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ISO 9001 & ISO 14000 diffusion analysis according to activity sectors

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1. Introduction

There is no doubt that the interest that ISO standard has aroused in the academic field has its parallel in industry. Up to the end of December 2009, at least 1,064,785 ISO 9001 (2000 and 2008) certificates had been issued in 178 countries and economies. The 2009 total represents an increase of 81,953 (+ 8%) over 2008, when the total was 982,832 in 176 countries and economies. On the other hand, regarding to the other family of standards, also up to the end of December 2009, at least 223,149 ISO 14001:2004 certificates had been issued in 159 countries and economies. Annual growth is stabilized at almost the same level as in 2008 – 34,334 in 2009, compared to 34,242 in 2008, when the total was 188,815 in 155 countries and economies (ISO 2010).

The diffusion of the both standards (ISO 9001 and ISO 14011) have in fact been widely analysed, but there is a bias in the perspective used: there are some papers that focus on the patterns of evolution in its geographical dissemination (e.g., Saraiva and Duarte, 2003, Franceschini et al., 2004, Marimon et al., 2006 and 2009, Albuquerque et al., 2007, Casadesus et al., 2008; Sampaio et al., 2009, Franceschini et al., 2010), while we have not found literature that focus on the dissemination within the industrial or service activity sectors, independently of the localization of the companies certificated.

The objective of the paper is, therefore, to analyse the way the ISO 9001 and ISO 14001 standards spread in a particular sector: is this pattern similar for all sectors or does each sector have its own peculiarities? Whether it is the same or not, the analysis of mature sectors with regard to ISO 9001 and ISO 14001 certifications might give a clue to practitioners about other sectors that are at earlier stages in terms of diffusion.

The structure of the paper in order to achieve the objective has five sections. After this introduction, a literature review will be explored in the second section. In the third section the methodology will be described, as well as the methodology and results. The discussion and conclusions will be done in the last section.

2. Literature review

According to Teece (1980), the dissemination of management tools and systems is analogous to the dissemination of innovations in general—in that they both follow an 'S-shaped curve' that consists of three distinct phases. These phases were identified by Stoneman (1995) as: (i) an initial low rate of adoption at the beginning (producing a relatively 'flat' curve); (ii) a subsequent increase in the rate of adoption (producing a 'steep' gradient to the curve); and (iii) a saturation in the adoption (producing another 'flat' part of the curve).

Focusing on the specific ISO 9001 and ISO 14001 standards, there is an unbalanced number of references. The academics have been more productive analysing the diffusion of ISO 9001. These general ideas on innovation diffusion have been applied to the specific question of the diffusion of the ISO quality management standards around the world. Some studies (Corbett and Kirsch, 2004; Vastag, 2003) have examined the question from the geographical point of view; according to these studies, the different levels of commercial activity that exist across different countries explain the varying number of certifications of quality standards.

Albuquerque et al. (2007), who analysed the global diffusion of the ISO 9000 and ISO 14000 quality management standards using a diffusion model that included several possible 'cross-country contagion effects'; according to these authors, the diffusion of such standards is driven primarily by geography and/or bilateral trade relations.

A somewhat different approach to the question of diffusion of the ISO standards has been taken by other authors (Franceschini et al., 2004, Marimon et al., 2006, 2009 and 2010, Casadesus et al., 2008), who have defined the dissemination curve as a so-called 'logistic curve'. The notion of the 'logistic curve' was developed by Pierre Verhulst, a 19th-century Belgian mathematician who had the initial aim of accounting the growth rate in the population of a given biological species (Boyee and Di Prima, 1992).

