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ScienceDirect
Journal of Cleaner Production 16 (2008) 1741–1754
Journal of Cleaner Production
www.elsevier.com/locate/jclepro

ISO 14001 diffusion after the success of the ISO 9001 model

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Received 28 June 2007; received in revised form 18 October 2007; accepted 18 November 2007
Available online 4 March 2008

Abstract

The interest shown by organizations and other entities linked by the implementation of environmental management systems (EMS), especially the family of ISO 14000 standards and the EMAS regulation in Europe, has grown spectacularly all over the world in recent years, even though a certain saturation has been detected in some countries. That leads us to ask, is EMS implementation already saturated? This article will analyze the case of the successful ISO 14000 standard, based on previous experience with the most widely used standardised management systems in the entire world: quality management systems (QMS). Will EMS follow in the footsteps of QMS?

The analysis carried out, using a logistic curve that fits quite well to explain the nature of this growth, distinguishes three general patterns to explain the diffusion of these norms, namely, expansionistic, mature and retrocessive.

Keywords: ISO 14000; Environmental management systems; Standardization; Diffusion

1. Introduction

During the past few years there has been a significant growth in the standards issued by agencies specialized in standardization in the economic field. This growth has largely been due to the marked process of economic globalization and integration that western economies have experienced over the last two decades [1].

Standardization could be generically defined as that activity aimed at putting order into repetitive applications that arise in the field of industry, technology, science and the economy [2]. In its beginnings, at the start of the 20th century, standardization arose to limit the anti-economic diversity of components, parts and supplies so as to favour their interchangeability, facilitating serial production and the repair and maintenance of products and services. In a global economy without standardization and the fruits of it – regulations, standards and technical specifications – exchanges would be exceeding difficult. Consequently, standardization fosters international trade thanks to the elimination of obstacles due to different national practices. Notwithstanding, these standards often form non-tariff barriers to international business relations as they are not truly global. As several authors have pointed out [3,4], while there are fewer and fewer tariff barriers, non-tariff barriers – technical standards and regulations which affect the requirements of products, services and, indirectly, production processes – take on greater importance.

At present there is a great number of national and international standards attempting to order and systematize – among other things – the implementation of business management systems in terms of very different functions and operating activities, such as quality improvement (ISO 9000, TS 16949, QS 9000, EAQF, VDA, etc.), occupational hazard prevention (OHSAS 18001), corporate social responsibility (SA 8000, AA 1000 and the ISO 26000 draft standards), R&D activities (the Spanish UNE 166000 EX experimental standard), human resources management (Investors in People), and of course the case that interests us: environmental impact (the ISO 14000

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doi:10.1016/j.jclepro.2007.11.002

family of standards and EMAS). All of these standards included in the set of Management System Standards (MSS) are dealt with. However, it must be made clear that these MSS are not based on standards which refer to the attainment of a specific objective or result – that is to say, they are not result or performance standards, but rather standards which establish the need to systematize and formalize a whole series of business procedures related to the different fields of business management in a series of procedures [5].

From a global perspective, the success of disseminating all these management standards seems to be closely linked to the dynamics of the globalization process of western economies and the main players in them – multinationals: if standardization originally came about in order to limit the anti-economic diversity of components, parts and supplies in an economic environment in which outsourcing and relocation of business activity prove to be strategic elements, it must nowadays promote a certain homogeneity in business management systems in order to favour such processes. Specialists in this field point out that in the absence of a regulating power of a global and public nature, the task of designing, implementing and enforcing standards, in areas in which such measures have traditionally been thought of as part of the regulation of public powers, is increasingly taken on by different regional or global institutions of a non-governmental nature [6–8].

All these standards employ very similar methodologies for their creation, structuring, implementation and third-party verification processes. Two series of standards issued by the International Organization for Standardization (ISO) stand out among them, due to their successful dissemination: the ISO 9000 series, related to the implementation of quality systems, and the ISO 14000 series, related to the implementation of environmental management systems, and at the same time the analytical objective of this article.

The ISO 9000 phenomenon has aroused great interest and has been extensively studied in academia. While the literature is not as extensive as that analyzing ISO 14000 implementation, research on the ISO 9000 can be found [9–12]. Although the results of these studies are very diverse, it could generally be stated that external factors, especially the coercive pressure of customers, are very important motivators in the implementation of the standards referred to. Regarding the methods used in these studies, they are generally based on opinions obtained from surveys circulated among company environmental and quality managers, and thus reflect an inherent bias.

Recently, research focusing on the endogenous process of ISO 9000 dissemination has been carried out internationally, and the work of Saraiva and Duarte [13] and Franceschini et al. [14] stand out. Now, in the academic literature known to us, only Professors Corbett and Kirsch [15], in an extension of the research carried out by Vastag [16] and Marimon et al. [17], have analyzed the joint dissemination of ISO 14000 and ISO 9000. These studies are interesting not only due to their descriptive and predictive capacity regarding the dissemination process of these international standards per se, as highlighted by the authors, but also because they offer certain empirical evidence with regard to whether an analogy can be drawn between the dissemination process of these standards and the dissemination of innovations in general.

There is a crucial difference between the studies we have read and the present one. Those studies were done at a time when the number of certificates was growing year by year, with both standards in clear expansion, a situation in many countries that is very different from the present one. In fact, and as the ISO itself includes in its latest annual report analyzing the international dissemination of both standards, recent years have seen a certain drop in the number of certificates in several of the countries which had historically been leaders in this area (see Ref. [18]). That is why we wonder if this phenomenon, primarily found in QMS, will also occur in EMS.

The purpose of this article, with its clearly exploratory and pilot content, is to analyze in detail the evolution of the ISO 14000 certificates on an international level, in order to predict their future diffusion. To that end, and since it is the only standard to be studied until now and will quite possibly become a clear reference in the field of standardization, the diffusion process of the successful ISO 9000 will be used. It is logical to think that the ''steps'' followed by this management standard will be fairly similar to those that will be taken by the ISO 14000 standard in the coming years. In this way it may be possible to determine whether homogenous guidelines exist in the phases of the dissemination process of both certificates – including the decline phase which could be defined by the concept of decertification. In addition, it will analyze whether it is possible to assess the scope of these decline phases, which prove to be of interest to the different agents involved in the implementation of the aforementioned standards. Proposals that have emerged from the exploratory and projective work carried out and that could be tested in future work are also specified in the final part of this article.

2. Current situation of the leading EMS standards

The ISO 14000 family of standards establishes a reference model for the implementation of company environmental management systems, defined as those parts of global management systems that describe the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for preparing, applying, reviewing and maintaining company environmental policies. It contains standards that include guidelines and suggestions for matters such as environmental management, environmental auditing, environmental labelling or life cycle assessment. Nonetheless, the only normative standard within this series is the ISO 14001, which provides a list of specifications and requirements that an EMS should meet. It is the only one against which the company can be assessed and certified [19].

The ISO 14001 standard is divided into five major sections: (a) environmental policy, which involves making a statement of environmental intentions and principles; (b) planning, which requires the company to specify the processes it uses to identify the environmental problems that must be tackled and to define specific objectives and targets; (c) implementation and operation, which involves both defining

responsibilities for the system and guaranteeing the identification of training needs, the internal and external knowledge of the system, the control of documents and operations, and the preparedness for and response to emergencies; (d) checking and corrective action, which entails procedures to monitor operations and to prevent and mitigate any non-compliance with objectives and targets; and (e) management review, which implies setting up processes through which senior managers review the suitability and effectiveness of the system and introduce appropriate changes [19].

The ISO 14001 standard was published in September 1996 (although some companies had already been certified in accordance with a previous draft). The main rationale for the creation of the ISO 14001 was that its worldwide acceptance would expedite international trade by harmonizing otherwise diffuse environmental management standards and by providing an internationally accepted blueprint for sustainable development, pollution prevention and compliance assurance [20]. Nevertheless, the process of creating the standard was long and complicated, as detailed by Haufler [21]. The last review of the standard dates from 2004. A transition period that ended in May 2006 has been established. From that point onwards, the ISO 14001:2004 standard has been the only one acknowledged by the IAF (International Accreditation Forum) member states.

