, income and health, combined, have evolved over the years, giving more importance to quality of life than to economic variables. In chart 8, data obtained in Alagoinhas and Vera Cruz are compared with the national average.

Just as the national average, the CDI of these municipalities in Bahia has also grown over the years; however, remain below the national average, a factor that justified why much of the municipal rates, discussed below, are lower than expected which makes the need for investments in this poor areas even more urgent.

In the health sector, the firsts variables considered are the health facilities as (hospitals) and available hospitals beds. In Alagoinhas and Vera Cruz the only improvement noticed was the increased of private hospitals, which means that the demand that should be remedied by the government has fallen in the private sector.

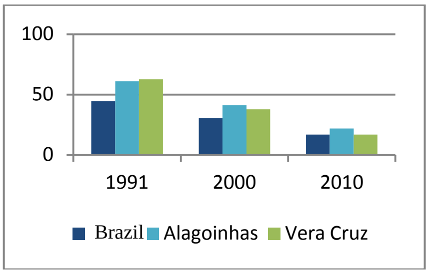


Chart 9 Infant Mortality Rate – Brazil vs. Alagoinhas and Vera Cruz (BA). Source: PNUD – 2013

Continuing in this perspective the infant mortality rate shows a little different scenario. In the chart 9 is possible to notice that both counties are above the nation average rate, which is a terrible situation which may be explained by the health system still very precarious, natural adversities like drought, and CDI below average. However the most interesting data is that Vera Cruz's improvement was more significant than Alagoinhas (that is 3 times bigger than Vera Cruz in the economic conditions) which can be a result from a weak administration by the city hall creating a fragile health system.

Other alarming data are obtained when analyzing the education sector. Investment in education is still undervalued, which was observed when it computes the number of schools and regular students in Alagoinhas and Vera Cruz. Acording to IBGE (charts 10 and 11) was a general decreased. The number of schools pulled back in both counties, as the number of the regular students. To compare the development of education in municipalities with a national average, there is the CDI focused on education (chart 12), which is a composite of indicators of schooling of the adult population, the school flow of young population, literacy rate and frequency of the student. Under this perspective both cities present a growth during the years (1991-2010), but they still figure below the nation rate. However, this index does not depict the actual situation of education in the city, bearing in mind that the variables it considers tend to mask the real lack of infrastructure.

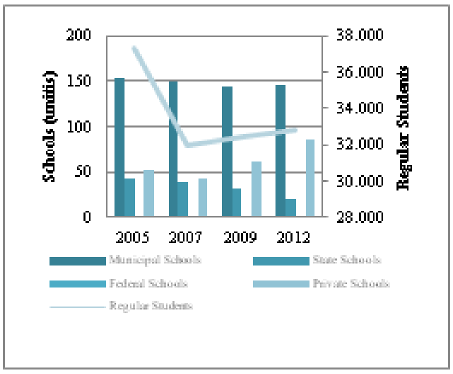


Chart 10 Schools and Regular Students – Alagoinhas (BA). Source: IBGE (2013)

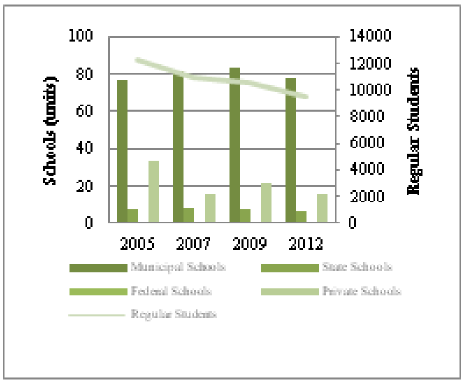


Chart 11 Schools and Regular Students – Vera Cruz (BA). Source: IBGE (2013)

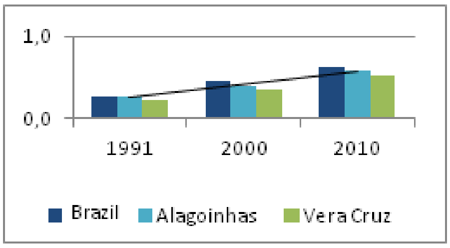


Chart 12 CDI-E Brazil vs. Alagoinhas and Vera Cruz. Source: PNUD – 2013.

5 Conclusion

Based on the data acquired we can conclude that the reactivation of marginal fields Bom Lugar and Morro do Barro, located in the municipalities around Alagoinhas and Vera Cruz (BA), respectively, caused changes in the economic and social dynamics of these cities. In both municipalities analyzed, Alagoinhas (second largest GDP of Bahia) and Vera Cruz (small town located in a tourist island), there is a trend.

Economically, the reactivation of the activities of the oil sector in the region boosted the industry, generating jobs and collaborated with the increasing profit of the public treasury. However, to an industry sector contribute to the improval of life quality and development of a locality, social indicators should demonstrate positive changes at least in the same proportion of the rising incomes and the incentive that comes from oil. Unfortunately, this economic improvement was not reflected for the population. Under the social standpoint the results were not satisfactory once that the growth rate of economic indicators were much higher than the growth rate of social indicators that repeatedly gets to be negative in both counties.

This analysis presented collaborates with the understanding of some government measures such as the Social Fund, and the regulation by law of the royalties destined for education and health, since these sectors, which should be the main beneficiaries of government revenue are repeatedly ignored.

6 References

AGÊNCIA NACIONAL DO PETRÓLEO GÁS NATURAL E BIOCOMBUSTÍVEIS.ANUÁRIO ESTATÍSTICO 2012. Rio de Janeiro, 2012. 1 v. Available in: <http://www.anp.gov.br/?pg=60983#Se__o_2>. Accessed on: 4 ago. 2013.

PROGRAMA DAS NAÇÕES UNIDAS PARA O DESENVOLVIMENTO. Desenvolvimento Humano e IDH. Rio de Janeiro, 2013. 2 v. Available in: <http://www.pnud.org.br>. Accessed on: 4 ago. 2013.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Cidades@:Alagoinhas. Rio de Janeiro, 2013. 1 v. Available in: <http://www.ibge.gov.br/>. Accessed on: 4 ago. 2013.

ALAGOINHAS Available in: <http://pt.wikipedia.org/wiki/Alagoinhas>. Accessed on: 4 ago. 2013.

328 Small and Medium Enterprises Sustainable Development Strategy view

Tutillo J A B, Alves J L S, Medeiros D D

José Alexander Benavides Tutillo (✉ e-mail: alexanderbenavides.t@gmail.com)
Department of Production Engineering. Federal University of Pernambuco, Av. Acadêmico Hélio Ramos s/n, Cidade Universitária, 50740-530. Recife, PE, Brasil.

Jordania Louse Silva Alves (✉e-mail: ajordania@hotmail.com)
Department of Production Engineering. Federal University of Pernambuco, Av. Acadêmico Hélio Ramos s/n, Cidade Universitária, 50740-530. Recife, PE, Brasil.

Denise Dumke de Medeiros (✉ e-mail: medeirosdd@gmail.com)
Department of Production Engineering. Federal University of Pernambuco, Av. Acadêmico Hélio Ramos s/n, Cidade Universitária, 50740-530. Recife, PE, Brasil.

Abstract: This paper aims to identify the rapport between Medium and Small Enterprises and Sustain ability concepts. Questionnaires where applied in small and micro enterprises laundries jeans located in Toritama, state of Pernambuco, Brazil. The research aims to identify the existence or not of Sustainable Development Strategy, enterprises commitment to future implementation, their difficulties to develop this strategy, and expect results from a possible strategy adoption. Collected information showed that these enterprises have some idea about the theme but most of them are not aware. Data can help other similar enterprises to reach sustainable development opportunities and competitive gains. Global Reporting Initiative, a sustainable reporting, was suggested for more consistent results and better market position.

Keywords: Sustainability, Sustainable Development Strategy, Medium Small Enterprise.

1 Context

Globalization generate several economic and commercial changes, this induced new challenges to enterprises, independent on the size. In the beginning of XX century, maximize activity utility was an essential component to enterprise market permanence (TENÓRIO, 2004).

However, during the years this view changed and new strategies treating of environmental protection, social responsibility and actions for better ethic and organization lucidity appeared (ASHLEY, 2005).

Thus, environmental preservation sight, together with social attention, made arise the sustainable concept that comprises economic, environmental and social dimensions. According to Tenório (2004), the sustainability goal is to reach an economic growth through respecting different social agents' desires and environmental protection, origin a better quality life to society.

To continue competitive, all kinds of enterprises of all sizes must adjust their strategies to new market and society needs (EC, 2011). Facing this scenario is also essential to Medium and Small Enterprises (MSEs) to improve environmental developing actions and try to mitigate a big challenge: how to allocate these activities engendering benefits to the enterprise.

It's important to remember that MSEs, have a pertinent place in the economy, especially in smaller economies, since these enterprises are close to the community, have good local understanding conditions and generate significant financial resources and employment (BUARQUE, 2008).

Regarding to sustainability, in 1987, the Sustainable development concept was propagating all over the world in the "Our Common Future" reporting. This reporting was presented as a final document of several researches made by World Commission on Environment and Development, WCED concerning environmental and development (WCED, 2011). After this, all segments increases their actions to implement and develop sustainable arrangements, to get better economic, social and market position.

In this context, adopt a sustainable program offers to the enterprise, specially medium and smaller, strategies application, developing all enterprise areas and giving competitive gains. This kind of enterprises are more personal and flexible, it's faster for them to show sustainable program adoption results (EC, 2011). Hence, sustainability, besides generate benefits for the society and environmental, also create benefit to the business by given competitive differential, low cost, efficiency and performance enhancement (CNI, 2006).

This paper aims to identify MSEs enterprises under study reasons to include or not Sustainable Development strategies in its management and check advantages, according to the MSEs assessment, which can be obtained by sustainable strategies inclusion.

2 Methods

This investigation is defined as a descriptive research. According to Hair et al. (2005), for descriptive studies, data collection may involve some type of structured interview process in which a questionnaire with specific items asks respondents to select something in a fixed number of options.

A questionnaire was applied in thirteen small and medium enterprises. Due to enterprises size all questionnaires were answered by the owner or manager. Some elements were analyzed to provide interviewed companies relationship with basic sustainability concepts, to find opportunities for sustainable development and transform them in competitive advantage.

The data analysis was performed by the Statistical Package for Social Science SPSS, version 17.0 and Excel software. All of the micro and small enterprises have textile processes (laundry) and some also have clothing.

3 Results

This section is divided in: Sustainability Concepts, SDS Implementation, SDS Development Difficulties and Possible results from SDS implementation.

The section will describe the selected analyzed items treating about the relation between Sustainable Development Strategy and MSEs. Items and results collected throughout questionnaires will be described.

3.1 Sustainability Concepts

Regarding to sustainability meaning, among the thirteen interviewed enterprises, six enterprises: three micro, three small and one medium, 46,2%, couldn´t define the concept; and seven, one micro and five small, 53,8%, knew the sustainable sense, as observed in Table 1.

Table 1 Sustainability awareness according to enterprises size

SIZE	SUSTAINABILITY KNOWLEDGE	
	YES	NO
Micro	3	
Small	3	5
Medium	1	-

Moreover, was observed in interviews that the total number of companies that have expressed know the sustainability concept, normally understand the issue basically as a correct company performance in the financial, environmental and social areas. Sustainability meaning respondents perception includes a definition focused on environmental protection enterprise, giving less emphasis, on the financial and social issue.

3.2 SDS Implementation

Regarding to cover a Sustainable Development Strategy, most of the studied enterprises, nine at all, replied that they don´t have any sustainable strategy,
However all of them are interested in adopt and develop this kind of strategy as soon as possible.

Three enterprises answered that they already have a sustainable development strategy.

Only one enterprise doesn´t have this kind of strategy and also has no plans to implement (Figure 4.1).

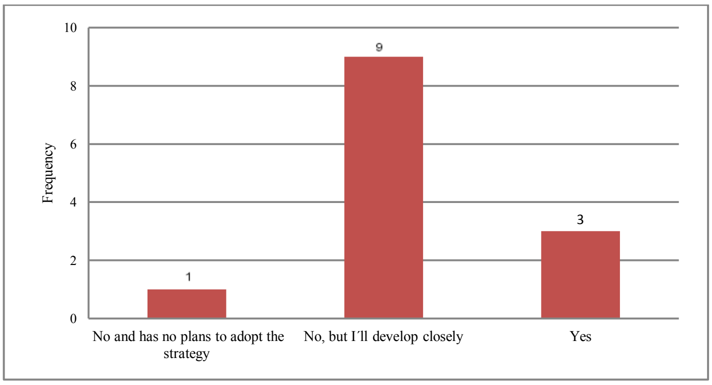


Fig. 1 SDS Implementation

By doing a joint review of SDS implementation and sustainability awareness it was observed that all the enterprises that have implemented SDS are conscious about sustainability, nevertheless the only company that is not interested in adopt a SDS unknown sustainability concept.

Table 2 SDS Implementation according to sustainability concept knowledge

SDS Implementation		
	Sustainability knowledge	
	Yes	No
Yes	3	-
No, but will implement closely	3	6
No, no plans to implement	-	1

3.3 SDS Development Difficulties

A list containing some possible limitations before SDS implementation was elaborated. Examination demonstrates that most of questioned enterprises indicated SDS concept knowledge lacks as the most relevant reason for not adopt this kind of strategy.

The second most significant reason for no SDS adoption was a sustainable mark reference default, in the sense of an implementation guide.

They also mentioned as a difficult, the government incentive lack.

Table 3 expose the usual difficulties items by selected frequency on data collect.

Table 3 SDS difficulties development

Item	**Difficulties**	**Frequency**
C	Issue unawareness	9
B	Reference mark absence	5
A	Extern accomplishment measure control lack	4
D	No high direction commitment	4

E	Difficult for environmental/social programs coordination	4
G	Lack of government incentive	4
F	Difficult for justify a Sustainable Development investment	2
H	No qualified personnel in theme	2
I	Laundry sector specific actions	1

3.4 Possible results from SDS implementation

Based on literature review some possible results from SDS implementation were disposed to be classified as interviewer evaluation. In other words, they were asked about which of selected items they think could be really reach by SDS implementation. Table 4 shows these items.

Table 4 Possible Results from SDS Implementation

	Totally agree	**Indifferent**	**Partially disagree**	**Totally disagree**
Attract and retain customers	8	2	1	2
Increase brand and enterprise reputation	9	1	2	1
Fulfill environmental/ social obligations	9	2	2	-
Improve relationship with community	10	1	1	1
Improve employees work conditions	9	1	3	-
Distinguish products from competing	11	2	-	-
Use the best way to improve philanthropic enterprise actions	1	1	3	8
Cost reduction	9	2	1	1
Join to new markets	5	7	1	-
Increase sales and receipt	8	3	2	-

For each evaluated item an interval scale made of five points was used to measure SDS application agreement degree.

4 Discussion

Majority interviewed enterprises, eleven in total, informed that for their view, the sustainable development strategy would be a restrict manager responsibility. This opinion can be positive, according to Pedersen (2009), MSEs management commitment with SDS is normally an exclusive responsibility of the manager/owner that is responsible to allocate strategy, financial, technological and human resources. In respect of enterprise special interest on some stakeholders, twelve enterprises selected this point as the highest evaluation level.

Employees, community and suppliers, were considered the most important details for eight enterprises.

However, five enterprises considered community as a less important factor.

Four enterprises unknown sustainability concept, neither SDS benefits for the enterprise, society and environmental. This unawareness is the biggest limitation for SDS adoption.

The unfamiliarly with the sustainable concept can be corroborated by SDS application difficulties recognition, in which nine enterprises appointed unawareness sustainability concept as the worst SDS adoption point.

The second major cause appointed was a reference mark lack to guide the enterprises in SDS implementation.

Difficult to coordinate environmental and social programs, extern control default to measure sustainable actions accomplishment and no management direction commitment, were appointed by four enterprises.

Other reason for no SDS application was the lack of government support.

Although most companies, eight in total, have agreed that attracting and retaining customers can be a result of the sustainable implementation development strategy, there were three enterprises that disagreed and two neutrality. Enterprises who disagreed with the proposal, evidenced that they considerate costumers opinion, i.e., most of their costumers don't priories goods that are produced by companies that have good relations with society and the environment.

Regarding new markets gain, companies that only reach local market have an indifferent attitude on the intention to participate in new markets, otherwise companies that participate in other regions of Brazil, completely agreed with the proposal.

This permit assume that companies operating outside the local market have a different view closely to new market trends, in this case, progress on sustainability and social responsibility issues. According to Abreu et al. (2008), northeast textile companies when access to international markets, the social and environmental profile conduct to a higher level of responsibility, due to environmental risk and greater exposure to society and regulators.

5 Conclusion

Elements analyzed provided a view of the relationship between companies interviewed and sustainability concepts. Was identified on studied enterprises the existence or not of a SDS, as well as enterprises commitment to a future implementation, their difficulties to develop this strategy, and expect potential results from a possible implementation has a relevant meaning to a sustainable management.

Was observed that some enterprises didn't know about what sustainability means, however, even in these cases, most of them expressed that they are interested in develop in the future a SDS, meaning that these enterprises intend to improve their sustainable management and has the knowledge about market environmental value.

The research shows an overview about MSEs and SDS. It is clear depth research needs to improve studied segments. Sustainability reporting is suggested in the form of the Global Reporting Initiative, a framework that supports the triple button line: economic, environmental and social impact. This reporting could improve the sustainable development in the MSEs enterprises and also promote a competitive advantage.

6 References

ABIT Brazilian Textile and Apparel Industry Association (2011) Available via http://abit.org.br/Home.aspx. Cited 3 Jan. 2011

Ashley P (2005) Ética e Responsabilidade Social nos Negócios. Saraiva, São Paulo

Buarque S (2008) Cidade do futuro: Desafios dos municípios de Pernambuco. Sebrae, Recife

CNI (2006) Responsabilidade Social Empresarial/CNI. CNI, Brasília

De Abreu M, Da Silva J, De Oliveira B, Júnior F (2008) Perfis estratégicos de conduta social e ambiental: Estudos na indústria têxtil nordestina. Gest Prod 15:159-172

European Commission (2011). In: Promoting a European framework for Corporate Social Responsibility: Green Paper. Available via http://eur-lex.europa.eu/LexUriServ/site/en/com/2001/com2001_0366en01.pdf. Cited 20 Feb 2011.

Hair J, Babi B, Money A, Samouel P (2005) Fundamentos de métodos de pesquisa em administração. Bookman, Porto Alegre

Pedersen E (2009) The many and the few: rounding up the SMEs that manage CSR in the supply chain. Sup C Man 14:109-116

Tenório F (2004) Responsabilidade Social Empresarial: Teoria e Prática. Editora FGV, Rio de Janeiro

WBCSD (2011) Corporate Social Responsibility: Making good business sense. Available via http://www.wbcsd.org/web/publications/csr2000.pdf. Cited 3 Jan 2011

WCED (2011) Our Common Future. Available via http://www.un-documents.net/oct-02.htm#I Cited 6 Jan

329 AGROINDEX: proposal of a methodology for concepting Sustainable Development Indicators for Organic Family Farming

Saldanha M CW, Carvalho RJM, Melo CS, Bezerra IXB

Maria Christine Werba Saldanha (✉ e-mail:cwerbasaldanha@gmail.com) Programa de Pós-Graduação em Engenharia de Produção. Centro de Tecnologia. Universidade Federal da Paraíba. Campus I, Bloco G, CxP 5045, CEP: 58051-970, João Pessoa-PB, Brasil.

Ricardo José Matos de Carvalho (✉e-mail: rijmatos@gmail.com) Programa de Pós0Graduação em Engenharia de Produção. Centro de Tecnologia. Universidade Federal do Rio Grande do Norte. Lagoa Nova, Natal-RN, Brasil.

Crisoleide Silva de Melo (✉ e-mail: crisoleidesilva@gmail.com) Mestrado em Engenharia de Produção. Centro de Tecnologia. Universidade Federal da Paraíba.

Isabela Xavier Barbalho Bezerra (✉ e-mail: isabelaxbb@gmail.com) Mestrado em Engenharia de Produção.Universidade Federal do Rio Grande do Norte.

Abstract: Assessing and analyzing continuously the development level of the communities of organic farming is fundamental to measure that development and also subside the decision making process. To present a proposal of conception methodology for development indicator systems set to familiar organic farming on the aspects of production, productivity, sustainability and human factors. Modeling was inspired by the method of elaborating indicators by Bezerra (2014), then being carried through Participative Ergonomics associated to the method of Ergonomics Analysis of Work. The Indicators System has 5 models: a) Field recognition and exploratory research, b) Studies and Research on indicators and indicators systems available in scientific and technical literature; c) participative and situated validation; d) development of a computer version; e) experimental application. The current proposal aims to help farmers monitor, take decisions and therefore improve the production management as well as contributing to subside the formulation of public policies.

Keywords: Ergonomics; development indicator; sustainability; organic farming, family farming.