However, it should be noted that the studies that have analysed the diffusion of quality and environmental management standards in accordance with this logistic curve (Franceschini et al., 2004, Marimon et al., 2006, 2009 and 2010, Casadesus et al., 2008, Franceschini et al., 2010) have analysed the diffusion across various countries but have not usually examined the phenomenon among different sectors of activity. There are some studies focused on the dissemination within a specific country or geographical area (Hashem and Tann, 2007). Although Marimon et al. (2006) did note the diffusion of the ISO 9001 and ISO 14001 standards among certain sectors of activity, their main interest was the concentration and instability of these industrial sectors, rather than a proper analysis of the degree of diffusion of the standards in specific sectors. It is therefore apparent that there is a gap in the extant literature regarding the diffusion pattern of ISO 9001 and ISO 14001 among sectors of activity.

3. Methodology, analysis and results

The first stage of our investigation will begin updating the model based on the logistic curve to explain the evolution of both ISO 9001 and ISO 14001 certifications on a world wide scale, and in this case taking the data as the aggregation of certifications from all the activity sectors. Secondly, it will be studied whether the diffusion process has proceeded in a relatively homogenous way in the different sectors of activity or if, on the contrary, certification has clearly occurred more quickly in certain ones. The analysis has been carried

out using indices of instability. Actually, two instability indexes will be used. The instability indexes will give us an idea of the capacity of each sector to maintain its relative position within the ranking.

Thirdly, the logistic curve is adjusted to the five top sectors in the ranking of ISO 9001 and ISO 14001 certifications in order to discuss similarities or discrepancies among these different sectors.

3.1. Data set

The number of ISO 9001 certified firms grew steadily each year, apart from the period 2001–2003 when there was an apparent interruption to the otherwise continuous growth in the total number of certified firms. This was a consequence of the introduction of a radically new version of the ISO 9000 family of standards (the 9001:2000 standard) in late 2000. The present study has therefore made adjustments to the data regarding the total number of organisations certified in ISO 9001 during the period 2001–2003. It is contended that this estimation represents a reasonable reproduction of what would have been the natural evolution of certified firms around the world during this period if the disruption caused by the introduction of the new standard had not occurred. The original data and the modified data are shown in Table 1. The table also includes the figures for ISO 14001 certifications.

Table 1. Evolution of the total number of ISO 9001 certificates during the period 1998-2008

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
a	271,847	343,643	408,631	44,388	167,210	497,919	660,132	773,867	896,929	951,486	982,832
b			453,019		620,229		638,087				
c	229,846	274,040	317,126	31,816	121,467	369,403	528,638	607,147	625,742	743,147	550,076
d			348,942		438,593		483,615				
e	7,112	10,881	17,476	24,222	34,650	44,512	48,374	65,511	78,825	117,787	98,182

a Certificates ISO 9001 at worldwide scale computed adding the country certificates (provided by ISO)
b Certificates ISO 9001 at worldwide scale computed adding the country certificates (estimated)
c Certificates ISO 9001 at worldwide scale computed adding the sector certificates (provided by ISO)
d Certificates ISO 9001 at worldwide scale computed adding the sector certificates (estimated)
e Certificates ISO 14001 at worldwide scale computed adding the sector certificates

Source: Compiled from ISO (2009, 2008, 2007, 2006, 2005, 2004, 2003) data

3.2. Methodology

The model used to analyse the diffusion of ISO 9001 is that proposed by Franceschini et al. (2004), and later adapted by Marimon et al. (2006, 2009 and 2010) and Casadesus et al. (2008). The model can be expressed as follows:

$$N = \frac{N_0 K}{(K - N_0)e^{-r_0 t} + N_0}$$

in which:

N represents the number of certificates (a function of time);
N_0 represents the number of certificates at the starting point;
K is the maximum level that can be reached (the saturation level); and

the initial growth rate is determined by r_0.