Before analyzing the dissemination of this standard, it would be interesting to clarify an important issue that usually causes confusion regarding this standard. The ISO 14000, with a structure and formulation that is very similar to the famous quality management standard ISO 9000, is not a standard that measures the environmental impact of the companies that implement it, but rather establishes the manner of systematizing and formalizing procedures related to the company's environmental impact processes. Consequently, it is not a standard dealing with objectives or results, but with procedures. From the point of view of management systems and taking into account that their area of applicability is different, it could be said that one of the main differences between this standard and the ISO 9000 is the fact that the ISO 14000 does indeed establish – however tenuously or ambiguously – a reference for the compliance of certain environmental objectives, since it holds that companies must commit themselves to compliance with the elementary environmental standards and regulations in force in each setting.

On the other hand, in Europe we also have the EMAS (Eco-Management and Audit Scheme) regulation. EMAS establishes the need to comply with said standards and regulations. It is a voluntary initiative designed to improve companies' environmental performance. Initially established by European Regulation 1836/93, it was revised in 2001 by European Regulation 761/2001 (EMAS II). Actually, EMAS requires participating organizations to implement an environmental management system (EMS) that must meet the requirements of the International Standard BS EN ISO 14001. Many organizations progress from ISO 14001 to EMAS and maintain certification/registration in both.

As can be seen in Table 1, in accordance with the latest data available from the Environment Directorate General of the European Commission, at the end of 2006 there were 3531 valid EMAS certificates in the European Union (EU-27). This number is lower than the number of valid certificates at the end of the years 2001 and 2002, and close to the number at the end of 2000 (3417 certificates), one year before the creation of the EMAS II. Even though the interpretation of these data seems complicated, given that the coming into effect of the EMAS II made it possible to register corporations, as well as sites, it seems clear that EMAS registration has at least stabilized if not decreased sharply.

In fact, the literature has started to indicate that both internationally and within the European Union EMAS lost the race against ISO 14001 long ago [22]. According to the studies done, one of the main reasons why companies are not registering with EMAS is related to the European limitedness of EMAS [23]. This being the case, in this article we only analyze the diffusion of the ISO 14001 standard.

Until now, the story of ISO 14001 diffusion has been a success story, as was the ISO 9000. The latest data offered by ISO [18] indicate that, as of December 2005, there were already 161 countries with ISO 9000-certified companies, and the number of certificates worldwide is at least 776,608. When ISO 14000 was published, 127,349 certificates had already been issued for ISO 9000. Like ISO 9000, ISO 14000 was also disseminated worldwide, although not yet with the same degree of success. With respect to the expansion of the ISO 14000 standard, the latest data available, also dating from December 2005 [18], indicate that 111,162 certificates have already been issued in a total of 138 countries.

Before proceeding with an analysis of the data obtained, we must point out that there are other reliable sources of worldwide ISO14001/EMAS certifications, such as those collected by Reinhard Peglau (Federal Environmental Agency in Germany) or those gathered by Environmental Systems Update (ESU). However, we will use the data provided by ISO, which simultaneously publishes ISO 9000 and ISO 14000 data with the same criteria and using the same sources in every country.

It should also be specified that data supplied by ISO regarding the number of certifications worldwide are used in this research (in particular reports with the latest data available [18,24,25]). It is very important that this data be viewed with some caution, as it may contain errors or aspects which need to be qualified. First, it should be taken into account that the current version of both standards allows single site certification, which would explain a huge reduction if multinational firms apply this model, although the details provided by ISO [18] do not place importance on this. Second, the ISO organization itself acknowledges the fact that there are some errors in its data, which are compiled through organizations from different areas in each specific country in a different way. That is why the reduction in the number of certifications analyzed in this article is not necessarily due only to companies which have stopped being certified, but may also be due to other reasons which are difficult to contrast in any research work.

Having said this and analyzing the data given by ISO itself in more detail, it is easy to see how the situation is not very

Table 1
Evolution of EMAS certifications in the European Union (EU-27)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Austria	35	141	190	294	362	331	298	254	265	256
Belgium	2	9	9	11	14	18	25	31	34	39
Bulgaria										–
Cyprus								–	–	–
Czech Republic								15	18	21
Denmark	15	83	116	152	170	130	121	120	121	116
Estonia								–	1	2
Finland	14	17	26	29	36	41	39	40	43	42
France	7	28	35	31	35	24	23	20	17	17
Germany	1116	1578	2007	2394	2662	2486	2218	1641	1491	1489
Greece	–	–	1	1	7	9	9	6	27	51
Hungary								–	2	8
Ireland	2	6	6	7	8	8	8	8	8	8
Italy	–	13	24	42	74	123	169	253	394	570
Latvia								–	–	–
Lithuania								–	–	–
Luxembourg	–	1	1	1	1	1	1	1	1	1
Malta								1	1	1
Netherlands	9	19	25	23	24	27	29	25	22	15
Norway	38	44	55	59	64	56	42	30	18	25
Poland								–	1	2
Portugal	–	–	–	1	2	3	12	23	42	52
Romania										–
Slovak Republic								2	2	3
Slovenia								1	1	1
Spain	1	18	51	103	165	263	314	412	522	666
Sweden	15	124	157	199	212	201	115	118	100	84
United Kingdom	15	59	72	70	76	76	75	66	64	62
Total	1269	2140	2775	3417	3912	3797	3110	3067	3195	3531

Source: EMAS helpdesk of the Environment Directorate General of the European Commission.
Note: please note that under EMAS II, since April 2001, corporate registrations are possible.

optimistic. Making a comparison using the latest data available [18,24,25], and only considering the 13 countries with the greatest number of certificates – which reflect more than 70% of all certificates worldwide – we obtain the data in Table 2. The nature of the analyses carried out from country to country makes it very difficult to work with a large number of countries, as well as making it quite possibly of little relevance. That is why a decision has been made to only focus, throughout the research, on the 13 leading countries in ISO certifications. Their behaviour is probably similar to that of the other 148 countries with companies that have implemented both standards – countries which only represent 30% of the certificates worldwide.

It is important to point out different aspects in Table 2: while there are some countries dealing with a declining number of ISO 9000 certificates (the United Kingdom and Australia), that is compensated on a worldwide scale by strong growth of China, Italy, Japan and Spain. Thus, although the number of certificates is increasing globally, the situation is worrisome, since various economically significant countries have already begun to experience a trend towards decertification. On the other hand, such behaviour is not detected with the ISO 14000: there continues to be modest growth in the great majority of countries, with the exception of China, where the growth is very high. As observed by Marimon et al. [17], this seems normal, since the implementation of the standard in question has always taken place under the aegis of its famous predecessor.

In order to compare the number of certifications existing in each country, while taking into account the relative importance of the economies of those countries, a relevant analysis should involve studying certification intensity using certain rates created for this study. This intensity of certification in ISO 14000 ($r14$) and ISO 9000 ($r9$) is the relationship between the number of certificates and an indicator of the GDP of each country. This indicator is the simple average of the GDP of the four years expressed in 1.00E + 09 current $US. In this way, $r14$ shows the number of ISO 14000 certifications for each 1.00E + 09 $US of average GDP for these four years. Similarly $r9$ shows the intensity of ISO 9000. These indexes allow comparisons between countries whose absolute certification numbers are quite different, but may show a similar behaviour towards these standards. To only provide an example, as this will be analyzed later, these indexes show that Spain and China are in the same cluster, even though China has almost four times as many ISO 9000 certifications as Spain. Hence, this indicator does not make economic sense; it is used as a constant deflator over the four years to avoid the fluctuations between $US and the currency of each country. Without doubt, it would be even more interesting to calculate this intensity, not in accordance with contribution to GDP, but rather, for example, in accordance with the number of plants or industrial

Table 2
Number of ISO 14000 and ISO 9000 certificates in the 13 countries with the highest number of certificates in 2002, 2003, 2004 and 2005