1 Introduction

Agribusiness has given a relevant participation in the Brazilian economic growth throughout the years. According to data provided by the Ministry of Agriculture (2013), agribusiness exportations ended the year 2014 presenting a surplus of US$ 79,4 billion, increasing its participation in the total exportations of the country to 39,5%. Such economic growth has occurred because of a favorable external conjuncture and also investments in modern production techniques. According to Araújo (2005) “the technological advance has changed the face of rural properties, mostly in the last 50 years (…) thus causing a leap in the agriculture productivity levels”. For Candido et al (2010), such development model based on the growth between production and consumption relationship has as its main implications the growth of the degradation level of natural resources, environmental pollution and the social inequality levels and wealth concentration.

As a result of such situation, the concepts of sustainable development and sustainability appear to offer new alternatives for agricultural practices that adopt principles that promote the sustainable development of agriculture. Among the alternative practices of sustainable farming one there is the organic farming which, according to the International Federation of Organic Agriculture Movements (IFOAM, 2005), consists of agricultural systems and products which fit into basic norms which exclude the of chemical fertilizers, artificial pesticides and herbicide and also genetic engineering and include long-term soil maintenance to enhance its fertility, compatibility with natural cycles and the maintenance of agricultural production. Niggli et al (2007) state that organic production systems may bring important contributions to empowering food through the means which provide soil fertility. As a result the resilience of food may come from fertile and well-structured soils for it ensures bigger water retention and protection to the biodiversity. As a result, in organic farming the soils capture and store more water than in conventional growing (Brief, 2012).

Family farming, which, according to Guanziroli e Cardim (2000), is featured as the one growing in which the aim of tasks on the premises is decided by both the producer and his family. Family work force is superior to hired work and the area of the property is within a limit set for each region of the country. According to Sousa et al (2005) such way of farming has demonstrated characteristics of adaptation and feasibility, once it is not only a way of generating jobs and income in the rural areas but also a way of developing sustainable production. According to 2006 census (IBGE 2009), family farmers accounted for 84% of the farms in the country and occupy 24,3 % of the cultivated area employing 74,4 % of the work force in the sector. Family farming, even being practiced in small areas, represents 32 % of agribusiness GNP, which corresponds to 10 % of Brazil’s GNP.

According to Blanc (2009) the increase in the organic sector in Brazil has been seen as a lever to the social emancipation of small family farmers thus becoming an agroecologic alternative for farming in this segment. In 2003 Brazil was introduced a legislation in which the government declared his will not only to regulate organic production but also to turn it into a lever to developing small scale agriculture. (Bellon, Abreu, 2006).

In that sense, ecologically based family farming matches the sustainability model for it gathers a group of techniques that aim to reduce the dependence on external energy and environmental impact and to obtain products with better quality, adding value to the producer, his social bases, labor, culture and territory. Moreover, it is important that sustainable usage of resources and the sharing of benefits for the biodiversity that can enable adequate processes of technological innovation and diffusion in activities and traditional practices of natural resources usage.

In the context of development and sustainability, according to Silva (2011), the production model that has been applied to family farmers in the territory of Borborema in Paraíba-Brazil, has searched for alternatives to growth based on the Agroecology, designing economically viable activities which employ great part of the family work force and avoid the contamination of the environment.

The territory of Borborema-Paraíba-Brazil, as described in the executive Summary of the territorial plan of Rural Sustainable Development (2010), occupies an area of 3.341,7 km², it has 21 municipalities and is located in the mesoregion of Agreste Paraibano, occupied 23,1% of the Estate of Paraíba.

Among the 21 municipalities in the region of Borborema, seven (Remígio, Lagoa Seca, Areial, Montadas, Esperança, Lagoa de Roça e Alagoa Nova) have since 2010 been involved in the process of revitalizing the production of agroecological potato by means of family farming. These municipalities are reconstructing the history of potato farming *(Solanum tuberosum L.)* with the support of NGO's such as AS- PTA and through projects carried and financed by the European Union, Executive Secretary of Family Farming of Estate, EMBRAPA (Brazilian Agricultural Research Corporation), EMATER (Business Technical Assistance and Rural Extension) and BNB (Banco do Nordeste) among other public and private organs

The reconstruction of the potato plantation in the region of Borborema is based on a new conjuncture that targets the production of healthy food in harmony with the environment, without the use of pesticides or chemical fertilizers. According to AS-PTA (2012), the introduction of the planting of potato in the area started in the 1930's and increased in the 70's and 80's by means of governmental support. However, the activity was conditioned to monoculture and the use of pesticides and chemical fertilizers.

Facing that reality it is necessary an ongoing analysis of the development level of such communities as a way of measuring the development generated by the activity of potato farming in that region.

The Indicators of Sustainable Development (ISD) are a preliminary guiding tool to analyze the level of sustainability a place or a location has. Silva et al (2010) emphasize that the indicators of sustainability are used a standard tool (…) they work as a basis for the analysis of development which have several dimensions (including environmental, geographic, cultural, social and economic factors), once they allow to verify the impacts of human actions in the environment. Based on these aspects aforementioned it is possible to evidence the statement of Candido et al (2010), which emphasize the importance of developing tools and/or indicators related to sustainable development in order to measure it, as well as afford data which externalize a socioeconomic, demographic, institutional, cultural and environmental reality of a country, region or location, thus responding to the complexity which involve new developmental molds.

From such considerations, the current article presents a proposal of conception methodology for development indicator systems set to familiar organic farming on the aspects of production, productivity, sustainability and human factors in order to help family farmers to monitor, take decisions and then improve the production management as well as offer a set of information which will work as subsides to managers for the formulation and implementation of public policies that provide adequate conditions for the process of local sustainable development.

2 Method

AGROINDEX modeling was inspired by the method of indicator elaboration applied in the civil construction industry, which resulted in the System of Performance Indicators in ergonomics for building construction – SIDECE (Bezerra IXB, 2013, Bezerra IXB, 2014, Carvalho RJM 2012) and features four models.

The methodology proposal in the system of sustainability indicators for organic family farming – AGROINDEX, has been conducted through Participative Ergonomics (Hendrick & Kleiner, 2006), associated to method of Ergonomic Work Analysis-WEA (Wisner, 1987; Guérin et al, 2001; Vidal, 2003).

Participative Ergonomics refers to the process of involving people in the planning and control of a significant part of their own work activities, with enough power and knowledge to influence processes and results and to set desirable aims (Wilson, 1995, *apud* Hendrick, Kleiner, 2006).

The WEA comprehends a group of global, systematic and intercomplementary analysis which enable the modeling of real activity in its own context and considering technical, human, environmental and social factors (Vidal, 2003). It has been used as a reference the methodology of Work Ergonomic Analysis-WEA (Wisner, 1987, Guérin, 2001; Vidal, 2003). The WEA comprehends a group of global, systematic and intercomplementary analysis which enable the modeling of real activity in its own context and considering technical, human, environmental and social factors (Vidal, 2003).

These methods shall be developed through a systematic process of social construction (Daniellou, 1988; Saldanha, 2004), which aims to involve and commit people who have technical competence, leadership and decision power in the farm communities, public power and pertinent institutions in order to construct this a system of indicators of that very nature.

3 Results

The system of sustainability indicators for organic family farming AGROINDEX features 3 moments: exploratory and field recognition research, modeling of system indicators AGROINDEX and experimental application.

Table 1 Methodological proposal for conception Sustainable Development Indicators for Organic Family Farming

Methodological proposal for conception sustainable development indicators for organic family farming
Exploratory research and field recognition
It aims to recognize the field and make contact with several research participants so that they are introduced to the scope of the research and invited to participate, involve and commit and also visit the plantations. Besides farmers and families other interveners' related to family farming will be present in this part of the study, such as the Secretary of Agriculture, Ibama, Fomentation Agencies, and NGO's among others
Systematic Field Research
The systematic field research relates to the systematic visit to family farming production sites, applying questionnaires, interviews and audiovisual records aiming global analysis and the study of the population from the communities involved in the project in order to acknowledge the work situation and its context. During this stage researches will also be carried with the aforementioned intervener organs related to agroecologic family farming to know their realities and necessities

	Modeling of system indicators Agroindex	
Modeling I	*Theoretical Conception of the AGROINDEX 1 System of indicators*.	
	Phase 1	Studies and Researches over the indicators and the system of indicators about production, sustainability and the human factors available in the scientific and technical literature.
	Phase 2	Selection of indicators and/or systems of indicators which involve production criteria, environmental sustainability and human factors and also that are pertinent to the interest of the current proposal.
	Phase 3	Construction of Indicators not contemplated in the previous phases.
	Phase 4	Phase of adjusting and measuring the indicators with the compulsory components thus constituting the first Agroindex Model.
Modeling II	*Participative validation of Agroindex 1* Validation is the degree in which an instrument measures what it is supposed to" (Polit, Beck e Hungler, 2004). For the current content and character validation, the first Agroindex Model shall be submitted to appreciation by a group of people, as indicated in Participative Ergonomics (Lynn, 1986 *apud A*lexandre, Coluci, 2011). Such validation will be performed from presenting a list of indicators through a likert scale of 5 alternatives so that the participants (family farmers, members of the Secretary of agriculture, IBAMA, fomentation agencies, NGO's, researchers and professors among others) respond about pertinence, usefulness and practicality of the listed indicators. This modeling process is also to receive indications of other possible indicators from the research participants, which results in a second version of the Agroindex model.	
Modeling III	*Participative and situated validation of Agroindex 2* This modeling process concerns the application of Agroindex Model 2 in family farm communities in the region of Borborema in experimental and implementation character, which results in the Agroindex 3 Model	
Modeling IV	*Developing Agroindex Software to be applied and used by the communities*. This modeling process refers to the development of Information Technology (software) Agroindex and to make it available to the family farm communities in the region of Borborema in the estate of Paraíba-Brazil. For a better understanding and comprehension of the results of Agroindex by the communities the results will be presented from a symbolic element of sustainability for the artisanal communities, such a tree, in which the leaves and fruit have different colors according to the sustainability level of each family/community, similar to the methodology "Arbre-*Arbre de l'exploitation agricole durable"* (Pervanchon, 2007, *apud*, Costa, 2010). In this way, each community/family will acquire a global image of sustainability in their property according to the color of the tree, highlighting the strong and weak spots and allowing the search for continuous improvement, i.e., better sustainability levels.	
Modeling IV	*Implementing agroindex release, training and final validation* Release and training for the use of Agroindex software in experimental character for validation and definite use by family farmers	

4 Discussion

The relevance of the current proposal is to broaden the debate over sustainable development in family farming through the development, application and release of realistic system of sustainability indicators for family farming agriculture involving the aspects of production, productivity sustainability and human factors in an integrated way.

In that sense AGROINDEX aims to contribute to: -Monitor the aspects of production, productivity, sustainability and human factors by the farmers themselves thus contributing in the search for sustainability and empowerment of families and the communities respectively; -Decision-making by the family farmers that contributes to improve the production management on sustainable bases; - Subside decision-making of the fomentation institution managers concerning the need of investments and results; -Improvement the management of projects of qualification and fomentation projects enabling the comparison of indicators before and after the interventions.; -Release a set of information which will subside the managers to formulate and implement public policies that allow adequate conditions for local development.

5 Final Considerations

The current proposal starts from the premise that the assessment of sustainable development must take into consideration the local features and diversities from the understanding of the activity and its anthropotechnological context (Wisner, 1997), and also from a participative methodology (Hendrick, 2005). From the ergonomics point of view, the proposal of this project inserts itself in the field of anthropotechnology and macroergonomics. In summary, Macroergonomics (Hendrick, Kleiner, 2006) teaches us that optimizing solutions must be searched in the articulation between technical systems and people management systems with special attention to Human Factors. Anthropotechnology (Wisner, 1994) states that the single adoption of foreign methods and technologies in a country, different from corporate organizational culture has led into failure several processes of transference of technology and knowledge. Because of that, it is recommended to search for theoretical elements combined with the adjustment of some tools and inserted in a process of solution development adequate to the organization.

6 References

Alexandre NMC, Coluci, M O (2011) Validade de conteúdo nos processos de construção e adaptação de instrumentos de medidas. Ciência & Saúde Coletiva, 16(7):3061-3068

Araújo MJ (2005) Fundamentos de Agronegócios. 2. Atlas, São Paulo

AS-PTA Batata agroecológica gera oportunidades para famílias agricultoras da Borborema. http://aspta.org.br/2011/08/batata-agroecologica-gera-oportunidades-para-familias-agricultoras-da-borborema. Acesso 18 abril. 2013

Blanc J (2009) Family farmers and major retail chains in the Brazilian organic sector: Assessing new development pathways. A case study in a peri-urban district of São Paulo. Journal of Rural Studies, 25(3)322-332

Bellon S, Abreu LS (2006) Rural social development: small scale agriculture in Sao Paulo, Brazil. In: Holt, G., Reed, M. (Eds.), Sociological Perspectives of Organic Agriculture: From Pioneer to Policy. CABI: Publishing.

Bezerra IXB, Carvalho RJM (2012) Construction and application of an indicator system to assess the ergonomic performance of large and medium-sized construction companies. Work, 41, http://iospress.metapress.com/content/375g42m43m5x5pm7/?supp=1&genre=article&spage=3798&issn=1051-9815&volume=41Acesso 10 agosto 2013

Bezerra IXB (2014). Desenvolvimento de um Sistema de Indicadores de Desempenho para Empreendimentos em Construção Civil, utilizando a Abordagem Macroergonômica. Dissertação de mestrado. PEP-UFRN

BRASIL, MDA – Ministério do Desenvolvimento Agrário, 2013. SAF – Secretaria da Agricultura Familiar, 2013. http://portal.mda.gov.br/portal/saf. Acesso 02 fevereiro 2014

Brief P (2012) The Potential of Organic Agriculture. Reducing Global Warming.

Cândido GA, Vasconcelos ACF, Souza EG (2010) Índice de Desenvolvimento Sustentável para Municípios: uma proposta de metodologia com a participação de atores sociais e institucionais. In: Cândido GA (Org). Desenvolvimento Sustentável e Sistemas de Indicadores de Sustentabilidade: Formas de aplicações em contextos geográficos diversos e contingências específicas. Ed. UFCG, Campina Grande-PB

Guanziroli C, Cardim SE (2000) Novo Retrato da Agricultura Familiar: O Brasil redescoberto. Brasília: Projeto de Cooperação Técnica FAO/INCRA. http://www.incra.gov.br/fao/pub3.html. Acesso 22 abril 2013

Guérin, F et a (2001) Compreender o trabalho para transformá-lo: a prática da ergonomia. Edgar Blucher, São Paulo

Hendrick HW, Kleiner BM (2006) Macroergonomia: uma introdução aos projetos de sistemas de trabalho. Virtual Científica, Rio de Janeiro

IBGE (2009) Censo Agropecuário 2006 – Agricultura Familiar: primeiros resultados - Brasil, grandes regiões e unidades da federação. IBGE, Rio de Janeiro

IFOAM (2005) International Federation of Organic Agriculture Movements. IFOAM Basic Standards: Bonn

Niggli U, Earley J, Ogorzalek K et al (2007) Organic agriculture and environmental stability of the food supply. http://www.orgprints.org/10752. Acesso 23 abril 2013.

Polit DF, Hungler BP (1995) Fundamentos de pesquisa em enfermagem. 3ª ed. Artes Médicas, Porto Alegre

PTDRS (2010) Resumo executivo plano territorial de desenvolvimento rural sustentável Território da Borborema-PB. http://sit.mda.gov.br/download/ptdrs/ptdrs_qua_territorio024.pdf Acesso 24 abril 2013

Saldanha MCW (2004) Ergonomia de concepção de uma plataforma Line Oriented Flight Training (LOFT) em uma companhia aérea brasileira: a relevância do processo de construção social de projeto. 236f. Tese Doutorado em Engenharia de Produção. COPPE/UFRJ.

Saldanha MCW, Carvalho RJM (2013) AGROINDEX – Índice de Desenvolvimento da Agricultura Familiar: uma aplicação na produção agroecológica da batata orgânica na região da Borborema-PB. Projeto de Pesquisa e Extensão. Edital Programa Redes Digitais-PB.

Silva AM, Correia AMM, Cândido GA (2010) Ecological Footprint Method: Avaliação da Sustentabilidade no Município de João Pessoa, PB.In: Cândido GA. Desenvolvimento Sustentável e Sistemas de Indicadores de Sustentabilidade: Formas de aplicações em contextos geográficos diversos e contingências específicas. Campina Grande, PB: Ed. UFCG, 236-271.

Silva ED, Silva MJ et al (2011) Estratégias de produção da batatinha agroecológica no Agreste da Paraíba. In: Anais VII Congresso Brasileiro de Agroecologia: http://www. abaagroecologia.org.br/ojs2/index.php/cad/article/view/11602. Acesso 23 abril 2013

Sousa MC et al (2005) Sustentabilidade da Agricultura Familiar em Assentamentos de Reforma Agrária no Rio Grande do Norte. In: Revista Econômica do Nordeste, v 36, nº 1, http://www.repositorio.ufc.br:8080/ri/bitstream/123456789/3948/1/2005_art_mcsousa.pdf. Acesso 22 abril 2013

Vidal MCR (2003) Guia para Análise Ergonômica do Trabalho (AET) na Empresa. Editora EVC, Rio de Janeiro

Wisner A (1987) Por dentro do trabalho: Ergonomia, método e técnica. FTD/Oboré, São Paulo

Wisner A (1994) A inteligência do trabalho: textos selecionados em ergonomia. Fundacentro, São Paulo

341 WCM Green Belt: Reduction of the exchange time of the "shirt" of roller mill

Carvalho A, Brito L, Brito J

Alisson Lara de Carvalho (✉ e-mail: alisson.carvalho@saint-gobain.com)
Saint Gobain – Barbacena-Brazil.

Lucas Costa Brito (✉e-mail: brito.lcb@gmail.com)
UFSJ - Universidade Federal de São João del-Rei, Praça Frei Orlando, 170, São João del-Rei - MG, CEP 36307-352.

Jorge Nei Brito (✉ e-mail: brito@ufsj.edu.br)
UFSJ - Universidade Federal de São João del-Rei, Praça Frei Orlando, 170, São João del-Rei - MG, CEP 36307-352.

Abstract: In this project, based on the World Class Manufacturing technique, some ways to reduce the exchange time of the “shirt” of roller mill were developed. As this equipment is so important in a lot of companies around the world and because of their difficulty in maintenance some alternatives are presented in this paper in order to try to improve the production and help to solve problems like this. Moreover the World Class Manufacturing Green Belt technique was used and because their steps were followed the success of the project was guaranteed.

Keywords: Roller mill, WCM, Green Belt.

1 Introduction

The evolution of the world economy associated with globalization has contributed to the rise of new consumer markets, especially the emerging economies like Brazil. This scenario associated with an increasingly competitive economy has shown a constant need to improve the resources and costs, making it necessary to make full use of the entire productive capacity. As a result, organizations are constantly seeking new management tools that directed toward greater competitiveness through quality and productivity of its products, processes and services, Kardec and Nascif (2009).

In 1980, through a company in the region of Barbacena - Brazil the production of silicon carbide was started. Later in 1999 it had become one company of the Saint - Gobain group. The obtaining of silicon carbide is made by mixing silica (sand or quartzite) and carbon (Petrocoque) carried on resistance furnace. This process is discontinuous due to the characteristics of the product; fusion does not occur, in other words, the reactions occur in the solid state (Saint Gobain, 2014).

Saint-Gobain Ceramic Materials from Brazil currently produces silicon carbide that is traditionally used as feedstock in the production of abrasives (grinding wheels, abrasives, cutting discs), refractory (brick, crucibles, gutters furnace) and serve as the input for the steel industry.

The world of manufacturing has undergone many major changes leading to guidelines on what is "best practice" or world class manufacturing (WCM) in terms of both methods of operation and performance (Hendry, 1998). So, aiming to increase production by reducing stopping time for maintenance, various factors of manufactures were analysed in order to act upon which it would get better results, Saint Gobain started the WCM project.

As said by Yamashina, 2000, the first step to world-class manufacturing is to implement TPM (Total Productive Maintenance) successfully and to create an active organization. So, led by an engineer of Saint Gobain, the group did the project green belt in the roller mill to reduce the stopping time for maintenance. The whole project was based on the technique WCM – World Class Manufacturing which provides resources to reinforce the production rules and avoid losses. According to Flynn, 1997, the WCM Project seeks to articulate the practices which are associated with world-class manufacturing and their interrelationships. Moreover, the TPM - Total Productive Maintenance technique was used, which according to Suzuki, 1994, the TPM improves business results considerably and ensures a safe, enjoyable, and productive work to optimize the relationship between people and the group with they work.

2 Process and techniques description

The production process of silicon carbide is quite complex. It passes through various stages to reach the industry in which it operates this work. Therefore, the whole plant was studied and the characteristics of the roller mill too. So, it was possible to achieve the best performance.