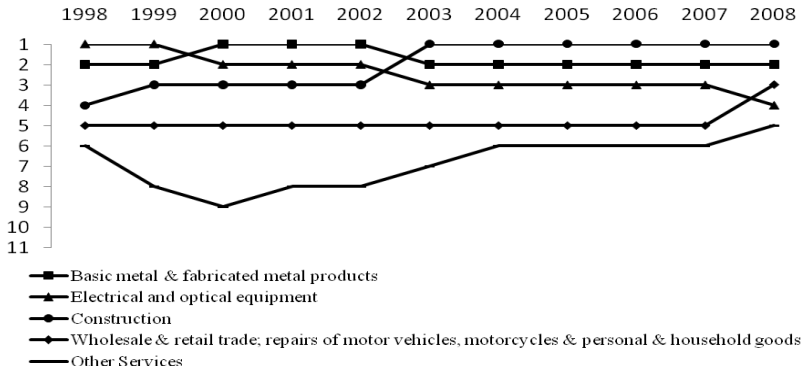
To analyse the stability of the ranking of sectors in more detail, the present study utilises the instability index, used by Marimon et al. (2006), based on Cabral (1997). This index measures stability in terms of the difference between the quotas of the sector s_i during two periods. The index ranges from zero (minimum instability) to one (maximum instability). It is defined as:

$$I = \frac{1}{2}\sum_{i=1}^{n} |s_{i2} - s_{i1}|$$

3.3. Top five sectors on ISO 9001 certifications

The sector of activity classification used is the same that ISO use in its annual surveys of ISO 9001 and ISO 14001 certifications. The list contains 39 sectors. As shown in Figure 2, the top five industrial sectors for ISO 9001 in the period 2000 to 2008, in terms of total number of 9001 certificates, were: (i) construction; (ii) basic metal & fabricated metal products; (iii) wholesale & retail trade, repairs of motor vehicles & motorcycles, and personal & household goods; (iv) electrical and optical equipment; and (v) other services. These top five sectors have been consistent since 1998. The absence of significant changes demonstrates a high degree of stability among ISO 9001 standards.

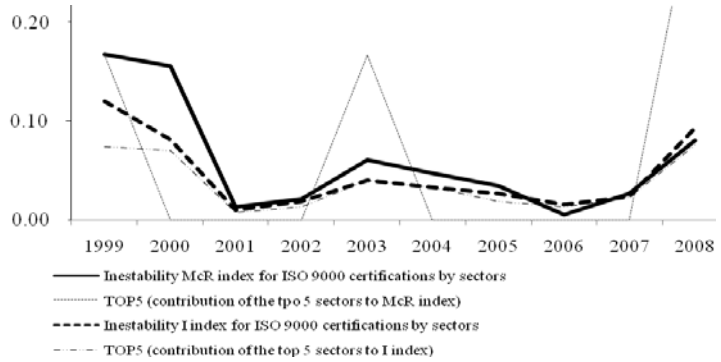
Figure 2. Evolution of the ranking of the top-5 sectors for ISO 900



Source: Compiled from ISO (2008, 2007, 2006, 2005, 2004, 2003) data

Figure 3 shows the evolution of the instability indices for the ISO 9001 standard. It is noteworthy that the maximum periods of instability were before the last version of the standard and in the last period (2007–2008). Figure 3 shows that the general tendency of the sectors of activity was relatively constant, with few variations.

Figure 3. Evolution of instability index of ISO 9000 among sectors of activity based on I index and on

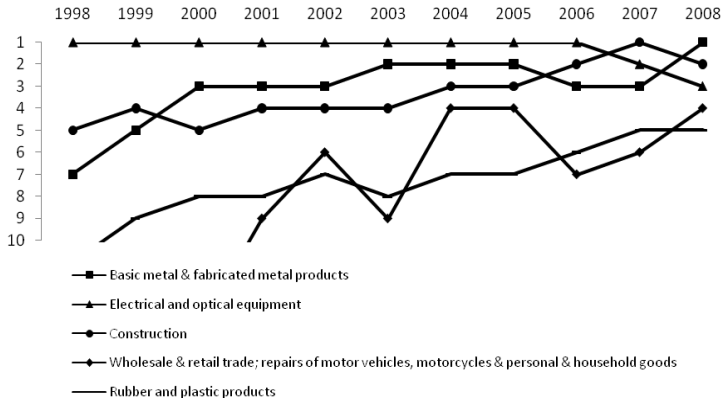


Comparing both instability indexes suggests that the evolution of instability according to the McR index is, in general terms, similar to the evolution of instability according the index based on Cabral (1997).