	ISO 14000 (2002)	ISO 14000 (2003)	ISO 14000 (2004)	ISO 14000 (2005)	ISO 9000 (2002)	ISO 9000 (2003)	ISO 9000 (2004)	ISO 9000 (2005)
China	2803	5064	8862	12,683	75,755	96,715	132,926	143,823
Italy	2153	3066	4785	7080	61,212	64,120	84,485	98,028
United Kingdom	2917	5460	6253	6055	60,960	49,151	50,884	45,612
USA	2620	3553	4759	5061	38,927	41,571	37,285	44,270
Germany	3700	4144	4320	4440	35,802	24,889	26,654	39,816
Japan	10,620	13,416	19,584	23,466	33,964	55,916	48,989	53,771
Spain	3228	4860	6473	8620	28,690	33,125	40,972	47,445
Australia	1485	1250	1898	1778	27,135	19,975	17,365	16,922
France	1467	2344	2955	3289	19,870	18,007	27,101	24,441
Republic of Korea	1065	1495	2609	4955	14,520	12,846	12,416	14,033
Netherlands	1073	1162	1150	1107	13,198	10,309	6402	9160
Canada	1064	1274	1492	1636	12,371	11,759	9286	12,503
Switzerland	1052	1155	1348	1561	10,299	9063	11,549	12,413
Total sample	35,247	48,243	66,488	81,731	432,703	447,446	506,314	562,237
Total world	49,449	66,070	90,569	111,162	561,747	567,985	670,399	776,608
Percentage	71.3%	73.0%	73.4%	73.5%	77.0%	78.8%	75.5%	72.4%

Source: put together by the authors from ISO (2003), ISO (2004) ISO (2005) and ISO (2006).

companies in each of the countries. However, the real difficulties inherent in being able to avail of appropriate data make it necessary to use the indicator mentioned.

Analyzing the intensity of certification using the aforementioned rates, as noted in the case of ISO 9000 certification in Table 3, a significant decertification in some analyzed countries may also be observed, particularly in places like Australia, the United Kingdom or the Netherlands. Conversely, the situation is very different in the case of the ISO 14000 standard, in which all the countries analyzed evidence growth in this rate. This growth may even be deemed spectacular in countries such as China, the Republic of Korea, Italy, France and Spain, where the rate has doubled in the last four years.

3. Diffusion models

The literature related to dissemination of the different management tools and systems is very extensive, since this is a research topic that has enjoyed great interest among academics of different fields (the synthesis reflected in Rogers [26] is particularly interesting). Specifically, the literature is very extensive on studies dealing with the dissemination of innovative technologies, which can also be applied in some way to management innovations; i.e. to innovations in general, as Teece [27] does, demonstrating that the models of technological innovation are not limited to tangible products. From these studies, it may be roughly deduced that the accumulative adoption of innovations over time follows an S-shaped or sigmoid curve reflecting the fact that few members of a social system adopt an innovation in practice during its first stages, and that the rate with which innovations are adopted rises until the process reaches its saturation point, when the growth rate falls anew. Stoneman [28] claims that this model usually explains well the phenomena of diffusion in the field of new technologies.

Some studies tackling questions similar to those formulated in this study, however incipient, have already been carried out

Table 3
ISO 14000 and ISO 9000 certification index in the 13 countries with the highest number of certificates in 2002, 2003, 2004 and 2005

	$r14$ (ISO 14000 intensity)				$r9$ (ISO 9000 intensity)			
	2002	2003	2004	2005	2002	2003	2004	2005
China	1.71	3.08	5.39	7.72	46.12	58.87	80.92	87.55
Italy	1.41	2.01	3.14	4.65	40.21	42.12	55.50	64.39
United Kingdom	1.52	2.84	3.25	3.15	31.67	25.54	26.44	23.70
USA	0.23	0.31	0.42	0.45	3.43	3.66	3.28	3.90
Germany	1.50	1.67	1.75	1.79	14.47	10.06	10.77	16.09
Japan	2.44	3.08	4.49	5.38	7.79	12.83	11.24	12.34
Spain	3.58	5.39	7.17	9.55	31.79	36.70	45.40	52.57
Australia	2.59	2.18	3.31	3.10	47.29	34.81	30.26	29.49
France	0.80	1.28	1.61	1.80	10.85	9.83	14.80	13.35
Republic of Korea	1.62	2.28	3.98	7.56	22.15	19.60	18.94	21.41
Netherlands	2.01	2.18	2.16	2.08	24.77	19.35	12.01	17.19
Canada	1.16	1.39	1.62	1.78	13.47	12.80	10.11	13.61
Switzerland	3.19	3.50	4.08	4.73	31.18	27.44	34.97	37.58

Source: put together by the authors from ISO (2003), ISO (2004), ISO (2005), ISO (2006) and data from OCDE.

and reported in the specialist academic literature. With regard to the development of the ISO 14000 and ISO 9000 standards, Corbett and Kirsch [15] propose a regression model that explains the number of ISO 14000 certificates in a given country on the basis of its exporting capacity, its degree of commitment to the environment and the number of ISO 9000 certificates issued in that country. However, it must be taken into account that this interesting study is static in nature, it does not analyze the development of both standards, the ISO 14000 and the ISO 9000, over time. In the study carried out, the authors conclude that the number of ISO 9000 certificates in a given country is one of the factors explaining the number of ISO 14000 certificates issued in the same country; however, they neither specify how such a dissemination occurs, nor do they analyze the sectorial factor, which, as they themselves state in the conclusions of their research, would be an interesting analysis.

On the other hand, Franceschini et al. [14] have established that the logistic curve explains the dissemination of the ISO 9000 well. As reflected in mathematical literature, the logistic curve model was applied for the first time by the Belgian mathematician Verhulst during the 19th century in the field of biology to account for the growth of a species. According to this model, a growth rate is at its maximum at the start, when there are very few individuals in the species and there is scarce competition for limited resources, and becomes zero once a certain size is reached. This is the size of saturation that the available resources permit. The model responds to the following expression:

$$N = \frac{N_0 K}{(K - N_0)\mathrm{e}^{-r_0 t} + N_0} \quad (1)$$

in which N represents the number of certificates, a function of time; N_0 represents the number of certificates at the starting point; and K is the maximum level that may be reached, the saturation level. The initial growth rate is determined by r_0.

On the basis of the aforementioned work, Marimon et al. [17] perceive how the logistic model in question is also applicable to the ISO 14000 standard. This research is based on the premise that the increase in the number of certificates for both standards would be proportional to the number of existing certificates at a given time. In addition, the same work observes how the dissemination referred to takes place in a rather similar way with respect to rates of concentration and instability in the different economic sectors analyzed by the authors. They conclude by affirming that both standards are very similar in terms of dissemination. In fact, Corbett and Kirsch [15] and Vastag [16] had already stated that one of the factors that could account for the number of new ISO 14000 certificates in a certain country is precisely the number of ISO 9000 certificates.

Applying the logistic models previously mentioned to current worldwide data, Fig. 1 is obtained. From this, it may be observed how the said model suits the current certification data perfectly, with a fit of more than 99% for r squared in both curves. At present, we are at 64.6% of the saturation level for the ISO 14000 and 84.6% for the ISO 9000, despite, as Marimon et al. [17] point out, ISO 14000 certification is experiencing rather faster growth than the ISO 9000. Considering 95% as a possible saturation point, the forecast according to this model is to arrive at a maximum of 160,000 ISO 14000 certificates and some 870,000 ISO 9000 certificates worldwide.

Individual country by country analysis, as Marimon et al. [17] have done with some countries, allows easy observation of how the aforementioned logistic curves adapt to practically 100% of the empirical data compiled.

4. The ISO 14000 and its diffusion relationship with the ISO 9000

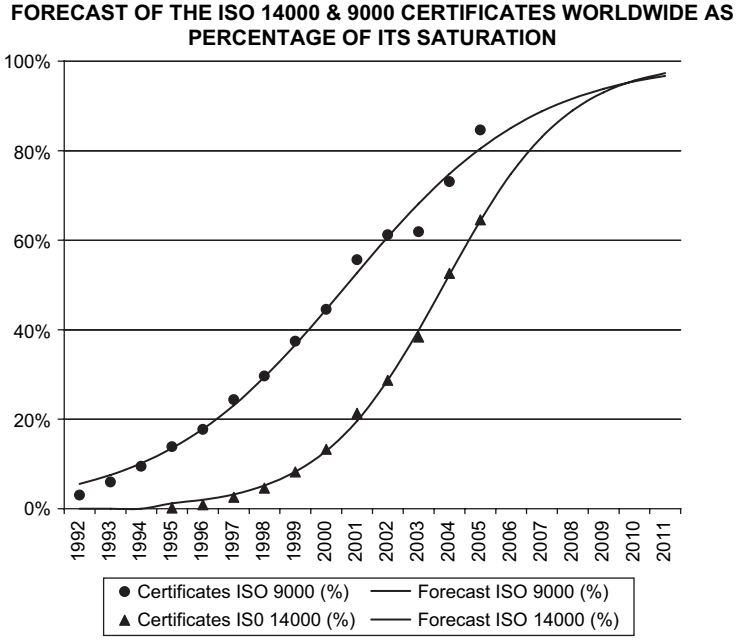
To analyze the relationship between ISO 14000 and ISO 9000 certifications, it was decided to continue to work with the ''Certification Intensity'' indicator previously mentioned. As stated previously, although this could be improved, it at least allows us to work with data that may be better contrasted, since it would be impossible in any other way to compare the number of certificates in countries with a potential such as China's against the number in countries of a smaller size.