The processing plant - Macro Abrasives, is where the material arrives and processed to get the final material.

2.1 WCM Green Belt

The method helps guarantee the success of the project. In essence, the method is the plan that helps to make sure the team has covered all the bases and done so in the right sequence (Sigma Quality Management, 2007).

According to Khani (2014), World Class Manufacturing presents the combination of conceptions, principles, policies and different techniques for management and operation of productive organizations. This conception after World War II and the results of activities that led to a revival of Japanese industry was given life. In conceptual determining of production in the world class, also variety definitions have been proposed. Researchers introduced world-class manufacturing concept by the definition: World class manufacturing is a wide agreement on the continuous improvement of quality, cost, waiting time, and the customer service. Another researcher has defined World class manufacturing as the continuous attempt to improve quality, decrease expenses, waiting time, and the customer service. Also, he considers the continuous attempt to improve quality, decrease expenses, waiting time, and the customer service in the context of customer service and innovation as the differentiation of the production and operation of world-class. Developing World Class Manufacturing has mainly 2 major reasons.

The first one is globalization and another one is organizational paradigm. Many definitions in the field of globalization phenomenon have been presented so far. For example, some specialists consider the globalization as the process of structural development in the economic, political and social activities that is led to the emerging forms of transnational and regional power and international relations.

Rass (2011) with the vast discussion upon organizations of World Class Manufacturing expresses Alignment theory in the organizations of world-class production. He considers the Information Technologyas the imperative and key factor to create alignment of organization. Also, he considers the close relationship between strategic resources (cultural structure, information processes and human capital) and believes that if these resources and responsibilities were in line with technology and IT, organization would reach World Class Manufacturing.

3 Project Description

Due to the case that this was a Green Belt project where some steps must be followed, first of all the Master Plan (planning schedule of the whole project) was implemented, in order to define all the steps and dates.

Based on the Master Plan and the data about the roller mill, the Cost Deployment was done, where the group noticed that the Setup was the focus of the improvement. The other points showed in the Cost Deployment, for example lack of material or maintenance were treated in other project by other group.

Thus, it was noted that there was a high time for changing the roller mill "shirt", approximately 25 hours, which could be reduced by 30% in order not to waste three shifts of production in each changing and now spend just two shifts. So, reducing by 30% the roller mill will achieve better production rates. Moreover, after this changing the maintenance equipment will be available to work in others areas, as shown in Figure 1.

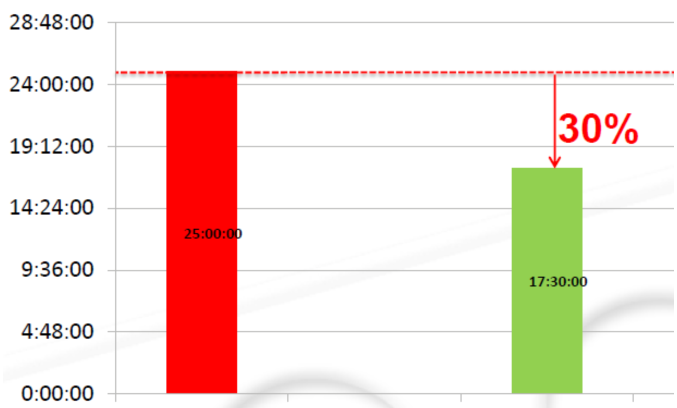


Fig. 1 Total change time. Red bar means initial time and green bar final time.

4 Implementation of the Steps

After defining the goal of the project the steps outlined in the Master Plan were done in order to succeed at the end of it.

4.1 *Step 1: Choose one type of material exchange, set a starting point and goals*

Due to the wear of the roller mill the production efficiency is drastically reduced. Thus it becomes necessary to carry out its replacement. Such change in turns requires time, which makes the production stopping during this period.

After analyzing the major changing points the setup seemed to be the best way to reduce the stopping time. According to the Figure 2, where the first bar is before and the second bar after made the changes, the principal point was setting up the acoustic case where the roller mill used to be (pink bar in the Figure 2). This figure shows exactly the changing before and after making change. An important point that the group noticed was the time. At the beginning of the project, the real time of changing was 17 hours (it is not the total time as shown in Figure 1). So the goal became to reduce by 30% of the 17 hours, and then applying the changes the changing time became 12 hours, as shown in Figure 2.

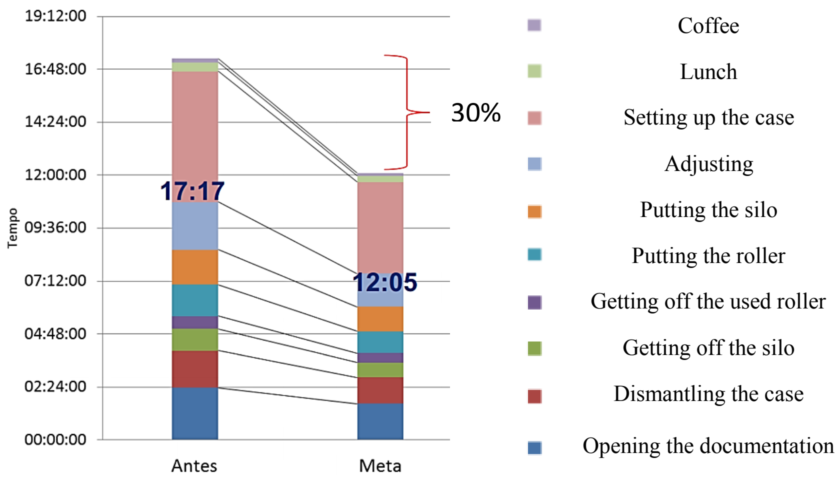


Fig. 2 Reduction of total change time.

4.2 *Step 3: Setting the best standard and training operators*

Several analysis were carried out in steps in order to obtain the optimal shift pattern of the roller mill. To start with an analysis in the first exchange was made and what could be improved was showed, and thus gave the Gantt chart to the project.

From the Gantt chart and other sources, several points have been identified and changes were proposed to them. Such as the presence of bag in front of the mill making it impossible to drive the truck (use to take off the parts of the roller mill), bad storage protections and consequent disorganization of the same difficulties and the withdrawal of the silo, Figure 3.

Fig. 3 Examples of problems detected.

Thus, in order to identify all points of improvements, the Diagram of the Causes and Effects was also created, in addition to the 5 Whys Method. In order to reduce the handling and therefore the time for tricks and search tools / parts, there was the Spaghetti Diagram.

With all the data collected, some procedures were created and actions were taken in order to achieve project success. Checklist pre-exchange, which ensured that all outside activities were fulfilled and the swap process began on schedule with no delays were created. Moreover, the group created an Instruction of Procedures ensuring that every step of the planning was followed without any doubt. There were all members of the group green belt and operator training, so that everyone can learn to deal with each step of the project and exchange procedure. All acoustic roller mill houses were tagged which facilitated knowing the order for assembling it later.

Therefore, a new Spaghetti Diagram based on the best shift was created, Figure 4. In Figure 4, the lines mean the way that truck and operators did the changing. After relocating things in the area, it is clear that the way to work was reduced, consequently the time of changing was reduced too.

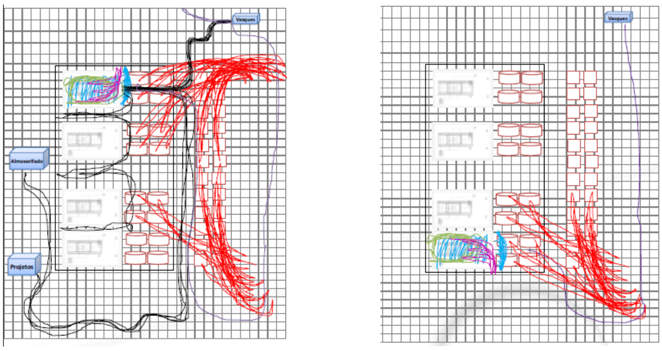


Fig. 4 Spaghetti Diagram - First figure is the model before the changes and the second is after change in which line means the lifting done in the process.

4.3 Step 4: Introduce a registration system anomaly

First of all, it was very important deciding the best system registry with the possible anomalies that can be found in the exchange procedure and a gap to add new ones.

After defining what, who and when operators were trained. Continuous monitoring of the process always done.

4.4 Step 5: Analysing and solving anomaly

In each exchange the priorities of anomalies, defining countermeasures, 5 Whys, Diagram of cause and effect and implementing the tracking table were reviewed. Therefore some measures could also be taken to optimize the process, such as improving the system of identification of the acoustic house, fixing tag in the fixed part of the house too.

4.5 Step 6: Improve the standard more

In order to further improve the standard, activities have been divided into micro activities and thus fitted the flow chart (VA - Earned Value).

In addition to activities proposed in the flowchart, an ECRS (Eliminate, Combine, Reduce and Simplify) technique was applied. Completing all actions for improvement, a new time expect of 9 hours and 30 minutes to the next trade was defined.

4.6 Step 7: Introduce an automated system

An analysis of the current method of exchange was conducted, and it was found that many boards had lots of screws, lack of standardization and high torque bolts. Thus in order to automate the system, pneumatic screwdrivers and screws were acquired been standardized.

4.7 Step 8: Monitoring the steps

For all members of the Green Belt Group and other employees of the manufactures to have access to all project information, a board “Large Table” was made, which contained all the steps of the project.

5 Results

At the end of the project, the goal was achieved and good results were obtained. Due to some new anomalies identified it is expected to reduce shifting time further in future charts.

What is more, the proposed target for each member of staff was achieved, reaching the ideal point of knowledge for the entire group.

Thus, reducing the time of exchanging the “shirt” of the roller mill there was a great reduction in cost as a result. Therefore, there was a rise of 30 ton per month of the roller mill production. And reducing from 25 hours to 10 hours the changing and make a profit of R$154,800 per year, based on their production and cost.

6 Conclusion

Projects like this show the importance of carefully observation of the process, as the key to achieve success. Small changes can bring big results as shown.

Besides that, it is important that the process should continue to be monitored so that the gains are maintained. Continuous analysis of anomalies and monitoring of trade, following the procedures of planning exchange, training employees whenever there are significant deviations and systematically monitor the indicators of exchange time and the main deviations are fundamental keys to success.

Moreover, after implanting these steps it has become clear that working with Reliability Centered Maintenance (MCC) instead of fixing just because the equipment failed. And developing this concept that according to Raposo (2004), means a systematic approach to maintenance planning, considering aspects of reliability and because of it numerous benefits are presented in the literature arising from the application of MCC in maintenance programs.

7 References

Barbara B. Flynn, Roger G. Schroeder, E. James Flynn, Sadao Sakakibara, Kimberly A. Bates, (1997) "World-class manufacturing project: overview and selected results", International Journal of Operations & Production Management, Vol. 17 Iss: 7, pp.671 - 685

H. Yamashina, (2000) "Challenge to world-class manufacturing", International Journal of Quality & Reliability Management, Vol. 17 Iss: 2, pp.132 - 143

Kardec, A. Nascif, J. (2009). Manutenção: Função Estratégica. Rio de Janeiro, Editora Qualitymark, 384p.

Khani, (2014). World Class Manufacturing. Management and Technology. Pp. 507-513.

Linda C. Hendry, (1998) "Applying world class manufacturing to make-to-order companies: problems and solutions", International Journal of Operations & Production Management, Vol. 18 Iss: 11, pp.1086 – 1100

Raposo, J.L.O. (2004) "Reliability Centered Maintenance apply in electrical systems: a proposal for use of analysis risk diagram in decision. vii, Salvador, Brazil

Ross, D.F., "Aligning the Organization for World Class Manufacturing", Production and Inventory Management Review 19, 2011. 9-99.

Sigma Quality Management, (2007). The Green Belt Six Sigma Toolkit, 1p. Raleigh, NC.

Saint Gobain (2014) Ceramic Materials. http://www.saint-gobain.com.br/pt/empresas/pesquisa/materiais-ceramicos. Cited 06 April 2014

Suzuki, Tokutaro, (1994). TPM in Industry Process. 6p. Productivity Press, New York.

342 Collaborative Networked Organizations In The Brazilian Clothing Industry

Silveira M A P da, Alves D S

Marco Antonio Pinheiro da Silveira (✉e-mail: marco.pinheiro@uscs.edu.br)

Professor do Programa de Pós Graduação em Administração. USCS Universidade Municipal de São Caetano do Sul. Rua Santo Antonio, 50, Centro, 09521-160, São Caetano do Sul, São Paulo. Brasil

Davis Souza Alves (✉e-mail: davis@e-davis.net)

Mestrando do Programa de Pós Graduação em Administração. USCS Universidade Municipal de São Caetano do Sul. Rua Santo Antonio, 50, Centro, 09521-160, São Caetano do Sul, São Paulo. Brasil

Abstract: This research was based on the model of Collaborative Networked Organizations (CNO). The research focused on the clothing industry, which usually out sources production processes. It is important that participants in a CNO have a common Value System, or else, there may be different perceptions of the results and an inter-organizational conflict. Camarinha Matos and Macedo (2010) defined a Conceptual Model of Value System in Collaborative Networks, based on the definition of value and evaluation. Using this model, we analyzed the supply chain of women's clothing manufacturers from São Paulo, Brazil. The mapping of activities and actors of the network was based on the eight qualitative aspects of the model. Results showed that the value system is not fully common among participants and the collaborative network should use more intensively Technologies of Information and Communication.

Keywords: Collaborative Networked Organizations, Value System, Clothing Industry.

1 Introduction

This research is based on the model of Collaborative Networked Organizations (CNO), proposed by Camarinha Matos in different studies, with different co-authors. Camarinha Matos and Afsarmanesh (2004) define Collaborative Networked Organizations as autonomous groups of small/medium-sized companies or groups of people who, independent of contracts, are linked by means of a network in order to work in different lines of business: according to the authors, this setting promotes more competitiveness, agility, in addition to fostering innovation and exploring new businesses.

The Virtual Organization concept has been researched by different authors. Lima (2002) states that a virtual organization is basically the one that emerges from a market opportunity and searches for partners from a variety of areas in order to make a product available. “There is a parent-company-Broker-which usually has a main competence, though lacking some complementary competences. In order to mention a few characteristics of the virtual organization, it links people, resources and ideas by means of technology. It is extremely adaptable; it has no rules or rigid structures, and it integrates key-competences between real organizations. In addition, it is an enterprise that can be brought to an end after meeting demands. Finally, its concept arises from the competitive conjecture."

Clothing manufacturers usually outsource most of their production processes, and are in charge of performing such tasks as design, trade and finances. In this model, suppliers play an important role and it is important that a collaborative network between participants be established.

2 Theoretical Framework

2.1 Valor the Conceptual Model of the Value System

Camarinha Matos and Macedo (2010) define the concept of Value System and highlight that this system plays an important role in the collaborative network, as it is determinant in the decision-making process and in the environment of the participants of a business network. Consequently, the identification of the existing value system in the network and its participants is essential whenever the collaboration process needs to be improved. Therefore, the authors highlight the importance of managing the Value System in a CNO. "When partners have different value systems, they may have different perceptions of the results, which may cause non-collaborative and inter-organizational conflicts". (CAMARINHA MATOS AND MACEDO, 2010). Thus, Camarinha Matos and Macedo (2010) proposed eight theoretical definitions related to the value system in a CNO, where the eighth definition is a summary of the previous ones, represented in an equation format. The first seven definitions are addressed next, according to the authors´ view.

a) **Definition 1 = <u>Value</u>:** It is related to the use and/or importance of something.
b) **Definition 2** = **<u>Object of the evaluation</u>:** Object of the evaluation can be any valuable thing to the evaluator (for instance, resources, processes, behaviors, relationships, beliefs, information, etc.).
c) **Definition 3 = <u>Evaluator</u>:** Defined as an individual, collective subject or tool that performs the verification, the analysis of a certain object.
d) **Definition 4 = <u>Evaluation</u>:** Evaluation is the process of judging, measuring or calculating quality, importance or quantity of something.

Judging, measuring and calculating are performed essentially in two basic manners: in an objective manner, by applied rules and formulas to the data that characterize the evaluated object, and in a subjective manner, using the perceptions of importance, the quality or quantity of something. In other words, the value of something depends on the function used to evaluate it.

The overall object is not judged, but its specific characteristics such as technological and social competences and prestige. Therefore, it is important to provide a way of specifying a particular property of an object. Products, services and behavior have several characteristics and each one of them can be evaluated independently. When making an overall evaluation, several characteristics are evaluated so that they are aggregated to individual values in order to make up an overall value. To better clarify this notion, two other terms are introduced: *Evaluation Dimension and Evaluation Perspective*.

e) **Definition 5 = <u>Evaluation Dimensions</u>:** They are the characteristics of an evaluated object. Examples of characteristics in collaborative networks: competences, financial robustness, prestige and level of trust of the participants.

f) **Definition 6 = <u>Level of Importance</u>:** The relevance of an evaluation dimension for an evaluator.

g) **Definition 7 = <u>Evaluation Perspective</u>:** It is a chosen set of evaluation dimensions and corresponding weights to evaluate an object from a certain point of view.

Once the 7 necessary definitions are understood in order to understand a value system in collaborative networks proposed by Camarinha Matos and Macedo (2010), the next sub-session presents Sweet Girl – the Brazilian company studied in this paper

2.2 Process Description and Collaborative Network Sweet Girl

Sweet Girl is a company that has been operating in the fashion business, manufacturing clothes and selling them for over 18 years, more specifically, manufacturing young women´s clothes. In its hierarchy, the company has internal and external employees. Its organization structure is presented in figure 1, below.

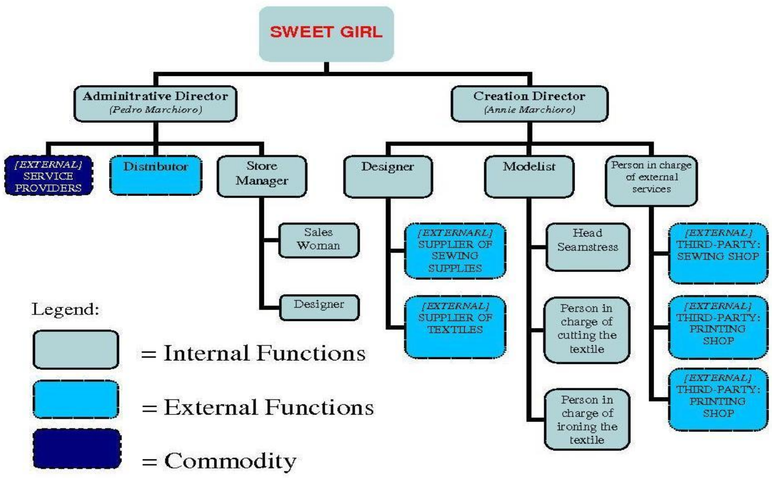


Fig. 1 Company´s Organizational Chart. Source: developed by the authors

In addition to the hierarchy, figure 1 shows where each job position is, whether it is internal, external or third-party companies of commodities. All the members take part, directly or indirectly, in the manufacturing of the company´s products. It is also possible to see the power of centrality exerted by the Creation Director as the controller of the managers who deal with third-party companies. The interaction between internal actors is seen in figure 2, through a typical production process of the company, where it is possible to see an extremely lean structure in which all phases of the production process are directed at companies that have the necessary expertise in their business and that add value to their products.

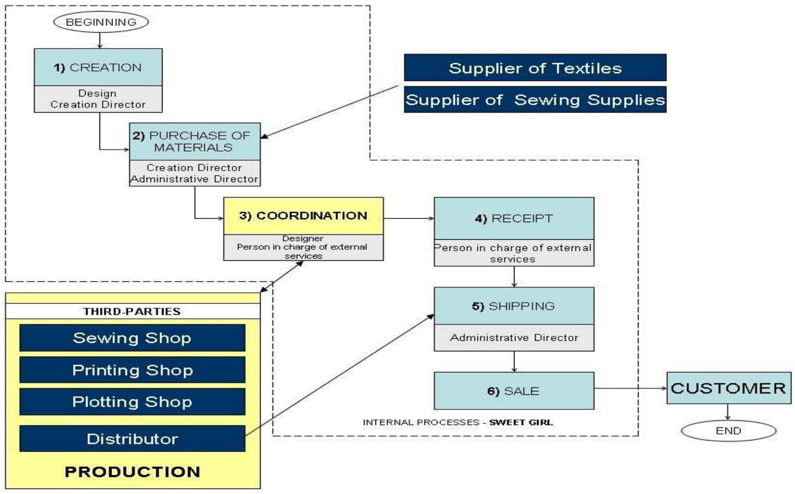


Fig. 2 Sweet Girl´s internal processes and third-party network Source: developed by the authors

By analyzing figure 2, six dependent macro-activities are evident, each one of them with an internal manager in charge of its control. Furthermore, it is possible to see the interaction between Sweet Girl´s members and activities as well as the network of companies to which supply and production activities are outsourced. An aspect to be highlighted regarding the processes used by Sweet Girl is its use of Information Technology and Communication (ITC). The company only uses it internally in the creation stage. It also uses an ERP software called Millennium Business of Millennium Network Co.; however, these technologies are not used in the existing relations with third-party companies and suppliers.