3.4. Top five sectors on ISO 14001 certifications

An analogous analysis is conducted for ISO 14001 certifications. The "Basic metal & fabricated metal products" and "Construction" sectors have been placed in the top two positions lately, while the "Electrical and optical equipment" sector, which had been in the first position from the very start, has been losing ground over the last two years that have been analyzed. (see Figure 4).

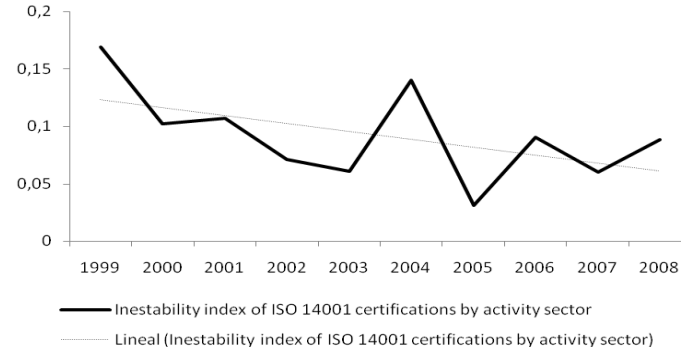
Figure 4. Evolution of the rankings by sector of economic activity as a proportion of the total number of ISO 14001certifications



Source: Compiled from ISO data (2003, 2004, 2005, 2006, 2007, 2008, 2009)

The trend of instability index is evolving towards lower values of instability (Figure 5). The ISO 14001 standard is maturing, and as time passes the positions in the rankings become more stable.

Figure 5. Evolution of the index of instability in the rankings of sectors in relation to the number of ISO 14001 certifications

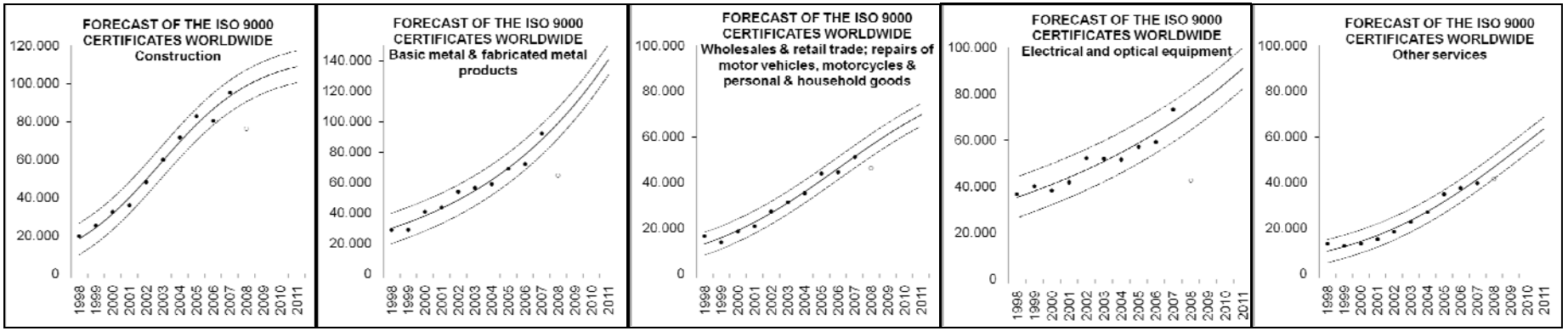


Source: Compiled from ISO data (2003, 2004, 2005, 2006, 2007, 2008, 2009)

3.5. Analysis of the diffusion of the ISO 9001 and ISO 14001 standard among sectors of activity

Figure 6 presents the current diffusion of ISO 9001 certificates for the top-5 sectors of activity in 2008. It is apparent that the logistic model provides a good fit for the data on the current number of certifications in each of the top-5 sectors (with the exception of the year 2008, for the reasons explained above), with a fit of more that 90% for R squared in all curves. However, although the evolution of all of the top-5 sectors follows a logistic curve, the current diffusion state of each (in terms of 'initial', 'expansion', and 'saturation' levels) differs among the various sectors of activity.