Representing certification intensity rates for both standards on one and the same graph for the 13 countries which have the greatest impact on an international level yields the graph shown in Fig. 2, in which the mean values of both variables have been marked with a horizontal and a vertical line that divide the graph into four quadrants. This figure shows the situation in 2002, the starting point of our analysis.

In Fig. 2, it is clearly seen that the two variables are related, with a Pearson's correlation factor of 0.666 at a significance level of 0.013. In any case, what is most relevant is, as Corbett and Kirsch [15] state, that the number of ISO 14000 certificates in a country has a certain relationship with the number of ISO 9000 certificates in that same country, some years after the analysis carried out by these authors. Moreover, it may be observed that very few countries are found in the upper left quadrant or in the lower right quadrant, implying that countries that are relevant with regard to one standard and not to the other are in the minority. In this sense, Japan is possibly the most noteworthy, having a low ISO 9000 certification rate with regard to its ISO 14000 certification rate. Some explanations for the ''delay'' in ISO 9000 certification may be found in Corbett and Kirsch [29].

A data update using information from 2003 yields a very similar graph, with slightly lower correlation rates. This correlation decreases in 2004 and 2005 (see Table 4), indicating that some countries are coming out of the diagonal in Fig. 2. This is the case of Japan and the Republic of Korea. They have made great efforts in terms of environmental responsibility but have remained at the same level of ISO 9000 intensity over the years.

For the purpose of analyzing the line of development that countries seems to follow with regard to the number of certificates, the 2002–2005 graphs have been superimposed so as



Forecast of ISO certificates worldwide considering the logistic curve.

	ISO 14000		ISO 9000	
	DF	Sum Sq	DF	Sum Sq
Regression	3	29504803542.73	3	2407501349672
Residual	7	25727264.27186	11	6761130320.651
Uncorrected Total	10	29530530807	14	2414262479993
(Corrected total)	9	14611876279.64	13	772653744844.4
R squared	.998		.991	

	Value	LL	UL	Value	LL	UL
N_0	2063.40	1265.79	2861.013	50818.44	32629.40	69007.49
K	172209.19	137517.04	206901.35	917655.01	749629.52	1085680.51
r_0	0.5003	0.4327	0.5679	0.3271	0.2601	0.3940

Fig. 1. Forecast of the ISO 14000 and ISO 9000 certificates worldwide as a percentage of their saturation.

to make it possible to observe the country ''movements'' detected. This graph is shown in Fig. 3.

Analyzing Fig. 3, a certain movement towards the right is observed for some countries and must be understood as an increase in ISO 9000 certification intensity. Standing out are the trends of three countries – China, Italy and Spain – that are registering a strong increase in their ISO 9000 certification intensities over these four years, clearly evidencing a situation of obvious expansion. The figure also shows some movement to the left, indicating a decrease in terms of ISO 9000 intensity (Australia, the United Kingdom and the Netherlands). As far as the ISO 14000 is concerned, displacement generally seems upwards, situating us in a period of expansion.

Indeed, analyzing the previous graphs in more detail, we believe it opportune to highlight three clearly differentiated

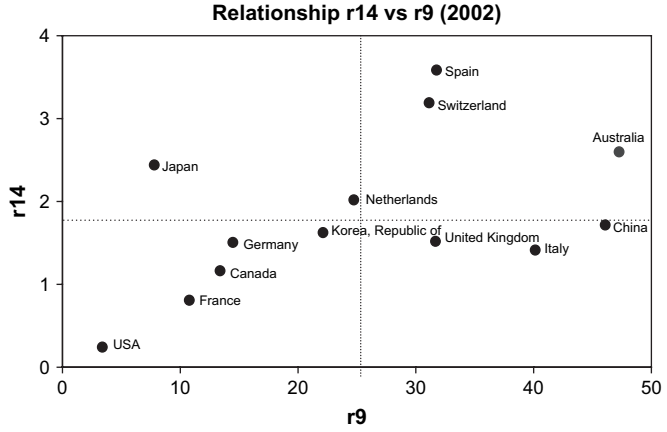


Fig. 2. Relationship between ISO 14000 and ISO 9000 certification intensities in 2002.

Table 4
Pearson correlation rates among intensities of both standards over the four analyzed years

	*r*14 (2002)	*r*14 (2003)	*r*14 (2004)	*r*14 (2005)
*r*9 (2002)	0.666 (0.013)			
*r*9 (2003)		0.663 (0.013)		
*r*9 (2004)			0.557 (0.048)	
*r*9 (2005)				0.473 (0.102)

In brackets are the *p*-values (bilateral).

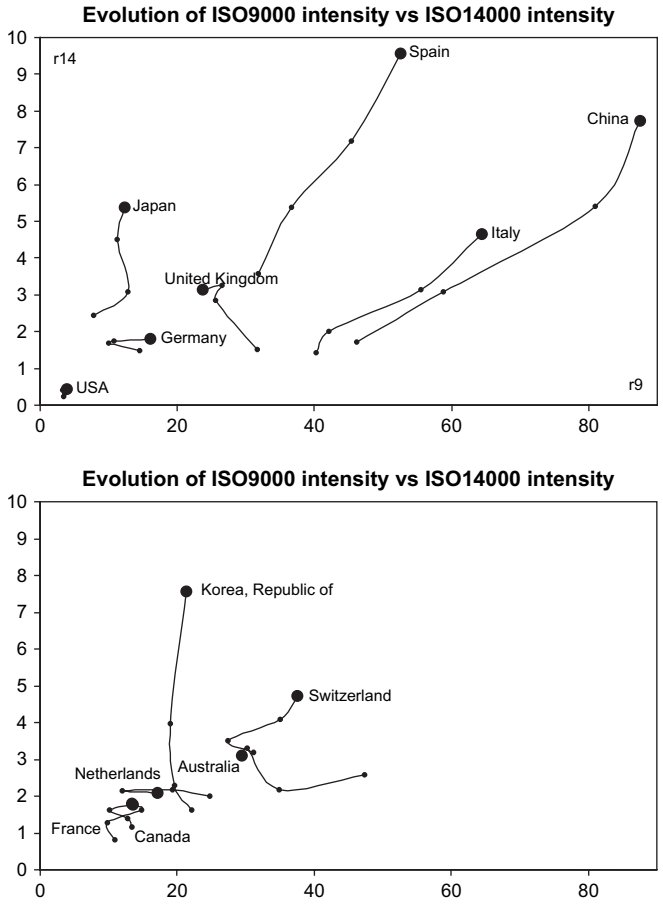


Fig. 3. Evolution of the relationship between ISO 14000 and ISO 9000 certification intensities (2002, 2003, 2004 and 2005). We have split the countries' array in two diagrams to keep it readable. The line of each country begins with a small point (2002) and ends with the big dot (2005).

behaviours, which we have assigned three different names: expansionist, mature and retrocessive.

4.1. Expansionist behaviour

This group is made up of countries with growth in their ISO 9000 and ISO 14000 certification intensity rates, ''moving'' towards the upper right-hand quadrant. China, Italy, Spain and, to a lesser degree, Switzerland stand out among the countries studied. These countries are all in a phase of growth for both standards, as shown in Figs. 4 and 5. In these figures, it is clearly seen how the logistic model used characterizes the number of certificates for both standards to a very satisfactory degree. This once again confirms that the aforementioned model is valid for representing and forecasting the growth of both standards beyond the forecasts made by Franceschini et al. [14] and Marimon et al. [17].