3 Methodological Procedures

The survey at Sweet Girl was done between April and July, 2013. Data collection was performed by means of interviews with the managers of Sweet Girl: Administrative Director, Creation Director, Designer and Person in Charge of External Services. The script, below, is composed of open and closed questions. Initially, it was explained to the managers the perspectives of the evaluation.

Next, the manager was requested to evaluate each third-party company according these perspectives, with both open and closed questions, using an adaptation of the scale presented by Camarinha Matos and Macedo (2010) in Figure 1, with possible perspectives of evaluation. Authors Camarinha Matos and Macedo (2010) used such scales as Good, Fair and Very Good. In this research the same scale was used, but adapted as follows: Very Good, Good, Neither good, nor bad, Bad, Very bad.

Cases regarded as valid by the survey were those in which the third-party company was evaluated by more than one manager. In these cases, an overall evaluation of a third-party company was obtained, done by each manager using the following criterion: a score was assigned to each category on the Likert scale as follows: five (5) as Very Good, four (4) as Good, three (3) as Neither Good, nor Bad, two (2) as Bad and one (1) as Very Bad. A comparison was then performed. Values for each perspective evaluated by the manager were added (Technological Competence, Social Competence and Prestige).

For each third-party company and supplier, the difference between overall evaluations by the managers who evaluated them was analyzed. If all the differences between evaluations were between zero (0) and two (2), it was then considered that the perceptions are similar and that the value assigned to the third-party company or supplier is the same. If there is a difference greater than two (2) between two managers, it was then considered that the perceptions were distinct and that there is a difference in the value system.

4 Result Analysis

The analysis of the data collected is divided into two parts. Initially, the adherence of the Sweet Girl network to the Collaborative Networked Organizations and Virtual Organization model is evaluated, proposed by Camarinha Matos and his co-authors. Next, it is evaluated whether there is a mutual Value System between the interviewed managers

4.1 Adherence by the Sweet Girl´s network to the Collaborative Networked Organizations (CNO)

By analyzing the suppliers´ network scheme in Figure 3, it is possible to see that the way Sweet Girl operates is adherent to the CNO model, as most of its activities are done by third-party companies. This result was, somehow, previously known and it is possible to state that most of the clothing companies operate based on this model. Sweet Girl fits into the Virtual Breeding Environment – VBE, based on a long-term cooperation agreement. The companies involved are all small- sized, consistent with VBE´s characteristics.

4.2 Value System in Sweet Girl´s network

4.2.1. Evaluation according to the points of view of the third-party companies and suppliers

Figure 3, which is sequentially presented, shows the results obtained from the interviews with the managers of Sweet Girl. As described in the "Methodological Procedures" section, it was determined that, for each third-party company and supplier, whether there was a difference between the evaluations of the managers that relate with them. By taking the described adopted criterion into account, it was noticed that the Sewing Shop was the only company to which a difference was identified between the evaluations of the managers. It was also the company that obtained the worst overall evaluation, considering the three managers who evaluated it. It is the largest one among the third-party companies and plays an important role.

As previously shown in the company´s organizational chart, it is possible to see in figure 3 two managers (evaluators) with the same number of direct contact with the suppliers and third-party companies (object of the evaluation), those being the Creation Director and the Designer, both relating to four objects of the evaluation.

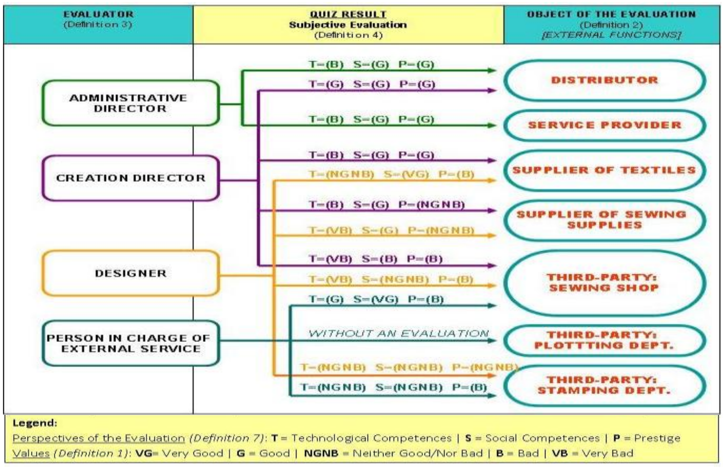


Fig. 3 Results of the evaluations of the suppliers according to each manager´s point of view Source: developed by the authors

Quantified results of the evaluation by Sweet Girl´s managers are shown for each object of the evaluation – third party companies.

1) Evaluation of the Distributor: Administrative Director: 10; Creation Director: 12 Mean: 11; Difference in the Evaluation: 2

Areas that evaluated this partner were the administrative and creation directors and it is possible to note by difference in the evaluation that there are great opportunities for improvement in the provision of services related to technological perception and trends of stabilization/growth related to all perceptions.

2) Evaluation of the Sewing Shop: Creation Director: 5; Designer: 6; Person in Charge of External Services: 11; Difference in the Evaluations: 5

Among the evaluated suppliers/partners, the Sewing Shop got three evaluations (creation director, designer and person in charge of external services). It was also the only evaluation regarded as distinct by the head office, as the difference between evaluations were higher than two points.

By taking the perceptions into account separately, it is possible to infer that these suppliers/partners are the ones who give rise to higher divergence of opinions and dissatisfaction at the expected level of services of these companies. Except for the person in charge of external services who attributed 4 points to the technological perception and five to the social one, it was inferred that the suppliers/partners need to reconsider their strategies, adopt new procedures and establish a direct communication channel with Sweet Girl aiming at improved adherence between the objectives of the company and of its customers.

3) Evaluation of the Printing Shop: Designer: 9; Person in Charge of External Service: 8; Difference in the Evaluations: 1

The areas that evaluated this supplier/partner were the designer and the person in charge of external service. According to the head office, the evaluations are regarded as similar with a difference of one point in the sum of the perceptions. It is noted that there is agreement between technological and social perceptions, identifying the need for improvement in these two perceptions. Regarding prestige, it is possible to state that they also need improvements aiming at the stabilization of the attributes involving this perception.

4) Evaluation of the Sewing Suppliers: Creation Director: 9; Designer: 8; Difference in the Evaluations: 1

The areas that evaluated this supplier/partner were the creation director and designer. According to the answers, the evaluations are regarded as similar with a difference of one point in the sum of all perceptions. It is noted that although there is a similarity in the evaluations regarding social perception and prestige, it is possible to state that the criteria that encompass the perception of prestige identify the need for improvement, while they also identify the need for stability/improvement of the attributes related to social perception.

5) Evaluation of the Supplier of Textiles: Creation Director: 10; Designer: 10; Difference in the Evaluations: 0

The areas that evaluated this supplier/partner were the creation director and designer. The evaluations are regarded as similar as they reach similar scores, adding to the score of all the evaluated perceptions. It is noted, however, that there is no agreement in any point of view, making it clear the existence of great opportunities of improvement in the provision of services related to technological perception, stabilization/growth in relation to social perception and improvements in relation to the prestige of these companies.

6 Final Considerations

The purpose of this research was to analyze the network of suppliers of the women´s clothing manufacturer Sweet Girl based on the Conceptual Model of Value System in Collaborative Networks by Camarinha-Matos and Macedo (2010). The mapping of activities and actors of the network was performed and later based on the eight qualitative aspects of the model. Results showed that the value system is not fully common among participants and the collaborative network should use more intensively Technologies of Information and Communication including their ERP software Millennium Business.

7 References

AFSARMANESH, H.; MARÍK, V.; e CAMARINHA-MATOS, L. M. Collaborative Networked Organizations: A Research Agenda for Emerging Business Models, 2004.

CAMARINHA-MATOS, Luis M., MACEDO, Patricia.“A conceptual model of value systems in collaborative networks.” Journal of Intelligent Manufacturing, 2010: 287-299.

LIMA, F. C R.Avaliação de custos da cadeia logística integrada. Tese (doutorado) – Universidade Estadual de Campinas, Faculdade de Engenharia Mecânica. 2002.

346 Analysis of practice sustainability implemented by traded companies: Case studies

Egea JS, Cavenaghi V, Battistelle RAG, Scoton EJ

Juliana Santos Egea (✉ e-mail: juju_egea@hotmail.com)
Departamento de Engenharia de Produção. Faculdade de Engenharia de Bauru. UNESP. Luiz Carrijo Coube, S/N. Bauru.

Vagner Cavenaghi (✉e-mail: vagnerc@feb.unesp.br)
Departamento de Engenharia de Produção. Faculdade de Engenharia de Bauru. UNESP. Luiz Carrijo Coube, S/N. Bauru.

Rosane Aparecida Gomes Battistelle (✉ e-mail: rosane@feb.unesp.br)
Departamento de Engenharia de Civil. Faculdade de Engenharia de Bauru. UNESP. Luiz Carrijo Coube, S/N. Bauru.

Edvaldo José Scoton (✉ e-mail: scoton@faac.unesp.br)
Departamento de Engenharia de Civil. Faculdade de Engenharia de Bauru. UNESP. Luiz Carrijo Coube, S/N. Bauru.

Abstract: Verify the importance of sustainability in two organizations of sectors: wood and graph comparing their sustainable actions provided by the sustainability report and other reliable sources in the literature. Thus, we seek to find the loopholes, paying attention to the differences between theory and practice considering the issue of sustainability, discussing modifications and additions involving these differences. During the work, the sustainable practices of the two organizations will be detailed (the three dimensions of sustainability), the first through field research; other reports in the literature and perceived in class. The three dimensions of sustainability, environmental, social and economic aspects, must be accompanied with the business competitiveness of organizations.

Keywords: Sustainability, organization, good practices.

1 Introduction

The authors Cunha Ferreira and Rossetto (2008) state that it is appropriate to verify the changes that occur in the responsible organizations for sustainable development , because they are increasingly subject to the requirements of the market and society.

Vehmas and Koskela (2012) argue that an important dimension of a competitive and sustainable organization is the relationship between environmental and economic performance understood as eco-efficiency.

Thus, it can be stated that sustainability involves strategy , management and profit. The social and economic dimensions generate risks and opportunities that deeply modify the sectors of activities and the reality faced by organizations today (Savitz and Weber 2007).

The modern business world has undergone technological change and globalization, innovating in implementing governance models, culminating in sustainable business management, economic and environmental aspects involving adapting products and processes of organizations. First, we identify the most significant environmental impacts and after this step, define the most appropriate way to minimize such impacts.

The social report was developed by the need for accountability of business to society, such as resources. In this sense, the social balance is an accounting system that provides social information aligned with the organization's strategies.

Therefore, ways of establishing the organization relationship of stakeholders and customers by disclosing information about their accounts and practical signals not only sustainability but focus on competitive intelligence.

Verify the importance of sustainability in an organization timber industry and other graphic comparing their sustainable actions provided by the sustainability report and other reliable sources with the literature that suggests that organizations sustainability, finding gaps and analyze them, the differences between organizational theory and practice when considering the issue of sustainability, discussing modifications and additions involving these differences.

During the work, the sustainable practices of the two organizations will be detailed (the three dimensions of sustainability), the first through field research; another through the literature and reports perceived in class.

Check the level of commitment and awareness on the part of the organizations studied, evaluating the importance of actions such as development strategies and competitive advantage, seeking to keep alive through the concept of corporate social responsibility.

The theme of this work is relevant because it is able to provide or simply maintain the sustainable development of enterprises is of great importance for its growth. We sought to determine the existence of patterns of economic, environmental and social practices in the operations of the organizations studied and operating modes of compliance with the best sustainable practices in the name of sustainable development.

Should follow the pre -determined actions, indicators and results disseminated usually present them as excellent tools to leverage increasingly maintain sustainability in the companies.

Aiming to follow the predetermined actions, indicators and results disseminated usually present themselves as excellent tools to leverage increasingly maintaining sustainability in the companies.

2 Theoretical Foundation

The same should be designed with the help of political and cultural issues. They are important for any analysis, linking other topics. In general, the definitions seek to integrate economic viability with ecological prudence and social justice, the three dimensions known as triple bottom line (Moura, 2002).

Attempt was also made to establish what is meant by the term sustainability. There is a consensus among researchers that this concept should be analyzed comprehensively, is a complex issue and has several approaches (Kato, 2008). Sustainability is the result of a standardized complex of an organization that has five basic characteristics:

interdependence, recycling, partnership, flexibility and diversity.

2.1 Corporate Sustainability

According to Strobel (2004) grows daily appreciation of environmental issues in the corporate segment, meeting new legislative requirements of the market and society. The predominant economic focus in planning, but was replaced by broad concept of sustainable development, in which the growth targets are associated with efforts to reduce the effects of the environment.

The impacts caused by the companies to the environment reflect its market and the organization's image before the public. Therefore, the organizations have to continually incorporate sustainability concerns in their reports.

Tinoco and Kraemer (2004) state that evidence is "disclose information of economic, financial, social and environmental performance of organizations of the social partners, stakeholders, considering that the financial statements and other disclosure information must not be misleading".

As Ribeiro Filho (2005) environmental disclosure implies the need to answer some questions:

What: information about events and transactions involved with environmental issues;

How: with the level of detail required by the relevance of the values and nature of expenses related to the company's interaction with the environment;

When: accounting should be done at the time when the triggering event occurs, or when additional supplementary information;

Where: Financial statements and notes, depending on the extent and nature of all information to be provided. It is noticed that the big difference in the concept of sustainability in business is able to associate the issue of eco - efficiency, with the notion of corporate social responsibility.

In other words, the company continues to profit, their main goal, passing to consider the impact of their activities on the environment looking to relieve them while performing social actions are for the benefit of its employees or the community.

2.2 Implementation of Sustainability of Organizations

The growing interest in sustainability has shown impacts on business strategies. Are increasingly charged statements that the company has a sustainable focus. This collection is performed both by society and by their corporate customers governments, among others (SGASRBI, 2009).

The above concept has been presented by several authors including Bertoncello and Chang (2007), as an increasingly important topic in the business context, revealing impacts on the goals and strategies of companies.

This corroborated for the establishment of international and national sustainable practices that signal to the market the commitment of companies with social responsibility.

Organizations have the ability to deploy multiple tools aimed at sustainability and can affirm that the choice of tool that the company will deploy is performed after research on which instrument more appropriate and sustainable practices to achieve organizational goals.

Social and environmental responsibility should consider the assumptions of the paradigm of sustainability. Social responsibility is characterized by the attitudes and activities based on ethical and moral values to minimize the negative impacts that cause environmental organizations.

Corporate social responsibility, according to Young (2004), has definitely become an important tool for the sustainability of organizations. Currently , the concepts that guide a socially responsible management - ethical and transparent relationship with all stakeholders that relate to the company for the development of your business and society , preserving environmental and human resources for future generations - bring several benefits to organizations ;Corporate social responsibility, according to Young (2004), has definitely become an important tool for the sustainability of organizations. Currently, the concepts that guide a socially responsible management - ethical and transparent relationship with all stakeholders that relate to the company for the development of your business and society, preserving the environmental and human resources for future generations - bring various benefits to organizations;

In a survey conducted by Uniethos Institute (200), the study group recognizes that the inclusion of sustainability in strategic planning is a necessity. Tal result is able to reveal that 69% of companies consider the interests of stakeholders in strategic planning.

Oliveira (2005) proposes four steps for the strategic planning:

a) Planning purposes: mission, purpose, goals, targets challenges and goals;

b) Planning means: to propose ways for the organization to obtain desired future state, expanding its production capacity - macro strategies, macro policies, strategies, policies, procedures and practices;

c) Organizational Planning: Wedge organizational requirements for implementing the proposed means. An example to be mentioned: the structuring of the company in strategic business units;

d) Resource planning: scale the human and physical capital and resource. Search for establishment of programs, projects and action plans necessary to achieve the desired future endowed with corporate social responsibility.

In this sense, the social balance is an accounting that provides social information. However, in isolation, it does not raise the possibility of analyzing or even compare the actions taken by companies with results reported in other reports, for example, the sustainability report.

According to Global Reporting Initiative - GRI (2002), sustainability reporting for publicly traded organizations help in mitigating variations in stock prices and capital costs, providing information to the general market. GRI methodology seems more complete and comprehensive before all other analyzed, divide the possibility of application in any business sector , regardless of its size, defining the indicators : economic, environmental and social , in that order of priority .

3 Methodology

The research in question can be characterized as exploratory qualitative study to use two detailed case studies and literature review. The case study is characterized as a category of research that seeks a unit that is analyzed.

After the presentation and development of concepts obtained by field research in the first company in the wood sector, sustainability report that depict current sustainability initiatives: and in the second, including literature review its sustainability report and reliable sources.

Regarding the literature review is based on texts on the topic of large bases of periodic data, such as Emerald, Science Direct, and SciELO journals Portal CAPES . The material will be researched tools and methods used by organizations chosen to deal with sustainability.

3.1 Selection Organizations

Two organizations were studied. The first, the wood industry, the highly competitive national and global level, has good values and practices with commitment, continuous improvement, innovation and sustainability in the quest to provide products and services market leaders, analyze its sustainability report and also fieldwork with individuals as well as other information involving the strategic management of companies. The second, the printing industry, serving regional and national audience, is possessed of good sustainable practices updated bibliographic form.

4 Results and Discussions

The two organizations were analyzed in three classifications:

4.1 Organization 1

From a reinforced strategy and top management support, there is evidence that corporate governance works very well in this organization, being featured in this category, as well as reduces the emission of greenhouse gases in 2012, through gas monitoring, control, measurement, aligned and efficient use good management practices. The disclosure of its contents is also strong.

As for effluent control, driven by innovation and new technologies, which deals with the principles of renewable energy by checking its relevance and the eighth in this segment by the average power consumption of the category. Your use number of biomass was positive, reaching percentages of reuse and new sources quite high. Their effluents are treated by him, through the Wastewater Treatment stations. This consumption was lower by 10% when considering the year 2011.

There is a formed social policy, as its name indicates, greatly increasing the value of the individual and diversity within the organization. Its principles are systematically manage, communicate clearly and make the employee participates, exposing their suggestions whenever possible. Invests heavily in social programs for the cities where the factories are located.

We continually use the principles of clean energy. In this topic, as stated above, it was mentioned that the eco-efficiency and cleaner production would be treated as the financial aspect. It can be stated that the concept of eco-efficiency is well developed, but the report contains little information, transmit this knowledge in other ways, including: cost reduction, consumption of clean energy, among others, implicit in other processes or categories.

Having the P + L nomenclature is not mentioned throughout the report, but as it is a multinational internship evolved into a sustainable, it can be stated that such gains are achieved through the realization of goals.

We note that the company prefers other disclosures and not the cleaner production, a somewhat older concept. Described above are activities that are carried out in this regard.

4.2 Organization 2

This organization does not have indicators that measure GHG emissions, the prospect will be soon for the first inventory, continuing its commitment to sustainability through the analysis of key actions for this process and attack them at the time of publication of the report , had replaced its fleet of cars from gasoline to alcohol, to minimize this situation.

There is little information regarding the control of effluents in its report. It is known that there were, chemical spills transported by specialized companies and not disposing effluent directly into the soil. Regarding the aspect of energy, which directly influences the financial aspect; the more it reduces, unless you pay; for a company that is still in development, it is clear that start attacking these realities.

The human aspect is highly valued, as well as the comfort of his family, raising basic benefits, but also analyze what this population needs more work, going to the correct focus that seeks to continuously improve, achieving good productivity index and low levels of absenteeism.

Despite the organization in society is known to have deployed concepts of cleaner production to floor with the great help of sustainability, eco-efficiency best practices and P + L are implicit environmental impacts are minimized as varied and generates profit.

There are financial measures for the previous use of the present - is inextricably linked to educational work in the use and improvements adopted as installing flow reducers, buying a recycler of water for processing sheet and plate buying processor that does not use water for development.

Remains the importance of the sustainability report for society in general knows actions of organizations, appearing as a brilliant tool for the dissemination of good practices, including sustainable.

A sustainable company is one that contributes to global sustainable development by generating economic, environmental and social benefits. There is a strategic rationale for seeking sustainable value in organizations.

So, with new concerns, companies that corporate sustainability, began to focus not only economic goals but also environmental and social, with the goal of generations and their own future needs.

5 References

Barbie E (1998) The Practice of Social Research. Belmont: Wadsworth Publishing Company v.8.

Barbosa PRA (2007) Índice de sustentabilidade empresarial da bolsa de valores de São Paulo. Exame da adequação como referência para aperfeiçoamento da gestão sustentável das empresas e para formação de carteiras de investimento orientadas por princípios de sustentabilidade corporativa. Dissertação (Mestrado em Administração). Universidade Federal do Rio de Janeiro.

