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Paving the way for the ISO 14006 ecodesign standard: an exploratory study in Spanish companies

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ABSTRACT

A Spanish ecodesign standard (the UNE 150301) is being used as a basic reference point in paving the way for the future ISO 14006 ecodesign standard which may foreseeably be passed in 2011. This article aims to analyze the experience regarding adoption of the UNE 150301 in Spain.

Following an analysis of the standard's structure, its objectives and scope, its real implementation process is then analyzed based on an exploratory qualitative study carried out in four Spanish companies that have been pioneers in adopting this environmental standard. The conclusion is drawn in the article that in all the cases analyzed, the greatest source of impact occurs in the phase in which the product is used and is related to energy consumption. Companies appear to be satisfied with the adoption of this standard and, in particular, point out that they have managed to reduce the environmental impact of their products. However, they draw attention to the fact that, to deal with certain instances of impact that increases in cost entail, administrative bodies need to establish mandatory regulations, as environmentally-friendly companies would otherwise lose competitiveness.

1. Introduction

Current theories maintain that the function of the industrial designer is essential in ecodesign, owing to the fact that they develop their work during the initial phases of the product development process (Lofthouse, 2004). For these reasons, the fundamental aim of designers along these lines should be to maximize the value of the product in a sustainable way, while minimizing its negative impact (Platcheck et al., 2008). As a result, there is a large amount of scientific literature which analyzes the different ecodesign strategies and tools available (among others, Cerdan et al., 2009; Fernández-Alcalá, 2007).

On the other hand, the need on the part of modern-day society to promote international standards which may contribute towards sustainable development have had a major influence on those ecodesign standards that can be considered to be one of the most noteworthy general tools available (Karlsson and Luttropp, 2006; Donnelly et al., 2006; Bengoetxea, 2007; Knight and Jenkins, 2009). Moreover, we should recall the fact that in recent years we have witnessed a speeding-up in the standardization process in an economy which is characterized by globalization and the deregulation of markets (Heras, 2006).

As far as environmental management is concerned, attention should be drawn to the role played by the ISO 14000 family of standards. Along these lines, we should draw attention to the ISO Technical Report ISO/TR 14062 (BSI, 2002) in the field of ecodesign. This document describes the integration process of environmental aspects into the product design and development process (Knight and Jenkins, 2009).

Within this context, the Spanish Standardization and Certification Association (Aenor) decided to take a further step in this direction in Spain in June 2003 and publish an ecodesign regulation: the UNE 150301 standard (Aenor, 2003). As an important background to this standard, the fact that both Spanish public institutions and private business have experienced major growth in terms of the adoption of different environmental management standards has had to be taken into account – such standards include the ISO 14001 standard and the EMAS model (Heras and Arana, 2010). This is true to the extent that Spain is currently ranked third in the world in terms of the number of ISO 14001 certificates issued and the first in terms that are played down with regard to the size of its economy (Heras et al., 2008).

The above-mentioned UNE 150301 standard goes beyond other environmental standards such as the ISO 14040 standard, which are used to analyze the life cycle of the product, or the ISO/TR 14062

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standard, which is designed to integrate environmental aspects in the development of products - as its purpose is to provide organizations with elements of an Environmental Management System in order for the design and development process involving products and/or services to be effective – also from the environmental standpoint (Aenor, 2003). Furthermore, special mention should be made of the fact that this Spanish standard is being used as a basis for creating the ISO 14006 ecodesign standard (Ihobe, 2008). Indeed, the drafting of this standard was approved in Beijing in 2008 by the ISO/TC 207 committee. The aim of this standard will be to integrate design and development into a management system in such a way as to reduce the environmental impact of the products designed – not only in the design and manufacturing phases, but also throughout the life cycle of the product.

The ISO/TC 207 committee is using this standard as basic reference points in the drafting process of the ISO 14006 (Ihobe, 2008): on the one hand, standards which analyze the life cycle of the product and form the basis of its design, such as the UNE 150301 standard, ISO 14040 (ISO, 2006) and ISO/TR 14062, which is going to be repealed; and on the other, the ISO 14001 and ISO 9001 standards, with which an attempt is made to facilitate their integration as far as possible. This standard is not, in principle, going to be certifiable, although the different national committees will be able to opt to transform it into a certifiable regulation in their own countries (specifically, it would seem that they are going to be certifiable in Spain and Germany) (Ihobe, 2010).

The aim of this article is to analyze how Spanish companies have adopted the UNE 150301 standard. Specifically, it focuses on an analysis of what the motivation, obstacles and benefits have been of such adoption – an issue that has not hitherto been studied in literature on the subject.

Following this introduction, the article goes on to analyze the structure and content of the UNE 150301 standard and its dissemination in Spain. It later continues in the third section to describe the research methodology used, while in the fourth section, the four case studies carried out in Spanish companies are analyzed. The fifth section contains the discussion and conclusions of interest to those groups involved in the adoption of this type of standard, and the references are provided in the sixth- and last- section.

2. The Spanish UNE 150301 standard

The UNE 150301 standard is an ecodesign standard which, via systematics based on the continuous improvement process, helps to reduce environmental impact in the different phases of the product's life cycle: obtaining and consumption of materials, factory production, distribution and sale, use and end of life.

The UNE 150301 standard was passed by Aenor, which also enjoyed the support of Ihobe in promoting it, the latter being a public environmental management company funded by the Basque Government. These two bodies are represented on the ISO/TC 207 technical committee, which is responsible for drafting the ISO 14006 standard.

The UNE 150301 standard is divided into four main sections (see Table 1): The first three contain, as in the case of other standards, the classic points regarding the "Purpose and field of application" (1), "Standards for consultation" (2) and "Definitions" (3). Section 4, titled "Requirements of the Environmental Management System for the Design and Development Process" (REMSDDO), is the part in which the cycle involving the continuous improvement of this standard is described (see Fig. 1).