4.2. Mature behaviour

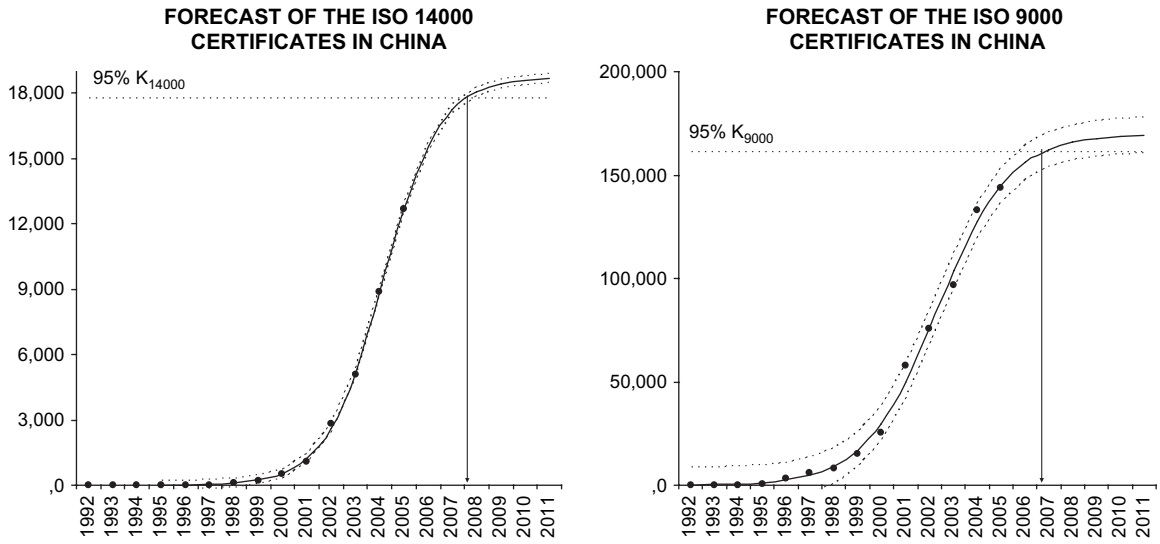
This group is made up of countries with increasing ISO 14000 intensity rates, but with decreasing rates for the ISO 9000. This is the situation of countries that have already reached a maximum level of ISO 9000 certificates, but have not reached the same limit with ISO 14000 certificates, very probably, among other reasons, because its real implementation in companies occurred much later. Of the countries analyzed, the Republic of Korea and the United Kingdom, among others, are found in this group. They reached a saturation rate close to 95% for the ISO 9000 logistic curve some years ago.

By way of example, the forecast models for both standards in the Republic of Korea and the United Kingdom are shown in Figs. 6 and 7. If we focus on ISO 14000 certification, the forecast model is perfectly adjusted to the real data obtained. This is especially interesting given that the Republic of Korea is a country which is just starting out according to the model shown of ISO 14000 certifications. The case of the United Kingdom is more complicated to analyze. The data does not fit the logistic curve, although some similitude with the S-shaped curve can be appreciated. Part of this discrepancy can be explained by the lack of accuracy of the data. The ISO has reported some data collecting problems in the case of the United Kingdom [24,25].

However, what is happening with the ISO 9000 certifications? As is noted in the figures, there is not only a clear drop in the number of certifications, but the trend appears to continue, and obviously the logistic curve can no longer be used to forecast ISO 9000 evolution. Clearly, it is very difficult to conduct analyses which are more than purely exploratory, bearing in mind the few years over which this phenomenon has been detected. However, a drop in stabilization is detected in the number of certifications that one might initially expect.

Undoubtedly, the analysis carried out would have been of special local interest if it had only been conducted for these two countries. However, after carrying out the same analysis for all the countries involved in this group, the exploratory results obtained are very similar: perfectly foreseeable growth in the number of ISO 14000 certificates of up to 95% saturation of the model, followed by a relatively ''chaotic'' drop in the number of ISO 9000 certificates once the saturation level has been reached ''in an orderly fashion.''

It is interesting to note how, at the same moment in time, one of the standards continues to grow in a relatively predictable way while the one, which has already reached the saturation limit, has begun to experience a drop in number. This makes us think – albeit with certain caution – that what is detected is not tiredness in the use of management standards on the part of companies, but rather proof that the requirements of each standard have been assimilated and met. This can in turn lead to the non-renewal of certificates. In other words, a standard is implemented and certified, maintained over time and, once its requirements have been accepted by the organization, certification is no longer sought and the company focuses its attention on another standard to be implemented. Standards, or at least the certification of these standards, may increasingly become ''use and discard'' products, and once the level required is attained, the trend may be to not certify them again, which does not mean not continuing to use the standard.



Forecast of ISO certificates in China considering the logistic curve.

	ISO 14000		ISO 9000	
	DF	Sum Sq	DF	Sum Sq
Regression	3	113468517.41	3	57620919555.95
Residual	8	63441.59	11	163875261.05
Uncorrected Total	11	113531959	14	57784794817
(Corrected total)	10	78671334.9	13	34906508616.36
R squared	.999		.995	

	Value	LL	UL	Value	LL	UL
N_0	7.69	4.23	11.14	180.95	-17.55	379.44
K	18719.81	17071.82	20367.81	169645.30	147236.45	192054.14
r_0	0.8540	0.7937	0.9142	0.6629	0.5399	0.7859

LL: Lower limit of the 95% confidence interval (the left dotted lines in the figures).
UL: Upper limit of the 95% confidence interval (the right dotted lines in the figures).

Fig. 4. Forecast of ISO 14000 and ISO 9000 certifications applying the logistic curve in China.

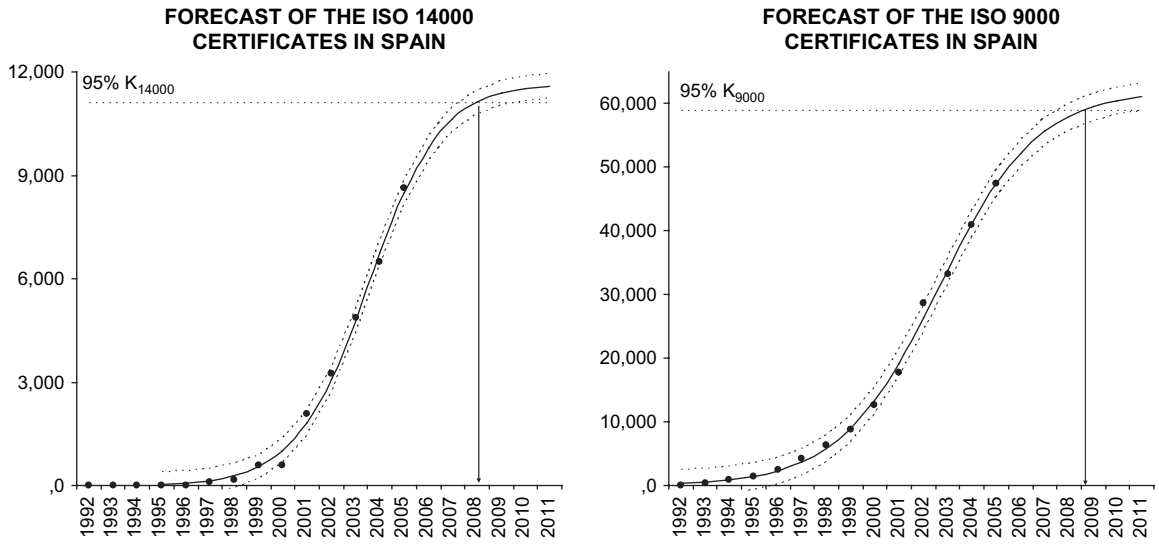
4.3. Retrocessive behaviour

This group is made up of those countries in which a clear decertification in both ISO 9000 and ISO 14000 certification rates has been detected. Taking into account the data until the year 2005 of the countries analyzed, there is no country following this pattern, although Australia is closest to this situation. Clearly, with a single country to analyze, it is very difficult to draw conclusions, even more so when these may be influenced by very specific aspects of each country such as a public administration campaign or funding for a certain type of certification or an error in taking into account data regarding certificates in that country. In any event, and as is noted in Fig. 8, the conclusions drawn from previous behaviour seem to be confirmed from a merely exploratory point of view: a very accurate forecast may be made using the logistic curve model in the expansive phases, but once 95% saturation in that model has been reached, the behaviour is quite chaotic, and generally evidences a continued decrease. It is clear that more reliable conjectures cannot be put forward from the little data available and with a phenomenon which is still so new.