Bertoncello SLT (2007) A Importância da Responsabilidade Social Corporativa como fator de diferenciação. FACOM. n 7. 1ª Semestre.

Duratex. Relatório de sustentabilidade (2012). Available at: <http://www.duratex.com.br/ri/pt/download/Duratex_RA_12.pdf>. Cited 05 Set 2013

Ferreira E, Cunha J, Rossetto CR (2008) Adaptação estratégica e gestão ambiental. Um estudo das mudanças organizacionais em uma indústria de fundição da região de Joinville – SC.

Fialho FAP (2008) Gestão da sustentabilidade na era do conhecimento: o desenvolvimento sustentável e a nova realidade da sociedade pós-industrial. Florianópolis. Visual Books.

GRI (Global Report Initiative) (2006). Diretrizes para Relatório de Sustentabilidade. Amsterdam.

Kato CA (2008) Arquitetura e sustentabilidade: projetar com ciência da energia. Dissertação de mestrado. Universidade Presbiteriana Mackenzie.

Koskela M, Vehmas J (2012) Defining Eco-efficiency: A Case Study on the Finnish Forest Industry. Business Strategy and the Environment, 21, 546-566.

Miranda AB, Teixeira BA (2004) Indicadores para o Monitoramento da Sustentabilidade em Sistemas Urbanos de Abastecimento de Água e Esgotamento Sanitário. Revista Engenharia Sanitária e Ambiental.

Molina J, Azorin F (2009) Environmental practices and firm performance: an empirical analysis in the Spanish hotel industry. Journal of Cleaner Production. 17, (5), 516-524.

Moura LGV (2002) Indicadores para a avaliação da sustentabilidade em sistemas de produção da agricultura familiar: o caso dos fumicultores de Agudo. Dissertação de mestrado. Desenvolvimento Rural. Universidade Federal do Rio Grande do Sul.

Oliveira DPR (2005) Planejamento estratégico: conceitos, metodologia e práticas. 22. ed. São Paulo: Atlas.

Paulraj A (2008) Environmental Motivations: a Classification Scheme and its impact on Environmental Strategies and Practices. Business Strategy and the Environment, Wiley InterScience.

Oliveira DPR (2005) Planejamento Estratégico**:** Conceitos, Metodologias e Práticas.

Savitz A, Weber KA (2007) A empresa sustentável: o verdadeiro sucesso é lucro com responsabilidade social e ambiental. Rio de Janeiro: Elsevier.

Tiliform (2013) Relatório de sustentabilidade 2010. <http://www.tiliform.com.br/tiliform/pt/index.php?GTR_VARS_acesso=modulos/sustentabilidade/lisNoticia.php&>. Cited 05 Set 2013

Tinoco JEP, Kraemer MEP (2004) Contabilidade e gestão ambiental. São Paulo: Atlas.

352 Application of heuristic evaluation in sensitive touch interface

Machado L, Vergara L G L

Laís Machado (✉ e-mail: l.machado@posgrad.ufsc.br)
Dpto. de Engineering of Product. Universidade Federal de Santa Catarina. Trindade – Florianópolis- Brasil.

LizandraGarciaLupi Vergara (✉e-mail: l.vergara@ufsc.br)
Dpto. de EngineeringofProduct. Universidade Federal de Santa Catarina. Trindade – Florianópolis- Brasil.

Abstract: The market currently offers a significant amount of new technologies that are rapidly absorbed by its users. But for a technology actually facilitate day-to-day lives, the products should be efficient and easy to use, otherwise it may cause frustration or even dispose of the product by its users. We notice therefore that usability is of great importance both to previous technologies and for new technologies, requiring verification techniques are always in accordance with the technologies that seek to observe. The current scenario is characterized by major changes in the types of interfaces and interaction in the form of products offered in the market. The touch technology is in many products such as mobile phones, tablets and others. Thus the present study makes an analysis of usability of a tablet by applying the heuristic evaluation.

1 Heuristic Analysis

Heuristic evaluation is an inspection method created by Jacob Nielsen and Molich (1993), one of the most used methods to find interface problems. Heuristic evaluation is a systematic assessment that can be applied by means of a list of criteria (called heuristics) to be observed at the interface, their good and bad traits, in order to realize future problems (noise) which can cause discomfort to user, and can solved previously.

The main goal of heuristic evaluation is to verify the usability of a given interface. For that specialists in usability or ergonomics can judge carefully its ergonomic compliance is required, based on principles recognized by usability (Moraes, 2002).

According to Nielsen (1993), the efficiency of the method to 3 reviewers is around 60 % to 4 reviewers, around 70% and 5 evaluators, around 75%. (Maciel, 2004).

Despite the heuristic evaluation did not use the presence of users, it is perceived as one of the most important methods for the analysis of interfaces .

For Nielsen (1994) heuristics have 10criteria and 18 sub-criteria that dot the ergonomic compliance , relevance and applicability in different levels of research.

In principle the evaluation can be conducted by a single reviewer , but it is already known that interfaces evaluated by a single reviewer finds on average 35% of the errors of the interface . As each reviewer tend to find different problems according to their experience and expertise , is indicated for more constructive results use 3-5 evaluators in order to find about 2/3 of the existing problems in the interface . (Nielsen , 1993)

This tool becomes a key part of many projects by allowing it to be applied at any stage of the project , from conception through assessment modeling and modeling as summative method and should be applied by a professional in the field of ergonomics interface, which has expertise for the implementation of the tool .

Typically heuristic evaluation takes 1 to 2 hours , and interfaces, larger and more complex requiring more time should be divided into smaller steps. Each step is performed to focus on an area of the interface to ensure the quality of assessment . (ROCHA, 2003)

Many experts in the field of evaluation use a strategy called inspection adjective / noun. When they find a problem in the interface , this problem is named according to the noise that is presented with an adjective (ambiguous, inadequate, inconsistent, vague) or a noun (design element, format, label, structure), to indicate characteristics for which is being listed as an error and then more details will be added to add more descriptions to errors.

As a result of the method has a list of problems encountered, discussed with reference to the principles violated in the process of creating the interface thus becomes easier error correction and selection of new replacement alternatives at the interface. For the application of heuristic evaluation is necessary to choose a list of heuristic principles to guide and frame our analysis.

2 Methods and Materials

For the tests in the evaluation of touch-screen interface, we used:

Tablet Samsung handsets brand called Tab2 with 7 inch screen illustrated by the following figure:

Fig. 1 Tablet used in the application of usability testing. Source: www.sansung.com

As users of touch-screen interface are varied with respect to time experience with the interface, users age, gender and other characteristics were defined as a basis for evaluation:

Persons 18-35 years old who have little experience in the touch-screen interface.

3 Application of the method

1 ° - System Status - Heuristic ATTENDED:

Regarding the status of the system generally keeps the user informed of the relations that are performing.

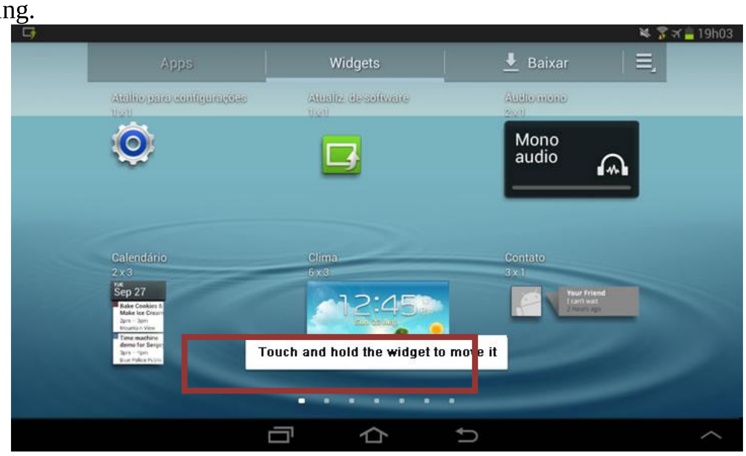


Fig. 2 Status of system

Fig. 3 Status of system (writing action)

2 - Match between system and the real world - Heuristic VIOLATED:
The tablet also presents the data and the actions that can be performed with titles and words easy to understand user. But still perceive some terms that are not the complete understanding by users or it is not yet used words as "widgets", abbreviations like applications used for word-only "apps" system aims to present actions.

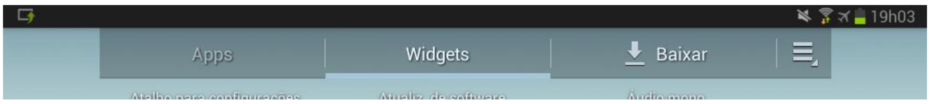


Fig. 4 compatibility with the real world

3 - User control and freedom - Heuristic ATTENDED:

The system has high flexibility, using different functions on the options to add items, modify and customize to suit each user. One example is the working area of the tablet, in which the user can add items that you use most and delete those that you use infrequently.

4 ° - Consistency and standards - Heuristic ATTENDED:

The tablet follows the conventions of computers and semantic features next. The machine has a button that brings together virtually every function in tabular form, it is possible to allocate some items on the desktop or delete them from the desktop. It also allows the user to position the most consistent with its use, group items on the same screen relationship in carrying out the task.

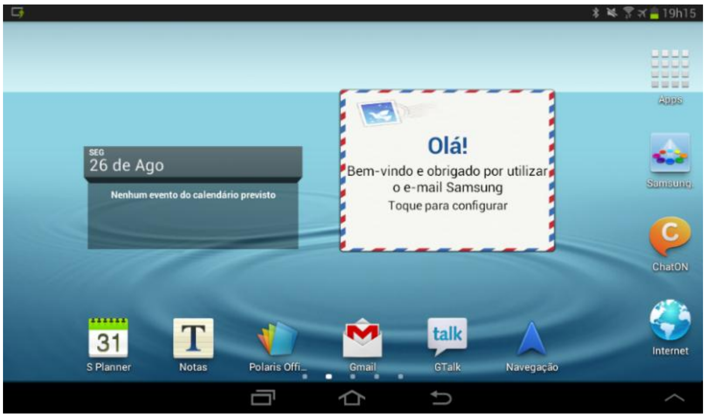


Fig. 5 Workspace that can be modified

5 ° - Error prevention - Heuristic ATTENDED:

The equipment includes the heuristic not to perform critical actions without confirmation of the action by the user. So when you delete an item or perform some critical action the machine will ask if they really want to perform that action, stating that no longer have to undo it, and only after confirming the system performs the action. Thus the system also avoids errors and unexpected actions by the user.

6 - Recognition rather than remembrance - Heuristic VIOLATED:

With respect to this heuristic, the equipment can not meet in full so that possess smaller size just to be with the limited area to display the data. When you're writing a message or typing a password, often ends up the virtual keyboard overlay the screen and which part you're looking at the screen, which is going against the heuristic of remembrance.

7 - Flexibility and efficiency of use - Heuristic ATTENDED:

With respect to flexibility equipment caters well this heuristic, allowing different forms of customization and also the agility of some functions according to the user experience. May perceive the application of this heuristic in the creation of new workspaces with group items according to the logic that the user is interested.

Fig. 6 Flexibility and efficiency

8 - Aesthetic and minimalist design - Heuristic ATTENDED:
The system presents no Question in exaggerated form. Overall, the aesthetic is based on ease of understanding the user's system.

9 - Help users in the recognition, diagnosis and correction: Heuristics ATTENDED:
The machine has a help system and also tips that always appear in the first uses of each resource, remaining until the user check the box "do not show again" to ensure that the user has read the message and already has the knowledge how to accomplish the task.

10 - Help and documentation - Heuristic ATTENDED:
The system features to aid novice users whenever a function is accessed for the first time, a dialog box that displays "tips" and offers some options for the user to know what action to perform.

Fig 7 Help of system

According to the assessment made on the basis of 10 heuristics, one realizes that the product meets the majority of requirements, taking eight heuristics and not given only two, the second heuristic on the system's compatibility with the real world, in which the apparatus has some terms that are not common consumer use as widgets, apps.

4 Conclusion

According to the assessment made on the basis of 10 heuristics one realizes that the product meets the majority of requirements, taking eight heuristics and not given only two, the second heuristic on the system's compatibility with the real world, in which the equipment has some terms that are not common consumer use as widgets, apps; and sixth heuristics, about recognition rather than remembrance that the product meets partially because by having a small size the equipment does not have all the data at once when you're typing a message or a password the virtual keyboard is often about the object you're typing which impairs the use and visual tracking task.

5 References

CYBIS, Walter de Abreu; BETIOL, Adriana Holtz; FAUST, Richard. (2010) Ergonomia e usabilidade: conhecimentos, métodos e aplicações. 2. ed. rev. e ampl. São Paulo (SP): Novatec, p. 422.

MORAES, Ana maria de. (2002). Design e avaliação de interface:ergodesign e interação humano-computador. Rio de Janeiro: iUsEr, 147 p. : ISBN 8590286215.

NIELSEN, J.(1994). Heuristic Evaluation. Em J. Nielsen (ed.) Usability Inspection Methods, John Wiley, New York.

NIELSEN, J. (2012) CARD SORTING: How many users to test.useit.com. Disponível em: <http://www.useit.com/alertbox/20040719.html> Visitado em: Agosto.2012.

ROCHA, Heloisa Vieira da; BARANAUSKAS, Maria Cecília C. (2003). Design e Avaliação de Interfaces Humano-Computador.Campinas, SP: NIED/UNICAMP.

SAFFER, Dan.(2009). Designing for Interaction: Creating Innovative Applications and Devices. Segunda Edição. Berkeley.

SFHINX BRASIL. (2013). Software tratamento de dados análise do conteúdo.Visitado em 02 de Novembro de 2013. Disponível em <http://sphinxbrasil.com/produtos/softwares/lexica-quanti-e-quali>

SEVINHAGO, Rodrigo. HERDEN, Adriana. VALLIM, Marcos BanhetiRabello.(2009). Análise de usabilidade do software de programação de três kits comerciais de robótica educacional. UTFPR - Universidade Tecnológica Federal do Paraná CIPECA – Centro Integrado de Pesquisa em Controle e Automação.

SHACKEL, B. (1991). Usability – context, framework, definition, design and evaluation. In. SHACKEL, Brian & RICHARDSON, Simon, eds. Human factors for informatics usability.Cambridge, Cambridge University Press, p. 21-38

Extended Abstracts

048 Analysis of credit constraints influence on companies' investments from Brazilian electricity sector

Cotomacio A, Rossetti N, Meirelles J

André Carrara Cotomácio (✉e-mail: andrecotomacio@gmail.com)Dept. of Production Engineering. Federal University of São Carlos. Sorocaba - São Paulo - CEP: 18052-780 - Brazil.

Nara Rossetti (✉e-mail: nara@ufscar.br)Dept. of Production Engineering. Federal University of São Carlos. Sorocaba - São Paulo - CEP: 18052-780 - Brazil.

Jorge Luis Meirelles (✉e-mail: jorgeluis@ufscar.br) Dept. of Production Engineering. Federal University of São Carlos. Sorocaba - São Paulo - CEP: 18052-780 - Brazil.

Extended Abstract: This study aimed to understand the behavior of the companies from Brazilian electricity sector as for the use of their own resources to provide capital for investments when these firms are affected by credit constraints, taking into account their size and degree of financial leverage (DFL). For this purpose, a derivative of the empirical model proposed by Fazzari, Hubbard and Petersen (1988) was applied. Following the study, the regression panel data technique was employed in a database comprising financial information from 16 companies that compose the Electric Power Index (IEE) from BM&FBOVESPA. The results obtained, when the degree of financial leverage (DFL) was used as the criterion to separate the sample to represent credit constraints, confirm Fazzari, Hubbard and Petersen's (1988) hypothesis. Such results are due to the dependence observed between the cash flow and investment variables for those companies with an unfavourable financial leverage degree, classified as constrained firms. For the uncon-strained ones though, with a favourable degree of financial leverage, this dependence was not confirmed. Nevertheless, using the size of companies (based on the value of total assets) as a criterion to separate the sample to designate credit constraints, dependence between cash flow and investment in the large companies, classified as unconstrained firms, was observed. For the small companies, classified as constrained firms, this dependence was not observed. This conclusion contradicts Fazzari, Hubbard and Petersen (1988), but confirms the trend presented by Kaplan and Zingales (1997), who argue that cash flow influence on investment does not grow monotonically with the credit constraint degree in a given company. According to Oliveira and Cunha (2012), the size of the companies is a good criterion to designate credit constraints. Yet, the result obtained in this study differs from their proposition, which is frequently referred to in academic papers.

055 Modeling for Performance Evaluation of Beef Slaughterhouses

Costa RP, Siluk JCM, Soliman M, Neuenfeldt Júnior AL, Machado CM, De Paris SR

Marlon Soliman (✉e-mail: Marlon Soliman)
Center for Innovation and Competitiveness.Federal University of Santa Maria.Roraima Avenue, n° 1000 building 7, room 300, Postal Code 97105-900 Santa Maria. Brazil.

Extended Abstract: The objective of this study was to propose a modeling to assess the performance of beef slaughter houses regarding its production costs, contributing to identify critical processes that adds value and increases competitiveness. The methodology comprehended, at first, a bibliographical research on accounting, costs management, strategic management and performance assessment, which pointed out that the activity-based costing method known as UP (Units of Production) and the concepts regarding to the Key Performance Indicators (KPI's) could be considered as the most appropriated methods to construct the indicators of evaluation. The proposed modeling is composed by fourteen steps: Definition of the production areas (1); Definition of the costs centers (2); Creation of the operative posts (3); Supervision distribution (4); Equipment cadastre (5); Determination of families of products (6); Market creation (7); Creation of groups of products (8); Cadastre of feedstock (9); Cadastre of products (10); Cadastre of productions (11); Allocation of expenses by cost centre (12); Allocation and division of indirect costs (13); and Allocation of expenses of indirect costs (14), returning in the end a structured tool to assess the industrial cost. In order to verify a practical application, we tested the modeling in a slaughterhouse located in Brazil, where the indicators Operational cost; operational cost per animal; operational cost/kg produced; UP's produced; UP's value; and UP's produced per animal; were evaluated for six months. The results were compared to previous established goals, allowing the managers to measure the efforts necessary to manufacture each product and enabling faster and more efficient solutions to make decisions.

056 Maturity of Performance Measurement Systems for Supply Chain Management

Frederico G, Martins R

Guilherme Francisco Frederico (✉e-mail:guilherme.frederico@ufpr.br)
Dpto. of Business Administration. Federal University of Paraná. Curitiba/PR. Brazil.

Roberto Antonio Martins (✉e-mail: ram@dep.ufscar.br)
Dept. of Industrial Engineering. Federal University of São Carlos. São Carlos/SP. Brazil.

Extended Abstract: The Supply chains have gained important focus after 2000's due to not only the opportunities that it can provide but also the complexity involved on its management. Into this context, the implementation of different management practices can help companies to achieve better performance in their supply chains. As part of these practices it can be considered the Performance Measurement Systems (PMSs). The theory for PMSs has been concentrated on only organization perspective. At the same time the theory about PMSs for Supply Chain Management (SCM) is focused more on scope of measurement leaving a lack with regards other dimensions that must be considered on the PMS maturity development. Therefore, this research aimed to answer the following research question: which dimensions should be considered for the maturity management of PMSs for SCM?From the main findings obtained through a systematic literature review it was possible to identify eleven PMSs for SCM which shows focus only on measurement scope. Also, two maturity models for PMSs were found out showing more dimensions to be considered on the maturity management of PMSs beyond scope of measurement. As the main contribution from this research a theoretical model presenting the alignment between the maturity of PMSs and PMSs for SCM is proposed to help practitioners and researchers on the maturity management of PMSs for SCM.

068 Between visions and images: re-reading MLP framework on Sustainability Transitions (ST)

Viegas C V, Vaz C R, Gusberti T H, Werustky V D'B O, Selig P M, Varvakis G

Cláudia Viviane Viegas (✉ e-mail: claudiavv@unisinos.br)
Industrial Engineering Post Graduation Program. University of Vale do Rio dos Sinos. Av. Unisinos, 950, Cristo Rei, ZIP 93022-000, São Leopoldo, RS, Brazil.

Caroline Rodrigues Vaz (✉e-mail: caroline.vaz@posgrad.ufsc)
Industrial Engineering Graduation Program. Federal University of Santa Catarina. Trindade, ZIP 88040-900 Florianópolis, SC Brazil.

Tomoe Hamanaka Gusberti (✉ e-mail: tomoe.gusberti@ufrgs.br)
Post doct researcher. Scientific and Technological ParkPraça Argentina, s/n, Building 11.102, ZIP 90040-020, Porto Alegre (RS), Brazil.

Viviane D'Barsoles Oliveira Weruskty (✉ e-mail:viviwerustky@gmail.com) Industrial Engineering Graduation Program. Federal University of Santa Catarina. Trindade, ZIP 88040-900 Florianópolis, SC Brazil.