Figure 6. Logistic curve and forecast of ISO 9001 certifications in the top 5 sectors of activity



	Construction		Basic metal & fabricated metal products		Wholesale & retail trade; repairs of motor vehicles, motorcycles & personal & household goods		Electrical and optical equipment		Other Services	
	Sum Sq	**DF**	**Sum Sq**	**DF**	**Sum Sq**	**DF**	**Sum Sq**	**DF**	**Sum Sq**	**DF**
Regression	36.6 E9	3	33.2 E6	3	10.7 E9	3	26.2 E9	3	6.4 E9	3
Residual	87.2 E9	10	126.1 E6	10	30.8 E9	10	98.3 E9	10	32.1 E6	10
Uncorrect Total	36.7 E9	10	33.3 E6	10	10.7 E9	10	26.3 E9	10	6.5 E9	10
(Corrected total)	6.4 E9	9	3.6 E6	9	1.6 E9	9	1.2 E9	9	1.0 E9	9
R squared	.986		.965		.980		.916		.969	

	Value	Ll	Ul	Value	Ll	Ul	Value	Ll	Ul	Value	Ll	Ul	Value	Ll	Ul
N_0	18,256	13,321	23,190	29,904	23,357	36,452	13,131	10,030	16,231	35,367	30,762	39,971	9,939	6,857	13,022
K	115,376	85,180	145,572	2.1 E6	-87.0 E6	91.2 E6	92,439	7,373	177,504	380 E9	-3.8 E18	3.8 E18	112,911	-166,379	392,200
r_0	.346	.229	.463	.123	-0.027	0.273	.224	.102	.346	.072	-0.018	0.164	.199	.046	.351

The dotted lines at both sides in the figures are the lower limit and upper limit of the 95% confidence interval.

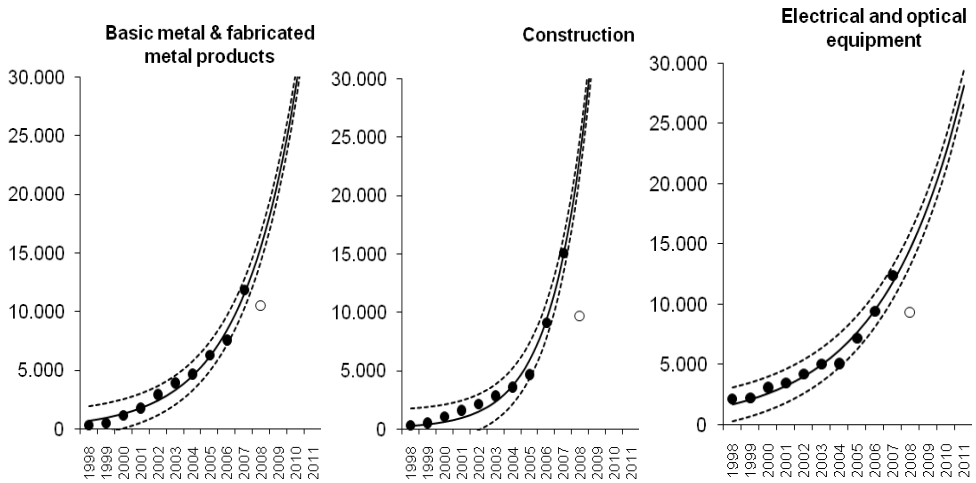
Ll: Lower limit of the 95% confidence interval

Ul: Lower limit of the 95% confidence interval

Source: Compiled from ISO (2009, 2008, 2007, 2006, 2005, 2004, 2003) data

Figure 7 shows the profiles of the logistic curves for the evolution of ISO 14001 certifications in the three sectors that top the rankings for certifications in 2008.