4.4. Other types of behaviour?

It is possible to define another group of countries: those with decreasing ISO 14000 certification rates, but showing continued growth in ISO 9000 rates. No country has been found in this situation, which seems reasonable enough, since the expansion of ISO 9000 was carried out with a sufficient head start and with sufficiently more impact than that of ISO 14000. It is logical that countries in this group have not been detected in the sample, and that there is no possibility of their detection when analyzing the rest of the population.

Following this exploratory analysis and taking into account the saturation levels of the countries analyzed as well as the different individual historical situations of each of them, it seems very logical to think that countries will pass sequentially through the three states: from expansionist to mature and from mature to retrocessive. In some way, it may be that the model followed by Australia is the one which most countries will gradually follow: continued growth in certain management standards which may be perfectly forecasted using a logistic curve, while others decrease at the same time as they reach their saturation level. It is true that such



Forecast of ISO certificates in Spain considering the logistic curve.

	ISO 14000		ISO 9000	
	DF	Sum Sq	DF	Sum Sq
Regression	3	5930017.17	3	6457414208.54
Residual	8	6214.83	11	10187810.45
Uncorrected Total	11	5936232	14	6467602019
(Corrected total)	10	2550632	13	3459985618.93
R squared	.996		.997	

	Value	LL	UL	Value	LL	UL
N_0	38.48	1.94	75.01	327.15	142.34	511.97
K	11668.31	8883.42	14453.20	62029.35	53045.29	71013.41
r_0	0.6695	0.5253	0.8136	0.4932	0.4237	0.5627

LL: Lower limit of the 95% confidence interval (the left dotted lines in the figures).
UL: Upper limit of the 95% confidence interval (the right dotted lines in the figures).

Fig. 5. Forecast of ISO 14000 and ISO 9000 certifications applying the logistic curve in Spain.

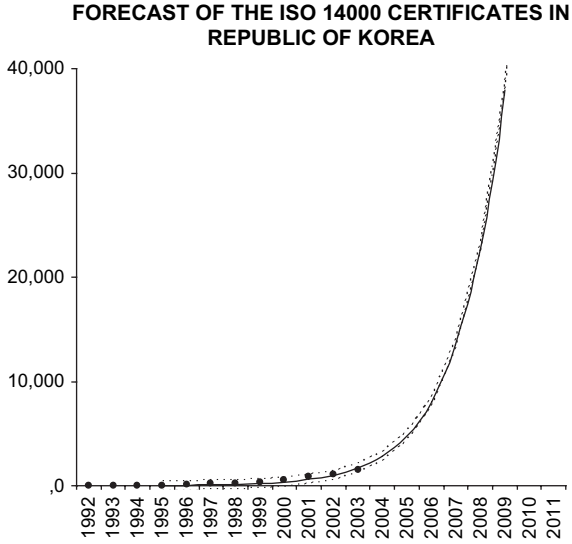
a conclusion has been reached in a relatively ''provocative'' manner, but it is impossible to delve deeper in an analysis of results when such decertification was first detected only one or two years ago. However, it is also true that this analysis is very interesting, in particular if it is proven that the patterns followed by the leading countries are applicable to the others, and even more so at a time when the number of environmental management standards is constantly growing (for instance, ISO 10015 and ISO 10031, recently approved standards such as ISO 14063 for environmental communication, and others which are at the draft stage, such as ISO 14005 for the implementation of an EMS).

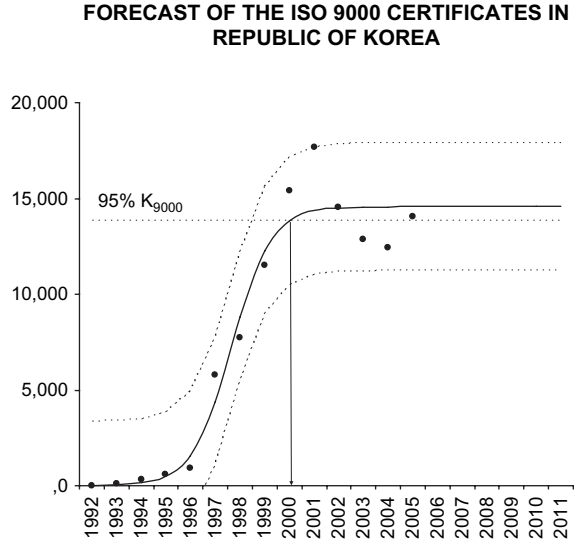
5. Conclusions

This article is not the first in which similar behaviours are detected between the implementation of an EMS according to the ISO 14000 standard and that of a QMS according to the ISO 9000. Thus, some authors [30,31] had already discovered that the reasons companies had in getting certified as well as the benefits they obtained with certification coincided for both standards. However, up to now very little analysis has been done to determine whether their dissemination followed the same parameters or not. In particular, some research work proposing dissemination models has been carried out [14,17], but at a time when both standards were in a process of expansion.

On the other hand, no research has been found regarding new effects such as the decrease in the number of certifications which has been detected in recent years. Firstly, it must be taken into account that this decertification concerns, above all, the ISO itself. In this sense, the latest report published by this organization [18] regarding the number of certificates includes a brief description of the possible causes of such decertification, as well as the results of a survey about it. In the aforementioned study, it is pointed out that one of the main reasons for decertification is ''Organization failed re-certification audit,'' although it must be taken into account that the main reason cited by companies (with a 54.2% rate of response) is ''Other reasons,'' so major conclusions cannot be drawn from this brief study.

In any case, worldwide decertification is evident, more so if we take into account the fact that many countries ranked as





Forecast of ISO certificates in the Republic of Korea considering the logistic curve.

	ISO 14000		ISO 9000	
	DF	Sum Sq	DF	Sum Sq
Regression	3	11373225.80	3	1479492117.20
Residual	8	71777.20	11	25543764.75
Uncorrected Total	11	11445003	14	1505035882
(Corrected total)	10	5946780.5	13	577173548
R squared	.987		.956	

	Value	LL	UL	Value	LL	UL
N_0	27.29	-5.79	60.38	10,96	-36.95	58.86
K	288029373644.4	-3.439e+019	3.4390e+019	14471.60	12967.7 0	15975.51
r_0	0.5169	0.2567	0.7771	1.2718	0.4923	2.0513

LL: Lower limit of the 95% confidence interval (the left dotted lines in the figures).
UL: Upper limit of the 95% confidence interval (the right dotted lines in the figures).

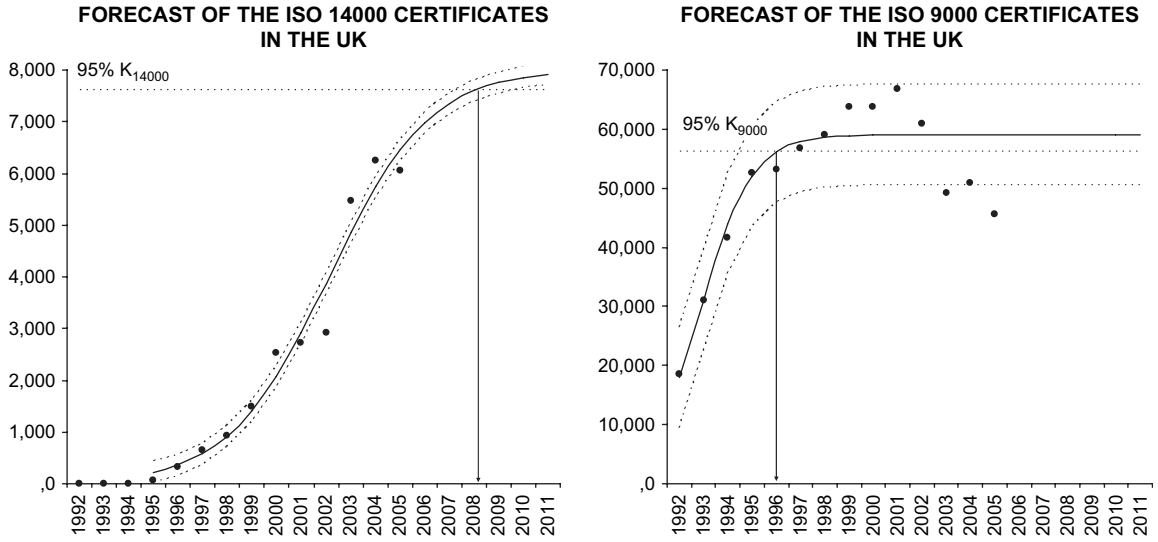
Fig. 6. Forecast of ISO 14000 and ISO 9000 certifications applying the logistic curve in Republic of Korea.

worldwide economic leaders, such as the United Kingdom or Australia, and up to a certain point Germany, are clearly immersed in this process of decertification. Undoubtedly, the total number of certificates throughout the world is maintained thanks to the impact of the more incipient countries with low saturation levels, particularly China, on forecast logistic models.