Paulo Selig (✉ e-mail:selig@egc.ufsc.br) and Gregório Varvakis (✉ e-mail: grego@egc.ufsc.br).
Engineering and Knowledge Management Post Graduation Program. Federal University of Santa Catarina. Trindade, ZIP 88040-900 Florianópolis, SC Brazil.

Extended Abstract: Sustainability Transitions (ST) is a multidisciplinary and multiple layered field of study that has been increasingly developed in the last two decades .especially through Multiple Level Perspective (MLP) framework. MLP states ST as dimensionally oriented to three aspects: landscape, socio-technical regimes, and niches. MLP has been widely employed to assess transitions in several strategic fields, as agriculture/food supply, energy, water/sanitation systems, and transportation. It has also received a massive bulk of criticism for leaning on niches as protected spaces for sustainable innovations, without consideration of gaps related to niches-consumption aspects. Visions and images are metaphorical forms of represent sustainable paths in terms of strategic planning. While visions relate to idealized future, based on desirable paths, images are linked to more realistic assumptions on future, propping itself on probable deployment of current situation. This article analyses three MLP/ST studies published in 2002, 2008, and 2010, taking visions and images concepts and development as cornerstones to coarsen MLP criticism. It is found that vision-type is dominant approach, but it does not bequeath necessary answers for filling the gap between niches' development and sustainable consumption - an issue that has been only recently targeted by ST studies, out of MLP mainstream.

082 Ergonomics action and production strategies: what's the relationship between them?

Gonçalves J, Camarotto J

Juliana Machion Gonçalves (✉e-mail: jumachion@dep.ufscar.br) Dpto. de Engenharia de Produção. Centro de Ciências Exatas e Tecnologia. Universidade Federal de São Carlos. São Carlos, CEP 13565-905, Brasil.

João Alberto Camarotto (✉e-mail: camarotto@dep.ufscar.br) Dpto. de Engenharia de Produção. Centro de Ciências Exatas e Tecnologia. Universidade Federal de São Carlos. São Carlos, CEP 13565-905, Brasil.

Extended Abstract: The contributions of ergonomics, in improvements in work situations, understand on activities in different working conditions with a view to processing, through ergonomic action. The professionals' participation from different areas and hierarchical levels, within the organization and individual workers, facilitates the identification, analysis and correction of problems in the implementation of the changes by promoting the integration of ergonomics as a variable in design operations improvements at the company. The activity's ergonomics is conducted by the relationship of health and productivity. The operation strategy can be articulated in this relationship, it has understood that there is a direct relationship between project operations and its operation on the factory floor. As objective, this research contributed to the advancement of knowledge about the effectiveness of the ergonomics actions, from the perspective of activity's ergonomics; in respect a management model that in ergonomics operation strategies of the company as a condition of processing work. The theoretical and methodological approach of this research was action research with the assumptions of the local ergonomics and ergonomic work analysis (EWA). As a result, it was confirmed that the company is guided by their operations strategies in order to decide and take actions to define role, objectives and activities of production. The health and productivity's strategies, related to ergonomics, were incorporated in the following policy areas: work organization, human resources, product and process technology, supply chain management, and performance indicators. Thus, the introduction of the ergonomics concepts' in decision areas of manufacturing strategy contributed to ensure adequate working conditions to workers.

117 Categorizing after learning from a database

Lozano J, Gómez A, Puente J, De la Fuente D

Jesús Lozano (✉ e-mail: lozano@uniovi.es), Alberto Gómez, Javier Puente, David de la Fuente
Dpto. de Administración de Empresas. Escuela de Politécnica de Ingeniería de Gijón. Universidad de Oviedo. Campus de Viesques S/N, 33204 Gijón.

Extended Abstract: We start having data over 10 numerical variables and one symbolical category, which forms a record, in a CSV database, up to a total of 1100 records. Then, we first evaluate with cross-validation the data, which takes in 10 steps 110records and check if it matches the symbolical real category from the inference of the other data. This forms an array of confusion in which the deviations from the diagonal are errors. If the training quality index, an error complementary coefficient, is under 0.9 (maximum 1) the data could contain potential for categorizing new data, but not in real world applications. After that, we could do training over the database, called A, to categorize another one, and called B. As a result, a decision tree constructed from A is applied to data B showing the probability of each category. In the test conducted, we used the module Algorithm: Decision Tree version 2.2, in language Perl (www.cpan.org), and both the process of evaluation and the categorization takes few minutes each.

118 El análisis DAFO como herramienta estratégica de la Planificación Urbana

The SWOT analysis as strategic tool for Urban Planning

Ros-McDonnell D, de la Fuente-Aragón MV, Ros-McDonnell L

Diego Ros-McDonnell (✉e-mail: diego.ros@upct.es)
Dept. Arquitectura y Tecnología de la Edificación. Arq&Ide. Universidad Politécnica de Cartagena. Paseo Alfonso XIII, 50, 30203 Cartagena.

Mª Victoria de la Fuente-Aragón (✉e-mail: marivi.fuente@upct.es)
Lorenzo Ros-McDonnell (✉e-mail: lorenzo.ros@upct.es)
Grupo I+D Gestión e Ingeniería de Organización. ETSII. Universidad Politécnica de Cartagena. C/Dr. Fleming, s/n, 30202 Cartagena.

Extended Abstract: One main urban planning objective is to improve the quality of life in cities. The environmental circumstances affect the urban areas, conditioning the city and territory planning and management. Urban planning needs tools to understand the different planning phases and stages, and facilitate the further development and implementation of plan's determinations. This paper focuses on the SWOT analysis as a useful tool to study the cities and urban planning status.

127 Engineering Social Innovation

Felekoglu B, Ozmehmet Tasan S

Burcu Felekoglu (✉e-mail: burcu.felekoglu@deu.edu.tr)
Department of Industrial Engineering, Dokuz Eylül University, Izmir, Turkey

Seren Ozmehmet Tasan (✉e-mail: seren.ozmehmet@deu.edu.tr)
Department of Industrial Engineering, Dokuz Eylül University, Izmir, Turkey

Extended Abstract: Social innovations create social value by addressing social needs and/or solving social problems. Social issues may involve education, health care, natural environment, etc. Although there is vast amount of research related to commercially driven innovations, little academic study exist solely focusing on social innovations. Particularly, there is a call for more research to identify the drivers of/antecedents to social innovation. Focusing on this call, our interest in this study is to better understand how social innovation is engineered, namely to investigate the drivers of social innovation. Following an extensive review of the social innovation concept and examples, a model was constructed based on the effective application of engineering management principles using four basic managerial functions; organizing, leading, controlling and planning. These functions were instrumental in identifying the five drivers of social innovation while combining and analyzing the findings from literature review. The five main drivers are awareness, a powerful boundary spanning mechanism, networking, availability of targeted funding and a committed development team. In this study, these drivers were explained in more detail and possible research directions were introduced for further research to better understand this emerging research field.

129 Assessment of Assembly System Design Alternatives in Low Cost Intelligent Automation

Ozmehmet Tasan S

Seren Ozmehmet Tasan (✉e-mail: seren.ozmehmet@deu.edu.tr)
Department of Industrial Engineering, Dokuz Eylül University, Izmir, Turkey

Extended Abstract: In competitive manufacturing environment where the demand of the product is rapidly changing, the company must respond to these changes while designing the assembly systems. During this design process, the companies usually face lots of dilemmas. The most important one includes maintaining low cost while securing legal safety regulations. Low Cost Intelligent Automation (LCIA) is an approach for effective manual production with manual stages, simple control systems and clever tools, which are integrated to produce the productive, flexible and high-quality method of assembly. In this study, an appropriate assembly system for a company is designed to meet the constraints and the desired quality of the final product while maintaining CE legal safety regulations by using the different approaches in LCIA philosophy while eliminating the waste, solving design problems and designing the automatic stations according to the safety regulations. First, the manual tasks are improved step by step by eliminating waste and standardizing the work. Later, the individual machine works are changed to easy automation. This eliminates the NIO (not in order) cases and prevents the further processes while considering the aspects of JIT principles. Finally, the schedules for the former assembly system design and the proposed two alternative designs developed using LCIA philosophy are evaluated considering cycle time and cost. Moreover, a number of propositions are made to further improve other related issues in designing assembly systems.

139 A Genetic Algorithm Based Approach for the Order Batching Problem

Tasan A S, Cergibozan Ç

A. Serdar Tasan (✉e-mail: serdar.tasan@deu.edu.tr)
Department of Industrial Engineering, Dokuz Eylül University, Izmir, Turkey

Çağla Cergibozan (✉e-mail: cagla.cergibozan@deu.edu.tr)
Department of Industrial Engineering, Dokuz Eylül University, Izmir, Turkey

Extended Abstract: Order picking is one of the main activities in the logistic operations and can be defined as the process of picking customer orders from their locations in a warehouse. In manual order picking systems, order batching problem is encountered when several orders are demanded. Order batching problem is the problem of finding a least cost batching combination which includes a number of customer orders. Optimal combination must satisfy all of the customer orders and total travel time of the picker(s) is tried to be minimized. In the literature, order batching problem is examined with exact approaches such as integer programming models, branch and price algorithms; approximation algorithms such as savings algorithm, priority based heuristics; and meta-heuristic approaches such as genetic algorithm, ant systems, variable neighbourhood search and tabu search. In this study, a genetic algorithm based solution approach is proposed for the order batching problem. In the algorithm, genetic operations are supported by a local search heuristic so as to search the solution space extensively. Performance of the approach is evaluated by several numerical experiments and proposed approach is compared with other algorithms in the literature. In the comparison study, similar assumptions and parameter configurations are used. According to results, proposed algorithm is found as competitive and can be easily implemented to real cases.

140 Hybrid Genetic Algorithm for the Single Row Facility Layout Problem

Cergibozan Ç, Tasan A S, Kilincci O

Çağla Cergibozan (✉e-mail: cagla.cergibozan@deu.edu.tr)
Department of Industrial Engineering, Dokuz Eylül University, Izmir, Turkey

A. Serdar Tasan (✉e-mail: serdar.tasan@deu.edu.tr)
Department of Industrial Engineering, Dokuz Eylül University, Izmir, Turkey

Ozcan Kilincci (✉e-mail: ozcan.kilincci@deu.edu.tr)
Department of Industrial Engineering, Dokuz Eylül University, Izmir, Turkey

Extended Abstract: Single row facility layout problem (SRFLP) is a combinatorial optimization problem which has a wide range of application areas including manufacturing plants and service buildings. The objective of SRFLP is to find a permutation that minimizes transportation costs between a numbers of facilities. SRFLP is known to be NP-hard. In the SRFLP literature, several exact solution techniques such as branch and bound, branch and cut, dynamic programming, linear programming, semi definite programming and approximation techniques such as greedy heuristics, simulated annealing, scatter search, tabu search, particle swarm optimization, ant colony optimization algorithm and genetic algorithm are studied. In this study, a hybrid genetic algorithm that combines genetic algorithm with a local search strategy is developed to solve SRFLP. In the algorithm, a permutation based representation is used and initial population is generated by random permutations in order to avoid initial bias. The population is improved using crossover and mutation operators, which generate new individuals. A local search heuristic is applied to the new generated individual to find a "local best solution". Various benchmark instances from the literature that range from small to large instances are used to evaluate the performance of the proposed algorithm. The results of the computational study show that proposed algorithm is effective and competitive. The algorithm gives near optimal solutions in acceptable computation time even for large instances.

143 A Bibliometric Study: Performance and Evaluation Measurement

Silva NM, Rocha A, Silva DVM, Cordeiro J, Mesquita F, Souza Júnior

Natália Mafra Silva (✉e-mail: nataliasilvamafra@gmail.com)

Anne Kathleen Lopes da Rocha (✉e-mail: anne.rocha@hotmail.com.br)

Dérick Vincent Melo Silva (✉e-mail: dvincentmelos@gmail.com)

Jafé Praia Lima Cordeiro (✉e-mail: jafepraia@hotmail.com)

Fernanda Souza Mesquita (✉e-mail: fernaandamesquita@gmail.com)

Armando Araújo de Souza Júnior (✉e-mail:armando-jr07@bol.com.br)

Faculdade de Estudos Sociais. Dpto. de Administração. Universidade Federal do Amazonas. Av. General Rodrigo Octávio 6200, Coroado I, CEP: 69077-000, Manaus/Brasil

Extended Abstract: This work presents a synthesis of the published research studies of ABEPRO (Brazilian Association of Production Engineering), containing "Development Measurement and Evaluation" and "Performance Development" themes, with the aim of presenting a bibliometric study for articles published between 2001 and 2011. From a total of 9.208 articles, 201 that included the theme of this research were selected. The study classified the themes into categories, evaluated the main strategies and research methods used, as well as quantified the main authors mentioned in the publications. The results of the study indicate how Brazilian researches perform their exploration utilizing the method of Case Studies, mixing both qualitative and quantitative, with quantitative studies dominating.AFE (Exploratory Factorial Analysis) was the principal technique utilized to evaluate the interpretation of common data in the researched articles. Amongst the most cited authors were Kaplan & Norton (55, 0%). Balanced Scorecard (BSC) was referenced in 41, 6% of the analyzed articles. A theme of Performance Measurement presented itself as one of the most influential topics within ABEPRO. As a result, this paper combines data which can contribute to academic discussions within the aforementioned topics and assists on organizational performance due to its use as a tool in quality management.

167 How to manage capacity in a production system by using the approach of clearing function

de Sampaio R J B, Wollmann R R G, Conte V C B, VieiraP F G

Raimundo J.B. de Sampaio(✉ e-mail:raimundo.sampaio@pucpr.br)
Pontifical CatholicUniversity of Paraná - PPGEPS

Rafael R.G. Wollmann(✉e-mail: rafael.wollmann@pucpr.br)
Pontifical CatholicUniversity of Paraná - PPGEPS

Viviane C.B. Conte(✉ e-mail: vcbini@uol.com.br)
Pontifical CatholicUniversity of Paraná - PPGEPS

Paula F.G. Vieira (✉ e-mail: paula.gomes@pucpr.br)
Pontifical CatholicUniversity of Paraná - PPGEPS

Extended Abstract: Recently several researchers have given a lot of attention to the issue of how to get useful information about capacity in industrial facilities at low levels of utilization of the resources as well as how to get useful information about production cycle times considering the workload of the system in order to support decision makers. So far, the main approach used to achieve these goals is that of coupling linear programming models and the concept of clearing function. Nevertheless, until now, the results have not been as remarkable as was expected to be. The study we present here to address this issue argue that a major reason for this disappointment comes from the way the clearing function is considered in the previous approaches. The assumption that the work-in-process is the only argument of the clearing function, and *ceteris paribus*, is not sufficient to obtain a model able to provide all the required information about throughput and cycle times in the system. We support in this study the argument that any clearing function factored as a function of clearance of the work-in-process in the system, must have, at least, two independent variables: one to represent work-in-process and another to represent the time spent in the system, and thus, that, considering clearing function as a function of an unique variable, the workload of the system, is misleading.

212 Modelo de simulación para estudiar terminales ferroviarias de contenedores atendidas por grúas móviles

García-Hernández A, García-Miranda I

Alicia García Hernández (✉e-mail:agarci1@ing.uc3m.es)
Iván García Miranda (✉e-mail: ivan.garcia@uc3m.es)

Área de Ingeniería de Organización. Dpto. de Ingeniería Mecánica. Universidad Carlos III de Madrid.
Avda. de la Universidad, 30. 28911 Leganés (Madrid).

Extended Abstract: Desde el punto de vista de la sostenibilidad del transporte, el transporte intermodal tren-carretera puede ser considerado como una alternativa frente al transporte exclusivo de mercancías por carretera. Sin embargo, las medidas aplicadas a favor del ferrocarril en Europa en las últimas décadas no han conseguido incrementar su uso hasta los niveles deseados. Las terminales ferroviarias juegan un papel importante dentro de una red de transporte, al ser el lugar donde la mercancía cambia de modo. Es por esto que el estudio y la mejora de su funcionamiento puedan ser considerados como aspectos clave para aumentar el atractivo del transporte ferroviario de mercancías. En la literatura, son numerosos los estudios de simulación empleados para analizar terminales que cargan/descargan trenes y camiones usando grúas pórtico y móviles. Sin embargo, en España y en Europa, también existen terminales que realizan esta función usando solamente grúas móviles. Estas terminales no pueden ser estudiadas con los modelos mencionados anteriormente dado que sus infraestructuras y su operación varían al no disponer deporticos. En este trabajo, se han estudiado múltiples terminales atendidas sólo por grúas móviles a partir de entrevistas con expertos en transporte intermodal, de la visita a una terminal y del estudio de diversas webs. En base a este estudio, se ha desarrollado un modelo de simulación, programado en Witness®, que dispone de distintas características preprogramadas (nº de grúas, nº de vías, etc.) entre las que un decisor puede elegir, a través de un fichero MS Excel®, para configurar y estudiar un amplio rango determínales. Este modelo, que proporciona indicadores sobre productividad, uso de recursos e infraestructuras y nivel de servicio ofrecido a los trenes y camiones, puede ser empleado para apoyar la toma de decisiones estratégicas y tácticas relativas al diseño de nuevas terminales y al rediseño de terminales existentes. Su utilidad se ha probado utilizando varios casos de estudio.

218 Modelo para el cálculo de LCC en grúas de terminales marítimas de contenedores: caso práctico

García-Miranda I, García-Hernández A

Iván García Miranda (✉e-mail:ivan.garcia@uc3m.es)
Alicia García Hernández (✉e-mail: agarci1@ing.uc3m.es)

Área de Ingeniería de Organización. Dpto. de Ingeniería Mecánica. Universidad Carlos III de Madrid.
Avda. de la Universidad, 30. 28911 Leganés (Madrid).

Extended Abstract: La motivación del estudio surge a partir de que la industria de las grúas portacontenedores está enfrentándose a un entorno altamente competitivo donde los países con costes laborales más bajos ofrecen a los operadores portuarios productos con un precio de adquisición más bajo, pero con unos componentes con una vida útil muy distinta y que disparan los costes operativos posteriores. Esto hace que el cálculo de coste de ciclo de vida o LCC (LifeCycleCost) sea una herramienta que pueda servir para comparar todos los componentes y que se tomen decisiones con mayor información. La innovación del estudio realizado permitirá a todo el sector involucrado en el transporte marítimo de contenedores considerar cuáles son los elementos a tener en cuenta a la hora de adquirir, mantener o renovar una grúa portacontenedores, así como las herramientas de mejora de diseño para las empresas fabricantes. Para ello, se realiza una revisión de la metodología LCC que se describe en la normativa UNE-EN 60300-3-3:2009. Tras esta revisión, se establecen las condiciones de contorno y las hipótesis de cálculo necesarias para establecer un modelo válido, definiendo la estructura de desglose de costes y la estructura de desglose del producto. La aplicación del modelo y cálculo se realiza con datos reales de una grúa portacontenedores. Tras la realización de todos los cálculos necesarios, se exponen los principales resultados con una comparativa por los distintos elementos que componen la grúa y por categorías de coste, permitiendo el análisis y discusión sobre las mejores prácticas y recomendaciones para que las empresas puedan hacer un uso de los mismos. Estos resultados permitirán una mejora en la toma de decisiones sobre la operativa de grúas portacontenedores, teniendo en cuenta el coste del ciclo de vida del producto, cuya vida útil media es de 25 años.

307 Preparation of a public hospital for lean healthcare and continuous improvement

Garcia-Sabater J J, Vidal-Carreras P I, Maheut J

Julio J. Garcia-Sabater (✉ e-mail: jugarsa@omp.upv.es)
ROGLE. Dpto. de Organización de Empresas.. Universidad Politécnica de Valencia. Camino de Vera s/n 46022 Valencia

Pilar I. Vidal-Carreras (✉ e-mail: pivicar@omp.upv.es)
ROGLE. Dpto. de Organización de Empresas.. Universidad Politécnica de Valencia. Camino de Vera s/n 46022 Valencia

Julien Maheut (✉e-mail: juma2@upv.es)
ROGLE. Dpto. de Organización de Empresas.. Universidad Politécnica de Valencia. Camino de Vera s/n 46022 Valencia.

Extended Abstract: The Lean manufacturing has been proved effective in all kinds of environments including healthcare. However most of the papers published about lean healthcare address very specific processes without spread to other areas of the organization. The presentation will address the issue of the implementation of continuous improvement (kaizen) throughout the hospital. Following the philosophy of lean manufacturing it should be done with a bottom-up approach. This requires change facilitators that are already described in literature. The first of these facilitators are Key Performance Indicators and setting a clear definition of organizational structure. The organization chart must respect the current organization of the hospital (public hospital articulated as a classical functional departmentalization. But it must also adapt to its value chains (called in hospital as “integrated clinical processes”). For example: the patient enters for primary attention, through the specialist, the patient may go into surgery ,then patient is hospitalized and may be, patient must have some homecare followed by physicians. Once the organization is correctly defined, autonomous groups must be created (similar to autonomous production group in industrial environment) to lead the organization toward continuous improvement.
This paper has been written with financial support from the Project "Path Dependence y toma de decisiones para la selección de herramientas y prácticas de Lean Manufacturing" (PAID-06-12-SP20120717) of the Universitat Politècnica de València.