Figure 7. Logistic curve and forecasts for ISO 14001 certifications in the "Basic metal & fabricated metal products", "Construction" and "Electrical and optical equipment" sectors



	Basic metal & fabricated metal products		**Construction**		**Elec. and opt. equipm.**	
	Sum Sq	DF	Sum Sq	DF	Sum Sq	DF
Regression	2.82 E8	3	3.58 E8	3	3.93 E8	3
Residual	1.93 E6	7	2.88 E6	7	2.38 E6	7
Incorrect Total	2.85 E8	10	3.61 E8	10	3.95 E8	10
(Correc. total)	1.20 E8	9	1.94 E8	9	1.00 E8	9
R squared	.984		.985		.976	
	Value	Standard error	Value	Std error	Value	Std error
N_0	707.47	208.24	224.58	66.93	1,686.23	268.61
K	4.94 E10	7.53 E16	1.70 E12	2.25 E19	2.64 E11	3.01 E18
r_0	.31	.08	.46	.03	.22	.05

The dotted lines at both sides in the figures are the lower limit and upper limit of the 95% confidence interval. Source: Compiled from ISO data (2003, 2004, 2005, 2006, 2007, 2008, 2009)

It should be noted that the last available year (2008) was rejected when drawing up the profile, since there are well-founded doubts about the validity of the data referring to it. The factors indicated by ISO as affecting the accuracy of the data have already been referred to above, and are particularly pertinent to the 2008 figures. To highlight this fact, a type of blank spot has been inserted in the graphs to indicate the values for that particular year.

4. Discussion and conclusions

There has been a wide diffusion of management systems, especially quality and environmental management systems and standards, in recent decades. Of these, the most widely implemented has been the family of ISO 9000 and ISO 14000 standards.

Academic study of the diffusion of management systems has usually been analysed from a cross-national perspective (see e.g., Franceschini et al., 2004, Corbett, 2006 and 2008, Marimon et al., 2006, 2009 and 2010, Casadesus et al., 2008). In the present study, for the first time, the diffusion pattern of the ISO 9000 and ISO 14000 families of standards has been analysed in terms of sectors of activity. The realization of this study allows extracting some conclusions. The top five sectors in ISO 9001 are diffused following a logistic curve. This logistic curve also fits well in ISO 14001. On the other hand this diffusion has been stable for ISO 9001 during the studied period, according to the indices of instability. The current diffusion of ISO 9001 certification in these sectors is heterogeneous. Nevertheless, homogeneous, steady growth is observed for ISO 14001 certifications.

Regarding the limitations of this type of analysis of prediction based on mathematical models, the validity of the data is crucial. In the database used in the present study has a weakness: the number of ISO 9001 certificates during the transition period 2001–2003.

The findings of the present study should be of interest to all institutions and organisations involved with this type of certification—including accreditation organisations, certifying bodies, and business consultants specialising in the implementation of the ISO 9000 and ISO 1400 families of standards. In addition, these empirical conclusions should be of interest from the strictly academic point of view—particularly for the line of research that analyses the diffusion pattern and adoption of ideas, models, systems, and tools of business management.

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References

Albuquerque, P., Bronnenberg, B. and Corbett, C. (2007), ‘‘A spatiotemporal analysis of the global diffusion of ISO 9000 and ISO 14000 certification’’, Management Science, Vol. 53 No. 3, pp. 451-68.

Boyee, W., Di Prima, R. (1992) Elementary Differential Equations, 5th ed., Wiley, New York, NY.

Cabral, L. (1997), Economía Industrial, 1st ed., McGraw-Hill, Madrid.

Casadesús, M., Karapetrovic, S. 2005), “An empirical study of the benefits and costs of ISO 9001:2000 compared to ISO 9001/2/3: 1994”, Total Quality Management, vol. 16, n.1, pp.105-20.