On discovering the first countries evidencing certain decertification in the number of ISO 14000 certificates, as well as with ISO 9000 certificates, this article has sought to analyze their pattern. A first approach is found by detecting that this decertification begins once the number of certificates has reached 95% of the degree of saturation shown by the logistic model. Will this be the pattern for all the countries involved? In particular, will it apply to those that are in their first stages of growth? Needless to say, the low number of countries in which such decertification has been detected, and in particular the short period of time during which it has been detected – not more than one or two years – does not make it possible to make too many conjectures.

However, from the analyses carried out, it has been possible to define three types of countries in terms of an expansion in both standards: the countries evidencing ''expansionist'', ''mature'' and ''retrocessive'' behaviours. Included in the first case would be those countries evidencing a constant growth in the number of certifications according to both standards – growth which may be easily modelled by logistic curves. China is the most representative country in this group, where the main reason to implement ISO 14000 standards is entrance into international markets [32,33], and a secondary one is to get environmental and management advantages and benefits similar to those documented for companies that adopted ISO 14000 in industrialized countries. Countries evidencing ''mature'' behaviour would be those in which the number of ISO 9000 certifications has reached 95% expansion, according to the model used, and a process starts involving a decrease in certified companies which is difficult to model, whereas the number of certified companies according to the ISO 14000 standard continues to grow. Lastly, those countries evidencing ''retrocessive'' behaviour would be included in the group in which the level of certifications decreases for both standards.

In any event, the most interesting thing about the types detected is how the impact of one standard has already started to decrease in the same country at the same time as another



Forecast of ISO certificates in United Kingdom considering the logistic curve.

	ISO 14000		ISO 9000	
	DF	Sum Sq	DF	Sum Sq
Regression	3	129506576.37	3	38252865938.92
Residual	8	2003832.62	11	444851387.07
Uncorrected Total	11	131510409	14	38697717326
(Corrected total)	10	53033758	13	2343872461.71
R squared	.962		.810	

	Value	LL	UL	Value	LL	UL
N_0	225.54	-80.58	531.67	17973.97	6231.57	29716.37
K	8014.43	4127.83	11901.02	57468.80	52651.54	62286.06
r_0	0.4968	0.2218	0.7718	0.9456	0.2540	1.6372

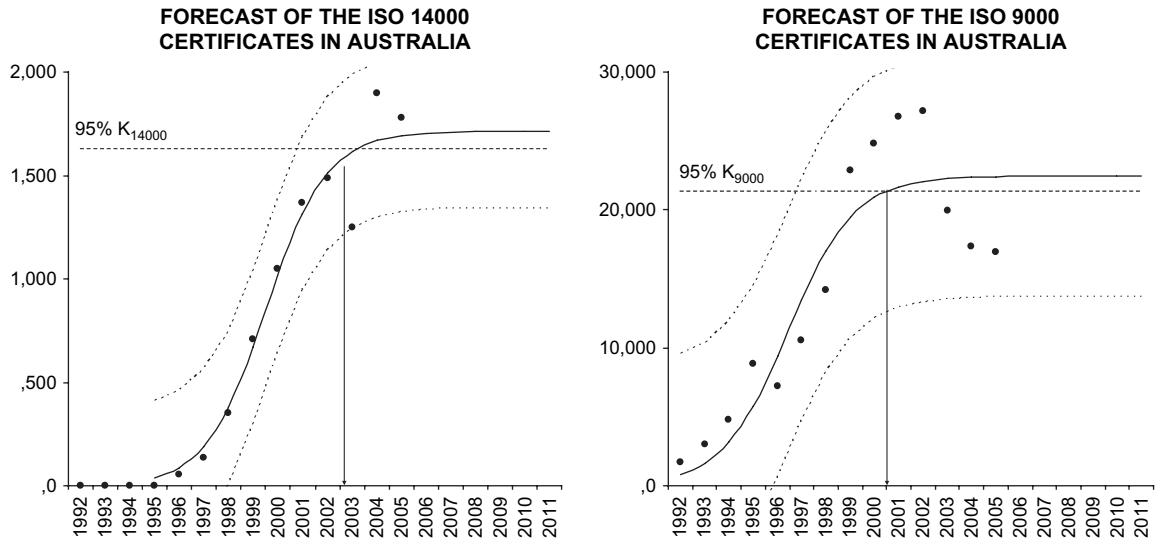
LL: Lower limit of the 95% confidence interval (the left dotted lines in the figures).
UL: Upper limit of the 95% confidence interval (the right dotted lines in the figures).

Fig. 7. Forecast of ISO 14000 and ISO 9000 certifications applying the logistic curve in United Kingdom.

continues its ''predictable'' growth. This is closely related to the first hypothesis which is an interesting formulation. That is why, based on the experience gained from our prior research and the practitioner and academic literature available, we consider it appropriate to conclude this exploratory pilot article by announcing a series of work proposals which we deem to be of interest and which could be contrasted in subsequent research.

The first of them, as we have mentioned, is related to the possible loss of appeal of the implementation of MSS, due to the fact that the intrinsic value of the certificates supporting such implementation decreases as the total number of certificates increases. Indeed, we understand that many companies – as has been pointed out to us at least in empirical studies carried out [34,35] – have embarked on the process of implementation and certification of ISO 9000 standards motivated by the competitive advantage and the differentiation of image resulting from having the certificate. It seems obvious that the intrinsic value of the certificate is not constant, but rather tends to decrease in an environment in which possessing the aforementioned certificates does not prove to be a distinguishing factor for companies. It is very possible that the same occurred with the ISO 14000 standard. Linked to this fact, it would be interesting to analyze the hypothesis that a competition factor is involved in the dissemination of MSS such as ISO 9000 and ISO 14000 of business management general models, and other models of excellence such as EFQM, Malcom Baldrige and the Deming model. All this means that as companies steadily implement, take on and certify a certain standard, it makes sense to certify for a period of time, but gradually this certification will lose its importance, and be discontinued. Of course, this does not mean that the standard is not used, but rather that it is simply not certified. From then on, the company will focus its attention on other standards or models which it will probably be more interested in certifying, either to show to its customers and competitors or to ensure its proper implementation.

On the other hand, and as authors such as Delmas [20] and Potoski and Prakash [36] have stated, it is clear that the political and regulatory context of each country and, in particular, the prescriptive role of public administrations plays a fundamental role in extending these MSS: direct or indirect grants for the implementation and certification of these systems may play a major role in the growth of certificates in a specific country, but also in the decertification process (as is the case of



Forecast of ISO certificates in Australia considering the logistic curve.

	ISO 14000		ISO 9000	
	DF	Sum Sq	DF	Sum Sq
Regression	3	13948268.04	3	3877543868.361
Residual	8	207192.96	11	173606506.64
Uncorrected Total	11	14155461	14	4051150375
(Corrected total)	10	4916682.73	13	1019271758.93
R squared	.958		.830	

	Value	LL	UL	Value	LL	UL
N_0	40.33	-35.81	116.46	824.73	-1358.43	3007.89
K	1712.82	1434.55	1991.09	22453.04	18140.22	26765.86
r_0	0.8198	0.3676	1.2721	0.7341	0.1063	1.3620

LL: Lower limit of the 95% confidence interval (the left dotted lines in the figures).
UL: Upper limit of the 95% confidence interval (the right dotted lines in the figures).