312 Coordination in Strategic SME Networks

Barbic F, Tafur J, Cagliano R

Frano Barbic (✉e-mail: frano.barbic@polimi.it)
Universidad Politécnica de Madrid, ETSII. Calle José Gutiérrez Abascal 2, 28006 Madrid, Spain.Politecnico di Milano, DIG. ViaLambruschini 4/b, 20156 Milano, Italy.

Javier Tafur (✉e-mail: javier.tafur@upm.es)
Universidad Politécnica de Madrid, ETSII. Calle José Gutiérrez Abascal 2, 28006 Madrid, Spain.

RaffaellaCagliano (✉e-mail: raffaela.cagliano@polimi.it)
Politecnico di Milano, DIG. ViaLambruschini 4/b, 20156 Milano, Italy.

Extended Abstract: The changing global environment favored spread of networks of small, specialized organizations, which use different types of network organizations in order to produce synergies. Despite the significant policy attention to SMEs as a tool to strengthen innovation and competitiveness, studies on coordination mechanisms in strategic SME networks are still anecdotal. In this study, we have followed Human & Provan (1997: 372) definition of strategic SME networks, which have been defined as "intentionally formed groups of small and medium sized profit-oriented companies in which the firms are geographically proximate, operate within the same industry, potentially sharing inputs and outputs, and undertake direct interactions with each other for specific business outcomes". The aim of this research is to contribute to the literature on governance forms of network organizations addressing the following question: "How characteristics of SME networks influence coordination of the network?" In order to find answers to this question, we conducted two case studies on the SME networks. In order to take into account the industry-dependent variables, we tested our framework in two different industries: the information and communications technology industry and the wood processing industry. The main source of data in both cases were in-depth interviews, which were triangulated with secondary data. Preliminary results show that the analyzed network characteristics, such as the number of involved actors, the power balance, the goal consensus and trust between actors have significant influence on the choice of governance forms. Furthermore, inconsistency between network characteristics and selected governance forms would likely lead to overall network ineffectiveness.

315 Can a statistical approach help to improve PDP in Brazilian food industry?

Santos A B, Trevisan B M

Adriana Barbosa Santos (✉e-mail: adriana@ibilce.unesp.br)
Computer Science and Statistics Department. São Paulo State University/15054000 - São José do Rio Preto, São Paulo, Brazil.

Bruna MartiTrevisan (✉e-mail: bru_mtrevisan@hotmail.com)
Undergraduate Student at the São Paulo State University, São Paulo, Brazil.

Extended Abstract: A resistance among professionals to include a statistical emphasis in quality and Product Development Process (PDP) management practices may explain the shortage of publications on Six Sigma in the food industry, both in Brazil and abroad. Based on the Six Sigma methodology, this paper examines whether statistical approaches effectively contribute to the improvement of PDP management practices in food companies, and whether the Six Sigma education can make a meaningful difference to increase the frequency of the application of statistical tools to PDP. A survey was conducted and fifty-seven Brazilian food companies from different sectors and of different sizes answered the structured questionnaire that included 52 items on: the company's general data; quality management programs; PDP management; and statistical approaches that support the PDP. The results showed that the amount of companies that regularly use basic Six Sigma tools does not statistically exceed 70%. Focusing specifically on PDP, we verified that 89.5% of the companies frequently apply sensory analysis without statistical data analysis; and 35% of the companies regularly use design of experiments (a powerful statistical technique from the Six Sigma methodology). The hypothesis that a statistical approach effectively contributes to improving PDP was not confirmed in statistical analysis, unlike suggestions in the literature. This implies technical limitations among PDP professionals, which, in turn, reinforce evidence of the gap between theory and practice on the topic of statistical education. However, among the large size companies that adopt Six Sigma, a more advanced knowledge of statistics was found. When these companies were compared to the smaller size companies, the quantity and complexity of statistical tools used in the implementation of development projects was statistically larger. The findings of this research suggest that weaknesses in statistical education can interfere with the efficacy of PDP management in food companies. In addition, the results emphasize the value of Six Sigma and its positive effects on the technical capability of PDP teams.

325 Revisiting three mixed up concepts: Decoupling Point, Mass Customization and Postponement

Saghiri S

Soroosh Sam Saghiri (✉email: s.saghiri@cranfield.ac.uk)
Supply Chain Research Centre, Cranfield School of Management, Cranfield University, Cranfield, UK, MK43 0AL.

Extended Abstract: Postponement strategies have drawn attention in both researchers and practitioners in the past several decades because several organizations aim to achieve operational efficiency such as low cost manufacturing in large volume and quick delivery and responsiveness. In particular, postponement strategies have been regarded as one of the key strategies in the entire supply chain. Postponement strategies are highly associated with other strategies and concepts such as Decoupling Point, Customer Order Decoupling Point, Product Differentiation Activities, Manufacturing Systems such as Make to Stock (MTS) and Make to Order (MTO), and Mass Customization with complexity. Several authors have published many articles on postponement strategies by linking it with these concepts but these terminologies were not properly used and inconsistent. In order to clarify the inconsistency and complexity, a systematic review was applied as the research methodology to achieve the objectives. Books and journals of high relevance were selected, evaluated, and analyzed. As a consequence, 71 books and articles were summarized, categorized and integrated to develop the conceptual framework for postponement strategies. The proposed framework shows how several types of postponement strategies are correlated to those terminologies. It will help researchers clarify and understand the correlations among them. It will also help industries apply suitable types of postponement strategy under different environments in volatile markets.

330 Supply Chain Cost Management in an Agile and Flexible Environment: Insights from a World Class Brazilian Company

Boechat E, Afonso P

Eraldo Boechat (✉e-mail: eraldoboechat64@gmail.com)
Departmento de Produção e Sistemas. Escola de Engenharia. Universidade do Minho. 4800-058 Guimarães, Portugal

Paulo Afonso (✉e-mail: psafonso@dps.uminho.pt)
Departmento de Produção e Sistemas. Escola de Engenharia. Universidade do Minho. 4800-058 Guimarães, Portugal

Extended Abstract: Cost management in the supply chain should be understood as a strategic management process that seeks to integrate activities with a focus on the efficient use of resources and the maximization of the overall value added of the value chain. This paper presents the results of a study conducted in a Brazilian leading company of the watch making industry. This firm has been establishing a direct and long-term relationship with more than twenty six suppliers. But also its downstream activities, which are very demanding, influence the firm's Supply Chain Cost Management (SCCM). Findings of this case study show that, in practice, SCCM can present a variety of possible configurations and different degrees of implementation which go beyond even sophisticated tools such as Total Cost of Ownership. Several characteristics of suppliers, products and aspects related with the firm's long term strategy and operational constraints influence SCCM in practice. Three key issues in terms of SCCM can be highlighted: upstream and downstream channels are interlinked, inventory management is critic, and TCO is useful but must be extended.

287 Effects on evolution of teamwork perceptions within undergraduate students. Clues for better development of such a sought skill

Vidal Carreras P I, Perello Marin M R

Pilar I. Vidal-Carreras (✉ e-mail: pivicar@omp.upv.es)
Grupo ROGLE, Dpto. de Organización de Empresas. Universidad Politécnica de Valencia, Camino de Vera s/n, 46022 Valencia.

M.Rosario Perello-Marin (✉e-mail: rperell@upvnet.upv.es)
Dpto. de Organización de Empresas. Universidad Politécnica de Valencia, Camino de Vera s/n, 46022 Valencia.

Abstract This paper presents a study on the evolution of teamwork perception within a university context. It is based on the theory that teamwork provides a deeper and more meaningful learning of the course contents, when used in a context of active methodologies. Hybrid methodology has been employed for this purpose; particularly, grounded theory has been applied for the qualitative part of the study. The specific tool used for the qualitative analysis has been ATLAS-TI. Subsequently, a quantitative analysis of the different types of perceptions' evolution and their relation to the work done at each course has been performed. The aim of this work is twofold: on the one hand, to categorize undergraduate students' perceptions on teamwork, and on the other hand, to analyse the possible influence of conducting different activities on the evolution of students' teamwork perception.

Keywords: Teamwork, perceptions, evolution, education management, best practices, grounded theory

1 Introduction

Nowadays, teamwork is one of the most sought skills in the labour market (Linda Riebe, 2010), however not always the students finish their academic period with an actual development of this skill (Young and Henquinet, 2000). There are studies confirming that the use of pedagogical approach Team-based learning encourages the development of this skill (Gallegos and Peeters, 2011). On the other hand, there are also experiences demonstrating that team-based learning produces positive effects both, on motivation and attitude of the student, and on academic achievement (Anson et al., 2003; Gatfield, 1999).

Analyzing teamwork, not only from the point of view of students, but also professors, opinion on its benefits is shared. However, despite the great amount of advantages, sometimes it also involves some drawbacks that hinder its proper application in university classrooms. For example, in certain contexts, there is a clear opposition from students, who are not used to this way of working, and feel confused and uncomfortable (Wenger and

Hornyak, 1999). Sometimes, although they think they know how to work in teams, they do not do it properly, they just divide the work into pieces without taking almost any advantages of the team. In fact, one of the biggest concerns that students manifest, is the waste of time that it may involve (Anson et al., 2003; Marin-Garcia and Lloret, 2008).Taking into account the professors' perspective, the most common disadvantages usually identified are: not having sufficient time during the classes; not having enough time to prepare team activities properly; to be afraid to lose class control (Anson et al., 2003; Lloret and Marin-Garcia, 2007).

Within this paper, the results of implementing certain active methodologies to improve teamwork skills are shown. This work pursues two objectives: on one hand, to categorize undergraduate students' perceptions on teamwork; and on the other hand, to draw conclusions about the evolution of this perception as a result of conducting different activities along the course (specific interventions).

Hybrid methodology has been used as research method used for this work. The qualitative part of the study is based on Grounded Theory (Glaser et al., 1968). According to this theory, the data are the foundations of the theory, and analysis of data generated aims to construct concepts. The reason why this methodology has been chosen is to eliminate any previous prejudice that the researchers may have about the issue and to b able to build a theoretical basis from field data in a rigorous and systematic way.

The structure of the paper is as follows; in section 2 the experience is described, in doing so, the implemented actions within each of the courses have been detailed. In section 3, the material and methodology employed to perform the analysis is described. In the fourth section, the results of both analysis are presented; on one hand, the qualitative analysis, which allows us to obtain a list of perceptions, and on the other hand, the quantitative analysis, that allows us to assess evolution in students' perceptions by connecting it with the carried out activities in the classroom (different types of interventions). Finally, the conclusions of the study and future research are discussed at the last section.

2 Description of the experience

The experience was conducted during (2012-2013) academic year, for the practical module of two courses from the School of Industrial Design Engineering at the Polytechnic University of Valencia. Specifically, the courses chosen for the experience were 'Marketing and Legal Aspects' (MYAL), in the 4th year of Engineering Degree in Industrial Design, and 'Business Organization' (OE), in the 3rd year of Electrical Engineering Degree. They are described in Table 4.

Table 4 Description of courses

Course	Year	Degree	Cred.	Students	Practices			Evaluation
					Nº	Hours	Tot	
OE	4º	Engineering Degree in Industrial Design	4,5	94	5	4	20	Each practice independent
MYAL	3º	Electrical Engineering Degree	6	94	7	2	14	Marketing plan (written work and oral presentation)

Regarding the intervention carried out in both subjects, OE and MYAL, noteworthy students were not specifically trained for the development of teamwork; on the contrary, it is assumed that students know the difference between group work and teamwork. However, they are provided with guidelines that promote successful teamwork such as: prior preparation of the work to be done, clear deadlines for each delivery time, conflict resolution during practices' classes or expected content of work well defined (Campion et al., 1993; Linda Riebe, 2010). Moreover, in the case of MYAL, working groups are formed by 4 students elected by themselves and are stable for the entire course. The product of the learning process is a project or program of professional intervention, namely a marketing plan, around which all training activities are organized (Fernandez March, 2006). Thus, MYAL, active learning methodology based on project is employed (a project for the entire course). For the case of OE, each practice has independent content, and there is not a direct continuity in the work done for each of the practices, nor in the composition of student groups of 4, formed by them, who perform it. The contents worked in each of the practices are: public presentation, value stream maps, motivation and leadership, production scheduling and ERP systems. Arguably, in OE, there is only Cooperative Learning (Fernandez March, 2006), as a teaching strategy. The class is divided into small groups, where students work in a coordinated manner to solve academic tasks and develop their own learning of organizing the class into small groups where students work in a coordinated manner to solve academic tasks and develop their own learning.

3 Materials and method

At the beginning of the semester, we pose survey to the students. We explain them that we were going to analyze their perception regarding teamwork in order to identify the actions that we could do to improve it. Survey participation was not compulsory, for those students participating in the study, they were rewarded with 0,3 extra points. The study is based on a qualitative survey of open-ended questions with space limited response that spreads through the institutional teaching platform called UPV PoliformaT (Roldán et al., 2006). Students participating in the study should conduct a survey at the beginning of the semester, and another one once the course was finished. The surveys sent were available from an opening date until an end date. Students could not respond outside that period to avoid disrupting the obtained information. Students' participation in both surveys was nearly 50% (44.7% for OE and 47.9% for MYAL)

We have used a hybrid methodology combining a first qualitative stage and an later quantitative stage.

For qualitative analysis, we have relied on Grounded theory approach. We have analyzed the data using ATLAS.TI tool, a computer program based on the exploratory analysis for theory building (grounded theory) (Muhr, 1991). ATLAS.TI has been used as a tool for the encoding process of the students' surveys. They are imported in csv format and then categorize the responses. This process is essential in qualitative research, since codification is the process itself of analyzing data from a survey, not a task that precedes the data analysis (Catterall, 1996; Miles and Huberman, 1994). Encoding allows for categories in data. The encoding process involves reading and analyzing all the data, assigning a label or common code, to any bit of data related to the same topic. Data bits related to any code are called quotations. Thus, when analyzing students' surveys regarding teamwork, codes are defined from the students' quotations. In this research, these codes represent the different students' perceptions on teamwork.

According to Tesch (Tesch, 1990), in the process of theory building , the categories of perceptions form the cornerstones of the theory. So as we go along in the treatment of the information, new codes are emerging until the theoretical saturation is reached. At that point, an increase in the sample does not provide extra items or categories on the results (Marin-Garcia and Lloret, 2008). In this study, when 45% of the primary documents were processed, the theoretical saturation was reached. However, we continued processing all the primary documents (up to 100%), since we were not only looking for identify the students' perceptions, but also its evolution.

At a second stage, we proceed to the quantitative study using a spreadsheet to assess the evolution in students' perceptions from the data of initial and final surveys.

4 Results and analysis

Having analyzed all the students' surveys, 14 perceptions regarding teamwork are obtained ie 14 ATLAS.ti codes. They can be found in table 2.

Table 5 Perceptions

Course / Perceptions from survey (Total and %)	**OE**		**MYAL**	
	Initial (148)	Final (146)	Initial (155)	Final (91)
1. The best way to work	0,68%	1,37%	0,00%	2,20%
2. Almost the best way to work	1,35%	1,37%	1,94%	4,40%
3. An opportunity to learn new concepts	7,43%	11,64%	13,55%	17,58%
4. An opportunity to get better results	17,57%	17,81%	10,97%	19,78%
5. An opportunity to help others	10,14%	10,27%	9,03%	15,38%
6. An opportunity to do less work or under less pressure	6,76%	6,16%	1,29%	1,10%
7. A way of working that implies job tasks division	2,70%	0,68%	1,94%	0,00%

8. A way of working that wastes more resources than individual work (time, coordination, planning)	12,16%	15,75%	11,61%	4,40%
9. A way of working in which, as a consequence of job tasks division, there are always problems for integration	0,00%	0,00%	0,65%	3,30%
10. A way of working that involves conflicting opinions (you can't do whatever you want)	10,14%	6,16%	16,13%	3,30%
11. A way of working that can imply problems in time availability	1,35%	0,68%	6,45%	12,09%
12. A way of working that can imply that the leader imposes his/her criteria on the rest of team members.	10,81%	4,79%	1,29%	0,00%
13. A way of working in which you may work with people with different requirement levels, and that can imply differences in workload and responsibilities and therefore unfair results	7,43%	15,07%	15,48%	13,19%
14. A way of working that may imply a source of personal problems	11,49%	8,22%	9,68%	3,30%

By observing all teamwork perceptions identified by the students, the first 7 in the table are positive perceptions (positive effects of this type of work). However, it is noteworthy that, although the first 5 perceptions themselves are, in pure theory, positive perceptions of teamwork, 6th and 7th are not truly positive perceptions, because they do not meet the full definition of teamwork. Specifically, for the 6th perception, students give an avoiding responsibility approach; as well as for the 7th perception, it corresponds to group work, but not teamwork. Still, they have remained in the study, because the objective is not to identify the ability or knowledge of the teamwork definition, but the evolution of the students' perception about this form of work. On the other hand, perceptions numbered between 8 and 14 were considered negative perceptions of teamwork (or adverse effects of this type of work). From the positive perceptions, we note that the most frequent, in both the initial and final survey, is the 4th one. Regarding to negative perceptions, the most frequent quotation is the 13th one. It is also quite frequent perception 8th. In order t-o assess the evolution of the perception of the students, we establish a criterion to define what we will call students with positive, negative and neutral vision in teamwork terms.

We considered that certain student has positive vision when the number of positive perceptions is greater than the negative one. Otherwise, we would consider that the student has a negative view. When the student has an equal number of positive and negative perceptions, we considered that his/her vision is neutral. The following Table 6 shows the results.

Table 6 Students' vision regarding teamwork.

	Positive vision		**Negative vision**		**Neutral vision**	
Course/survey	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
OE	8	12	19	18	15	12
MYAL	8	17	23	12	14	16

We can see how, for the OE course, as the data of Table 3 has shown in advance, the results of the initial and final surveys are more stable than for the MYAL course. Students with negative vision of teamwork enrolled in OE course almost maintained that vision after the interventions in class. However, 52% of the students enrolled in MYAL course having a negative vision of teamwork leave this perception. Particularly, as it is shown in table 5, the majority goes to increase the number of students who have a positive vision of teamwork. This category increased by 112%, the rest goes for the neutral vision which rise slightly (14%). For OE course, the amount of students having a positive vision rises in 50% while decrease students having neutral vision.

5 Conclusions and further research

As a result of analysis of the survey regarding evolution on student's teamwork perception in two different courses from the School of Industrial Design Engineering at the Polytechnic University of Valencia, that involve diverse teamwork activities, we will show the obtained conclusions.

On one hand, we have been able to establish 14 perceptions of teamwork, by analysing the available data through ATLAS.ti tool. Those 14 perceptions have been classify as those representing positive perception and negative perception of teamwork for students. This is very interesting because it allows us to assess the evolution in the vision of teamwork of students during the course, gathering the number of positive and negative perceptions of them

For OE course, teamwork was carried out without maintaining continuity in the number or identity of students forming teams. Teamwork was related only to the practical hours in the classroom, using as active methodology, the case method. For this course, and within this context, aggregated perceptions do not experiment major changes. However, if we analyze in more detail, we see that the evolution of the negative perceptions of students does not improve, but the positive perception of the students improved by 50%.

For MYAL course, teamwork has been developed by using learning-based projects. It is also noteworthy that students remained in the same workgroup throughout the semester. In this context, we have observed more pronounced changes throughout the semester. Specifically, 52% of students with a negative view of teamwork early in the semester, after the interventions carried out, have changed their view to positive. Moreover, students with a neutral view, remain largely unchanged.

Besides, it can be stated, from the results, that the implementation of methodologies such as case studies, cooperative learning and project-based, in a context of teamwork, increase the number of students who have a positive about teamwork.

As future research, we propose to increase the study comparing the perceptions of students in different degree programs, and even different locations to check the influence of context on the results. On the other hand, we considerate the option, in future experiences, of posing surveys for students providing a priori list of insights gained in this work to compare the results.

Agreements: The work described in this paper has been partially supported by the project "CORSARI MAGIC DPI2010-18243" by the Ministerio de Ciencia e Innovación del Gobierno de España within the Program de "Proyectos de Investigación Fundamental No Orientada"

6 References

Anson, C. M.; Bernold, L. E.; Crossland, C.; Spurlin, J.; McDermotr, M. A.; Weiss, S. (2003). Empowerment to Learn in Engineering: Preparation foran Urgently-Needed Paradigm Shift. Global Journal of Engineering Education, Vol. 7, No. 2, pp. 145-155.