Casadesús, M., Marimon, F., Heras, I. (2008), "Countries behavior regarding to the difussion of ISO 14000 standards", Journal of Cleaner Production, Vol. 16, No. 16, pp. 1741-1754.

Corbett, C., Montes, M., Kirsch, D., Alvarez-Gil, M. (2002), “Does ISO 9000 certification pay?”, ISO Management Systems, July-August

Corbett, C., Kirsch, D. (2004), “Response to “Revisiting ISO 14000 Diffusion: A New “Look” at the Drivers of Certification’’”, Production and Operations Management, Vol. 13, No. 3, pp. 268-271.

Corbett, C. (2006), “Global Diffusion of ISO 9000 Certification Through Supply Chains”, Manufacturing & Service Operations Management, Vol. 8, No. 4, pp. 330–350

Corbett, C. (2008), “Global Diffusion of ISO 9000 Certification Through Supply Chains”, International Series in Operations Research & Management Science, Vol. 119, pp. 169-199.

Franceschini, F.; Galetto, M.; Gianni, G., (2004), “A new forecasting model for the diffusion of ISO 9000 standard certifications in European countries”, International Journal of Quality & Reliability Management. Vol. 21, No. 1, pp. 32-50.

Franceschini, F., Galetto, M., Mastrogiacomo, L. and Viticchie`, L. (2008), “Diffusion of ISO 9000 and ISO 14000 certification in Italian commodity sectors”, International Journal of Quality & Reliability Management, Vol. 25 No. 5, pp. 452-64.

Franceschini, F.; Galetto, M.; Masiano, D.; Mastrogiacomo, L. (2010). “Clustering of European countries based on ISO 9000 certification diffusion”, International Journal of Quality &Reliability Management, Vol. 27, No. 5, 2010, pp. 558-575.

Gharavi, H., Love, P. and Cheng, E. (2004), “Information and communication technology in the stockbroking industry”, Industrial Management & Data Systems Vol. 104, No. 9, pp. 756-765.

Hashem, G., Tann J. (2007) “The Adoption of ISO 9000 Standards within the Egyptian Context: A Diffusion of Innovation Approach” Total Quality Management, Vol. 18, No. 6, pp.631–652.

ISO (2003-2010), The ISO survey of ISO 9000 and ISO 14000 Certifications: 12th - 17th cycle, ISO, Geneva.

Marimon, F.; Casadesús, M.; Heras, I. (2006), “ISO 9000 and ISO 14000 standards: An international diffusion model”, International Journal of Operations and Production Management, Vol. 26, No.2, pp. 141-165.

Marimon, F.; Casadesús, M.; Heras, I. (2009), “ISO 9000 and ISO 14000 standards: A projection model for the decline phase”, Total Quality Management & Business Excellence, Vol. 20, Nº 1, pp. 1-21.

Marimon, F., Casadesus, M., Heras, I. (2010), “Certification intensity level of the leading nations in ISO 9000 and ISO 14000 standards”, International Journal of Quality & Reliability Management, Vol 27, No. 9, pp. 1002-1020.

Sampaio, P, Saraiva, P. and Guimaraes, A. (2009) “ISO 9001 certification research: questions, answers and approaches”, International Journal of Quality & Reliability Management, Vol. 26 No. 1, pp. 38-58

Saraiva, P. M.; Duarte, B. (2003), “ISO 9000: some statistical results for a worldwide phenomenon”. TQM & Business Excellence, Vol 14, Nº 10, pp. 1169-1178.

Stoneman, P. (1995), Handbook of the Economics of Innovation and Technological Change, Blackwell Handbooks in Economics, Oxford, UK.

Teece, D. (1980), “The diffusion of an administrative innovation”, Management Science, Vol. 26, No. 5, pp. 464-470.

Vastag, G. (2003), “Revisiting ISO 14000: A new “Look” at the drivers of certification”, Working Paper, Indiana University.