Fig. 8. Forecast of ISO 14000 and ISO 9000 certifications applying the logistic curve in Australia.

Australia in which very particular behaviour is detected, probably for these reasons). We understand that this is an issue that should be contrasted in subsequent studies.

Similarly, it may also prove interesting to carry out an in-depth study on possible losses in terms of certifications owing to a lack of confidence in the system [35] and, in particular, if decertification can be explained by a possible trend in companies which have implemented the system to a substantive extent rather than merely symbolically in their organizations – as many companies do, according to some studies [37] – but they have no incentive to become certified.

There is yet another point that could be analyzed in future works in particular areas of the world. For instance, since the ISO 14000 standard is now the management system used as the basis for EMAS certification, it will be very interesting to investigate if the reduction of EMAS certifications harms the European economy or if it lessens the ability of companies to continually improve in the area of environmental management.

As has been stated, we understand that all these reflections and working hypotheses in the broadest sense of the word and which we leave open for study in the future are of great interest to researchers who are working along EMS lines of research which are gradually making their way into the academic field, as well as being of interest to different agents involved in the EMS dissemination process (e.g. multinational companies, accreditation and certification bodies, consultants, public sector agencies, etc.).

Acknowledgements

This article was written as part of a research project titled "The integrated management system (IMS) in Spanish companies" (SEJ2006-00682/ECON) financed by the Ministry of Science and Technology within the aid programme for R&D projects.

References

[1] Mendel PJ. International standardization and global governance: the spread of quality and environmental management standards. In: Hoffman A, Ventresca M, editors. Organizations, policy, and the natural

environment: institutional and strategic perspectives. UK: Stanford University Press; 2001.
[2] Dale BG. Managing quality. 3rd ed. UK: Blackwell Publishing; 2002.
[3] Krugman P, Obstfeld M. International economics: theory and policy. 6th ed. Addison-Wesley-Longman; 2003.
[4] Blanco H, Bustos B. Normalización y Comercio Sustentable en Sudamérica. Santiago de Chile, Chile: RIDES; 2004.
[5] Casadesus M, Heras I, Merino J. Calidad práctica. Una guía para no perderse en el mundo de la calidad. Madrid, Spain: Prentice Hall–Financial Times; 2005.
[6] Brunsson N, Jacobsson B. The contemporary expansion of standardization. In: Brunsson N, Jacobsson B, Associates, editors. A world of standards. Oxford: Oxford University Press; 2000. p. 1–17.
[7] Abbott KW, Snidal D. International 'standards' and international governance. Journal of European Public Policy 2001;8(3):345–70.
[8] Neumayer E, Perkins R. Uneven geographies of organizational practice: explaining the cross-national transfer and adoption of ISO 9000. Economic Geography 2005;81(3):237–59.
[9] Van Der Veldt D. Case studies of ISO 14000: a new business guide for global environmental protection. Environmental Quality Management 1997;Autumn:1–19.
[10] Zabihollah R, Szendi JZ. An examination of the relevance of ISO 14000 environmental standards: a survey of US corporations. Advances in Environmental Accounting and Management 2000;1:123–40.
[11] Mohammed M. The ISO 14001 EMS implementation process and its implications. A case study of Central Japan. Econ-Management and Auditing 2000;25(2):177–88.
[12] Nakamura M, Takahashi T, Vertinsky I. Why Japanese firms choose to certify: a study of managerial responses to environmental issues. Journal of Environmental Economics and Management 2001;42(1): 23–52.
[13] Saraiva PM, Duarte B. ISO 9000: some statistical results for a worldwide phenomenon. TQM & Business Excellence 2003;14(10):1169–78.
[14] Franceschini F, Galetto M, Gianni G. A new forecasting model for the diffusion of ISO 9000 standard certifications in European countries. International Journal of Quality & Reliability Management 2004; 21(1):32–50.
[15] Corbett CJ, Kirsch DA. International diffusion of ISO 14000 certification. Production and Operations Management 2001;10(3): 327–42.
[16] Vastag G. Revisiting ISO 14000: a new "Look" at the drivers of certification. Working paper. Indiana University; 2003.
[17] Marimon F, Casadesús M, Heras I. ISO 9000 and ISO 14000 standards: an international diffusion model. International Journal of Operations and Production Management 2006;26(2):141–65.
[18] ISO. The ISO survey of ISO 9000 and ISO 14000 certifications. Geneva: ISO. http://www.iso.ch/iso/en/iso9000-14000/pdf/survey2005.pdf.
[19] González-Benito J, González-Benito O. An analysis of the relationship between environmental motivations and ISO 14001 certification. British Journal of Management 2005;16(2):133–48.
[20] Delmas M. The diffusion of environmental management standards in Europe and in the United States: an institutional perspective. Policy Sciences 2002;35(1):91–119.
[21] Haufler V. Negotiating international standards for environmental management systems: the ISO 14000 standards. UN Vision Project on Global Public Policy Networks. New York; 1999.
[22] Loew T, Clausen J. Wie weiter mit EMAS? Schlussfolgerungen vor dem Hintergrund einer Längsschnittanalyse 1997 bis 2002. Diskussion paper No 4 sustainability. Berlin: Institute 4 Sustainability; 2005.
[23] Loew T. Environmental cost accounting: classifying and comparing selected approaches. In: Bennet M, Rikhardsson P, Schaltegger S, editors. Environmental management accounting – purpose and progress. Dordrecht: Kluwer Academic Publishers; 2003.
[24] ISO. The ISO survey of ISO 9000 and ISO 14000 certifications: 13th cycle. Geneva: ISO, http://www.iso.ch/iso/en/iso9000-14000/iso9000/survey13thcycle.pdf; 2004.
[25] ISO. The ISO survey of ISO 9000 and ISO 14000 certifications: 14th cycle. Geneva: ISO, http://www.iso.ch/iso/en/iso9000-14000/iso9000/survey14thcycle.pdf; 2005.
[26] Rogers EM. Diffusion of innovations. New York, USA: Free Press; 1995.
[27] Teece D. The diffusion of an administrative innovation. Management Science 1980;26(5):464–70.
[28] Stoneman P. Handbook of the economics of innovation and technological change. Oxford, UK: Blackwell Handbooks in Economics; 1995.
[29] Corbett CJ, Kirsch DA. ISO 14000: an agnostic's report from the front line. ISO 9000 + ISO 14000 News 2000;2:4–17.
[30] Pan J. A comparative study on motivation for and experience with ISO 9000 and ISO 14000 certification among far eastern countries. Industrial Management and Data Systems 2003;103(8):564–78.
[31] Poksinska B, Dahlgaard JJ, Eklund JAE. Implementing ISO 14000 in Sweden: motives, benefits and comparisons with ISO 9000. International Journal of Quality and Reliability Management 2003;20(5):585–606.
[32] Zenga SX, Tamb CM, Tamb Vivian WY, Dengb ZM. Towards implementation of ISO 14001 environmental management systems in selected industries in China. Journal of Cleaner Production 2005;13:645–56.
[33] Peng Tan L. Implementing ISO 14001: is it beneficial for firms in newly industrialized Malaysia? Journal of Cleaner Production 2005;13: 397–404.
[34] Casadesús M, Giménez G, Heras I. Benefits of ISO 9000 implementation in Spanish industry. European Business Review 2001;13(6):327–35.
[35] Casadesús M, Karapetrovic S. Has ISO 9000 lost some of its lustre? A longitudinal impact study. International Journal of Operations & Production Management 2005;25(6):580–96.
[36] Potoski M, Prakash A. Regulatory convergence in nongovernmental regimes: cross-national adoption of ISO 14001 certification. Journal of Politics 2004;66(3):885–905.
[37] Christmann P, Taylor G. Firm self-regulation through international certifiable standards: determinants of symbolic versus substantive implementation. First Annual Conference on Institutional Mechanisms for Industry Self-Regulation, Dartmouth University, UK, 2005.