Campion, M. A.; Medsker, G. J.; Higgs, A. C. (1993). Relations between work group characteristics and effectiveness: Implications for designing effective work groups. Personnel Psychology, Vol. 46, No. 4, pp. 823-847.

Catterall, M. (1996). Using computer programs to code qualitative data. Marketing Intelligence & Planning, Vol. 14, No. 4, pp. 29-33.

Fernandez March, A. (2006). Metodologías activas para la formación de competencias. Educatio siglo XXI, Vol. 24.

Gallegos, P. J.; Peeters, J. M. (2011). A measure of teamwork perceptions for team-based learning. Currents in Pharmacy Teaching and Learning, Vol. 3, No. 1, pp. 30-35.

Gatfield, T. (1999). Examining Student Satisfaction with Group Projects and Peer Assessment. Assessment & Evaluation in Higher Education, Vol. 24, No. 4, pp. 365-377.

Glaser, B. G.; Strauss, A. L.; Strutzel, E. (1968). The Discovery of Grounded Theory; Strategies for Qualitative Research. Nursing Research, Vol. 17, No. 4, p. 364.

Linda Riebe, D. R. B. S. G. M. (2010). Teamwork: effectively teaching an employability skill. Education + Training, Vol. 52, No. 6/7, pp. 528-539.

Lloret, J.; Marin-Garcia, J. A. (2007). Novel and Stable Lecturers' Point of View about University Students Working Groups, en P. Dondon, V. Mladenov, S. Impedovo, y S. Cepisca (dir), Mathematical methods and computational techniques in research and education, pp. 368-373. WSEAS Press.

Marin-Garcia, J. A.; Lloret, J. (2008). Improving Teamwork with University Engineering Students. The Effect of an Assessment Method to Prevent Shirking. WSEAS Transactions on Advances in Engineering Education, Vol. 5, No. 1, pp. 1-11.

Miles, M. B.; Huberman, A. M. (1994). An expanded sourcebook qualitative data analysis.

Muhr, T. (1991). ATLAS/ti - A prototype for the support of text interpretation. Qualitative Sociology, Vol. 14, No. 4, pp. 349-371.

Roldán, D., Ferrando, M., Busquets, J., & Mengod, R. (2006). Software libre en la Educaci+¦n Superior: PoliformaT, la plataforma de e-learning de la UPV.

Tesch, R. (1990). Qualitative Research: Analysis Types and Software Tools Psychology Press

Wenger, M. S.; Hornyak, M. J. (1999). Team Teaching for Higher Level Learning: A Framework of Professional Collaboration. Journal of Management Education, Vol. 23, No. 3, pp. 311-327.

Young, C. B.; Henquinet, J. A. (2000). A conceptual framework for designing group projects. Journal of Education for Business, Vol. 76, No. 1, pp. 56-60.

354 An overview on integrated marketing and production decisions in production planning models

Cruz Fernández-Madrid, Josefa Mula, David Juárez

Josefa Mula (✉e-mail: fmula@cigip.upv.es)
Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). Escuela Politécnica Superior de Alcoy, Plaza Ferrándiz y Carbonell, 2, 03801 Alcoy, Alicante, Spain

Abstract This work focuses on researching the relationships between the production and marketing decisions from a perspective that aims to improve production plans. This research can be used as a starting point to propose new production planning models which integrate marketing and production decisions as an answer to current conflicts between both departments, which generates numerous situations and sub-optimal plans in companies from both the marketing and the production perspectives.

Key words: Integrated production and marketing decisions; Production planning; Marketing planning; Integrated planning; Production programming and marketing.

1 Introduction

The production and marketing areas within a company frequently have totally different objectives. On the one hand, the production area bases its decisions on themes relating to production capacity and inherent manufacturing costs. On the other hand, the marketing area makes decisions based on market growth and product diversification. This decoupling mechanism allows marketing and operations to center their own activities and, thus, sub-optimum plans can result (Tang C.S., 2010). The decoupling mechanism between these two areas may also give rise to bitter conflicts due to marketing decisions having to be frequently adjusted to market dynamics, whereas operational decisions cannot be adjusted as quickly to such dynamics owing to the inherent process (Piercy, 2007). Therefore, in order to better anticipate and respond to market dynamics, a company may have to go beyond coordination by marketing and operations by jointly developing a collaboration plan (Donohue, 2005). Other authors (Malhotra & Sharma, 2002) insist on the need to align manufacturing and commercialization incentives to achieve organizational goals and objectives. Hausman et al. (2002) empirically demonstrate that business performance is greater when manufacturing and commercialization helps fulfil objectives.

Several studies have demonstrated that coordination between comercialization and production is difficult to achieve (Shapiro, 1977, St. John & Rue, 1991) and that organizational operation improves when this coordination is accomplished at high levels. In this context, and as commercialization and manufacturing are responsible for the main activities that add value to products and services, the action unit is necessary (Porter, 1985). Commercialization and manufacturing actions determine the structure of costs, product quality, delivery output and the company's global response capacity to customer orders (Hayes & Wheelwright, 1984). If both activities are not integrated, the accumulative pattern of decisions and actions, that is, the company's strategy, may lack cohesion and a point to focus on.

The main objective of this article is to investigate the relation between production decisions and marketing decisions from the improved production plans perspective. This research work will serve as a staring point to propose new production models that integrate marketing decisions and production decisions as a response to existing imbalances between the decisions of both departments, which often generate suboptimum plans in companies from marketing and production perspectives.

2 Literature Review

For decades, marketing as a philosophy has constantly evolved. One example of such are the various guidelines under which it has operated and has later transformed. The organizations that will triumph in the future will be characterized by being totally centered on the market and on their commitment to provide their customers with higher value (Kotler, 2005). In this way, the importance attached to marketing, not only as market research, but as philosophy in the organization, is also considered by Norzalita Abd. Aziz, Norjaya Mohd. Yasin (2004).

Quite frequently, the production and marketing departments within a company come into conflict with each other. No single criterion exists as to accurately define conflict. Yet according to Dyer and Song (1997), conflict is disagreement on a task as both parties perceive the aims or objectives of the other parties as being incompatible with their own. Shapiro (1977) identifies the main causes of these conflicts and states that functional integration confers the company a considerable competitive advantage. Many studies have found that the quality of the interaction between these departments is closely related with the corporate strategy (Powers, 1988; Miller & Roth, 1994; Kamarkar, 1996). In other words, if operational decisions are guided by each department's own objectives rather than by strategic objectives, the obtained result will be inconsistent and counterproductive (Goldratt & Cox, 1993).

Regarding the coordination between both departments to handle the conflict, various authors have studied departmental interrelations to help manage conflicts. De Dreu and De Vliert (1997) state that conflict must be kept at an optimum level and that managers must, therefore, follow it closely by observing the frequency with which it is presented and its level of seriousness (Morales & Yubero, 1999). So it would be suitable to design practical models to manage business conflicts where the marketing and production areas are linked with consumer satisfaction. It is worth stressing that no models linking the marketing and production areas with consumer satisfaction actually exist.

In the last few decades, greater emphasis has been placed on integrating the functionality of various areas in a company (Spencer & Cox, 1994; Singhal & Singhal, 2006; Transchel & Minner, 2008). Eliashberg & Steinberg (1993) indicate that the integration of the commercialization and production areas has started being acknowledged as a legitimate research field. Nevertheless, and as mentioned earlier, conflicts of interest and lack of coordination between the marketing and production departments are often those that cause sub-optimum plans (Freeland, 1980; Lee & Lee, 1999), especially in companies with functional structures (Shapiro, 1977; Tang, 2010). Part of the problem lies in marketing and production having different objectives, which leads to division between both areas (Karmarkar & Lele, 1989; Kingsman et al, 1993).

Chen et al. (2006) propose a decision model that optimally solves the production lot-sizing programming problem, which considers the dynamic aspect of customer demand and the finite capacity constraint in a plant. The model can be used as a complement optimizer in an advanced planning system within the ERP (Enterprise Resource Planning) frame, which coordinates different tasks in order to maximize the company's total profit. The results have shown that the solution generated by a coordinated policy overcomes the decentralized policy when maximizing profits. Other articles vouch for integrating interrelated decisions between two tasks. O'Leary-Kelly and Flores (2002) state that despite this integration of two areas being a complex matter, a strategic alignment among the organizational objectives, the external setting, and integrating manufacturing and marketing/sales decisions is necessary. This integration is a very complex phenomenon that requires a high analytical level, which is still to be developed.

Britan and Caldentey (2003) present a review of price models to manage the company's income. Among the works that stand out in this review, we find the two by Gallego and Van Ryzin (1994) and Britan and Mondschein (1997), who propose a solution to the dynamic pricing problem, at the expense of income or revenue management, and offer a mathematical model that provides solutions by dynamic programming. Maglaras and Meissner (2006) propose a model along the same lines as Gallego and Van Ryzin (1994, 1997), and manage to maximize the company's total foreseen income over a finite time horizon. Baker and Collier (2003) compare a conventional pricing method and a dynamic pricing method, and obtained excellent results with the second method for the company's real income. They carried out the implementation and comparison using a real case study of a company offering hotel services to do this.

Geoffrion (2002) acknowledges the importance of incorporating new technologies and optimization methods for operations management, and determines that dynamic product pricing is easy to implement, especially in companies offering services, and manages to improve real-time pricing. Pricing becomes a type of decision that is sporadically made less and less by commercialization specialists, and increasingly in a production management process, in which pricing decisions are dynamically integrated with operation steps and decisions, which are a classic concern of operations management.

Chien and Cunningham (2000) contemplate the relevance of integrating aggregate planning with the comercialization and finances areas. Damon and Schramm (1972) extend the aggregate planning model of Holt et al. (1955) by incorporating the variables that represent the commercial and financing management areas to integrate the decisions corresponding to these areas. Singhal and Singhal (2006) state that, nowadays, aggregate planning is useful for planning sales and operations as it performs a pivotal task, that of integrating production, operational, commercialization and finance tasks. Lusa et al. (2012) discuss an aggregate planning problem, which includes production, prices, treasury management and flexible capacity (by contracting and dismissing, and with an unlimited production subcontracting possibility), of sales. Demand is considered a non linear function of a product selling price. In this context, it is worth stressing the literature review by Martinez-Costa et al. (2013) on integrating marketing decisions into production aggregate planning models.

Zhang (2012) examines a coordinated decision on the price, promotion and inventory management as these non coordinated decisions can give rise to considerable profit loss in companies. In Lee (2001), several examples are provided to demonstrate that companies have to face high costs if they cannot coordinate decisions on pricing, promotion and inventory control. This work suggests that integrated decision models are necessary for the above-mentioned variables.

The effects of integrating marketing and manufacturing on new product development have been studied with the subsequent competitive advantage that it has for organizations (Swink & Song, 2007). The cited authors did an analysis of 467 finished projects. They determined that integrating marketing and manufacturing into each product development stage is associated with a greater competitive advantage of the products and, in turn, with greater investment project performance, and also with better product commercialization.

The sales force possesses knowledge about the market, which is essential for a wide range of decisions. The most well-known solution is that of Gonik (1978), who proposed and implemented a plan designed to obtain information about the market and to encourage working effort. Chen (2005) proposed studying the outline of Gonik (1978) and comparing it with a menu of linear contracts in a model in which the market information possessed by the sales force is important for the company's production and for decision making on planning inventories.

Sadjadi et al. (2005) present production integrated with commercialization and the inventory model, which determines the production lot size, commercialization expenses and the product selling price. Geometric programming is used to seek an optimum solution for the proposed model. Upasani and Uzsoy (2008) propose extending the models that integrate production planning and pricing decisions, which include the product delivery time and production capacity. It also considers that one of the main assumptions made in many price optimization strategies is that imperfect products do not exist, when it is virtually impossible to manage production with practically no defects. Sadjadi et al. (2011) put forward a new method in which production reliability is incorporated into the prices, commercialization and production planning. The model that the authors consider is capable of maximizing total profit when changing the price, marketing expenditure and production decisions when demand is affected by both the price and commercialization expenditure.

Fung et al. (2003) and Tang et al. (2003) consider the demand uncertainty problem in the market and uncertainty in production capacities. To face this problem, the authors contemplate a non linear, programming model with fuzzy logic to plan aggregate production with many products. For their model, they formulate fuzzy demand and capacity, and they propose a production and stock balance equation for the same period, as well as a dynamic balance equation. These are fuzzy equations that represent the possible levels that uncertain market demand can take.

3 Discussion

The following have been identified as conflictive objectives between the production and marketing departments: extending the product line; tailor-made products; changes on the product line; production planning; capacity-facility planning; quality control. Although some works have been done to strategically coordinate sales and production, they have not been dealt with sufficiently at the tactical and operational levels. Thus, there are many aggregate planning models that incorporate marketing decision variables. Indeed, the following marketing variables have been considered: price, Lee (2001); Zhang (2012); promotion, Lee (2001); Zhang (2012); sales force, Gonik (1978); Chen (2005); commercialization expenditure, Sadjadi et al (2005); Sadjadi et al (2011). However, inventory management models, based on analytical formulations in supply terms, have also considered marketing decision variables such as: price; promotion. No works have been found that look at integrating marketing decisions into tactical models for production planning; that is, a master plan for production and material requirement planning.

As for the modeling approaches, the authors used mainly dynamic programming models, mixed-integer linear programming and analytical functions for demand or supplies orders for inventory management models. Demand has been mainly considered deterministic, although some works have modeled demand uncertainty.

4 Conclusions

In general terms, we conclude that production planning models which integrate marketing decisions should include at least the following production and marketing decision variables: product variety; leader in costs; quality; delivery time; perceived profitability; inventory level; flexible manufacturing; accurate forecasts; production capacity; running time; speed to introduce products; special requests; promotion; commercialization expenditure; customer demand; demand uncertainty; product selling price; controlling costs. As future lines of work, we intend to extend the search for other databases by perfoming a systematic literature review that focuses on tactical production planning models (master plan and material requirement planning). Another future line of work that has been identified from this work is to determine the main differences between the objectives and constraints between both departments and to integrate them into the same decision model. Evidently, identifying the marketing and production decision variables to be integrated, their mathematical formulation and empirical evaluation is another future line of work.

Acknowledgment

This research has been funded by the Ministry of Science and Education of Spain project, entitled ‘Operations Design and Management in Global Supply Chains (GLOBOP)’ (Ref. DPI2012-38061-C02-01).

References

Baker T K, Collier D E (2003) The benefits of optimizing prices to manage demand in hotel revenue management systems. Production and Operations Management 12:502-518

Bitran G R, Mondschein S (1997) Periodic pricing of seasonal product in retailing. Management Science 43:427-443.

Bitran G R, Caldentey R (2003) An overview of pricing models for revenue management. Manufacturing and Service Operations Management 5:203-229

Chien Y I, Cunningham W H I (2000) Incorporating production planning in business planning: a linked spreadsheet approach. Production Planning & Control 11-299-307

Chen F (2005) Salesforce Incentives, Market Information, and Production/Inventory Planning. Management Science 51:60–75

Chen J M, Chen L T, Leu J D (2006) Developing optimization models for crossfunctional decision-making: integrating marketing and production planning. OR Spectrum 28:223-240

De Dreu Carsten KY, De Vliert Van E (1997) Using conflict in organizations. London UK Sage ed

Donohue K (2005) Supply Chain Collaboration, Supply Chain Through Leadership Meeting Presentation. Washington University in St Louis

Dyer B, Song M (1997) The impact of strategy on conflict: a cross-national comparative study of U.S. and Japanese firms. Journal of International Business Studies 28

Eliashberg J, Steinberg R (1993) Chapter 18 Marketing-production joint decision-making. Handbooks in Operations Research and Management Science 5:827

Freeland J R, (1980) Coordination Strategies for Production and Marketing in a Functionally Decentralized Firm. IIE Transactions 12:126-132

Fung R, Tang J, Wang D (2003) Multiproduct Aggregate Production Planning with Fuzzy Demands and Fuzzy Capacities. IEEE Transactions on Systems, Man, and Cybernetics, Part A 33:302-313

Gallego G, Van Ryzin G (1994) Optimal dynamic pricing of inventories with stochastic demand over finite horizons. Management Science 40:999-1020

Gallego G, Van Ryzin G (1997) A multiproduct dynamic pricing problem and its applications to network yield management. Operations Research 45:24-41

Geofrion A M (2002) Progress in operations management. Production and Operations Management 11:92-100

Goldratt E, Cox J (1993) La meta: un proceso de mejora continua. Monterrey, Mexico: Ediciones Castillo

Gonik J (1978) Tie salesmen’s bonuses to their forecasts. Harvard Bus. Rev. 56:116–122

Hausman W H, Montgomery D B, Roth AV (2002) Why should marketing and manufacturing work together? Journal of Operations Management 20:241–257

Hayes R, S Wheelwright (1984) Restoring our Competitive Edge: Competing Through Manufacturing. Wiley, New York

Holt C C, Modigliani F, Muth J F, Simon H A (1955) A Linear Decision Rule for Production and Employment Scheduling. Management Science 2,1:1-30

Karmarkar US, Lele M M (1989) The Marketing/Manufacturing Interface: Strategic

Kamarkar U (1996) Integrative research in marketing and operations management. Journal of Marketing Research 33

Kingsman B, Worden L, Hendry, Mercer L, Wilson E (1993) Integrating marketing and production planning in make-to-order companies. International Journal of Production Economics 30-31:53-66

Kotler P (2005) The role played by the broadening of marketing movement in the history of marketing thought. Journal of public policy and marketing 24:114-116

Lee WJ, Lee KC (1999) A meta decision support system approach to coordinating production/marketing decisions. Decision Support Systems 25:239-250

Lee H (2001) Ultimate enterprise value creation using demand-based management. Stanford Global Supply Chain Management Forum Report No SGSCMF-W1-2001.

Lusa A, Martínez-Costa C, Mas-Machuca M (2012). An integral planning model that includes production, selling price, cash flow management and flexible capacity. International Journal of Production Research 50:1568-1581.

Maglaras C, Meissner J (2006) Dynamic pricing strategies for multiproduct revenue management problems. Manufacturing & Service Operations Management 8:136-148

Malhotra M, Sharma S (2002) Spanning the continuum between marketing and operations. Journal of Operations Management 20:209–219

Martinez Costa C, Mas Machuca M, Lusa A (2013) Integration of marketing and production decisions in aggregate planning: A review and prospects. European Journal of Industrial Engineering 7:755-776

Miller J, Roth A (1994) A taxonomy of manufacturing strategies. Management Science 40:285-304

Morales J, Yubero S (1999) El grupo y sus conflictos. Cuenca. España: Ediciones de la Universidad Castilla la Mancha

O’Leary-Kelly SW, Flores BE (2002) The integration of manufacturing and marketing/sales decisions: impact on organizational performance. Journal of Operations Management 20:221-240

Piercy N (2007) Framing the problematic relationship between the marketing and operations functions. Journal of Strategic Marketing 15:185–207

Porter M (1985) Competitive Strategy. The Free Press, New York

Powers TL, Sterling JU, Wolter JF (1988) Marketing and manufacturing conflict: sources and resolution. Production and Inventory Management Journal 1:56-60

Seyed J Sadjadi, Maryam Oroujee, Mir B Aryanezhad (2005) Optimal Production and Marketing Planning. Computational Optimization and Applications 30:195–203

Seyed J Sadjadi, Seyed Ahmad Yazdian, Kamran Shahanaghi (2011) Optimal pricing, lot-sizing and marketing planning in a capacitated and imperfect production system. Computers & Industrial Engineering 62:349–358

Shapiro B (1977) Can marketing and manufacturing coexist?. Harvard Business Review 104-112

Singhal J, Singhal K (2006) Holt, Modigliani, Muth, and Simon's work and its role in the renaissance and evolution of operations management. Journal of Operations Management 25:300-309

Spencer M, Cox JF (1994) Sales and manufacturing coordination in repetitive manufacturing: Characteristics and problems. International Journal of Production Economics 37:73–81

St John, CH, L W Rue (1991) Coordinating mechanisms, marketing and manufacturing consensus, and marketplace performance Strategic Management Journal 12:549–555

Swink M, Song M (2007) Effects of marketing-manufacturing integration on new product development time and competitive advantage Journal of Operations Management 25:1203–217

Tang C S (2010) A review of marketing–operations interface models: From co-existence to coordination and collaboration. Int. J. Production Economics 125:22–40

Transchel S, Minner S (2009) The impact of dynamic pricing on the economic order decision. European Journal of Operational Research 198:773–789

Upasani A, Uzsoy R (2008) Incorporating manufacturing lead times in joint production-marketing models: A review and some future directions

Norzalita Abd Aziz, Norjaya Mohd Yasin (2004) The influence of market orientation on marketing competency and the effect of internet-marketing integration Asia Pacific Journal of Marketing and Logistics 16:3-19

Zhang J L (2012) Integrated decision on princing, promotion and inventory management. Asia-Pacific Journal of Operational Research 29

Organisers

Institutional Supporters