As far as its dissemination is concerned, it should be pointed out that in Spain in March 2010 there were 43 certified companies (Fig. 2). Especially of note is the fact that 24 of the 43 cases of implementation have taken place in the Basque Autonomous Community (CAPV), one of the autonomous regions with the greatest concentration of ISO 14001 registered companies. This is due, among other factors, to the major campaign that has been pursued by the Basque Government via Ihobe, which has organized numerous events to spread the word about the standard to companies and provide aid that amounts to 50% of the auditing and consultancy costs involved in the implementation process (Arana et al., 2010).

In terms of distribution according to sector, it should be stressed that, despite the fact that the standard initially focused on the industrial sector, there are 25 architects' studios that have been certified and 84% of the companies that have implemented the standard are related to the building trade.

Table 1
structure of the UNE 150301 standard.

1 Purpose and field of application	
2 Standards for consultation	
3 Definitions	
4 Requirements of the REMSDDP	
4.1 General requirements	
4.2 Environmental policy of reference	
4.3 Planning	4.3.1 Identification and assessment of aspects
	4.3.2 Legal and other requirements
	4.3.3 Objectives and goals
	4.3.4 PDD environmental management programme
4.4 Implementation and operation	4.4.1 Structure and responsibilities
	4.4.2 Training, awareness-raising and professional competence
	4.4.3 Communication
	4.4.4 Documentation pertaining to the REMSDDO
	4.4.5 Control of documentation
	4.4.6 Operational control
	4.4.6.1 Planning of design and development
	4.4.6.2 Initial elements of design
	4.4.6.3 Results of design and development
	4.4.6.4 Review of design and development
	4.4.6.5 Verification of design and development
	4.4.6.6 Validation of design and development
	4.4.6.7 Control of changes in design and development
4.5 Checking and corrective action	4.5.1 Monitoring and measurement
	4.5.2 Non-conformity, corrective action and preventive action
	4.5.3 Registers
	4.5.4 Audit of the REMSDDO
4.6 Review by the management	

Source: put together by the author from the UNE 150301 standard (Aenor, 2003).

3. Methodology

With a view to responding to the questions raised, an empirical study was designed of a qualitative nature based on a case study. This methodology was selected owing to its suitability when analyzing the complex process involving the pionering UNE 150301 adoption, in which – as has already been stated – diverse agents and actors interact. Research of a descriptive nature was planned, albeit mainly exploratory, which facilitates penetration in and understanding of the subject being studied so as to try and detect

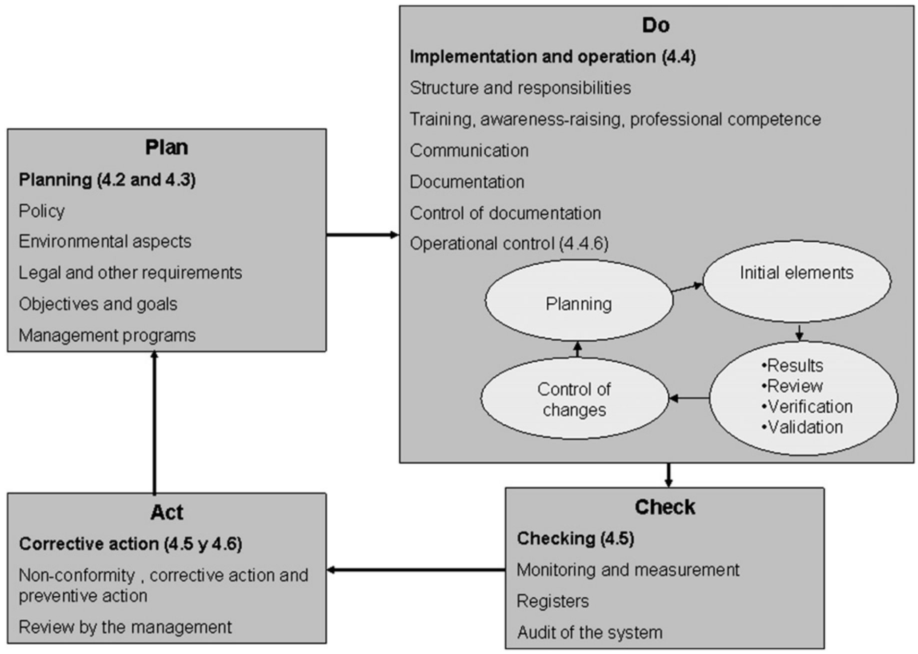

Fig. 1. Continuous improvement process of the UNE 150301 standard. Source: put together by the author from the UNE 150301 standard (Aenor, 2003).

propositions which are liable to be generalized in terms of the practices observed (Eisenhardt, 1989; Yin, 2003).

The field work was developed over time between January 2009 and September 2010, and had four components. Firstly, close to 9 in-depth interviews with different agents and supporting actors involved in the dissemination of UNE 150301 were conducted: members of environmental promotion agencies, consultancy firms and certifying bodies. Secondly, a series of semi-structured in-depth interviews were conducted with managers and technicians from seven organizations which revolved around a semi-structured script. In this respect, the aim of the interviews and consultation involved obtaining narratives from the interlocutors, rather than obtaining specific responses (Yin, 2003). Alongside this, intense participant observation work was carried out via a continued series of visits to the organizations being studied, in the course of which a very important set of evidence was gathered from both the analysis of documentation related to the UNE 150301 adoption available in the different areas of work of the companies concerned and in non-structured consultation with personnel accessible in them that followed no specific pattern. Fourthly and lastly, the organizations analyzed made a very broad-ranging set of documentation available for research related to the ecodesign process (management manuals, operative procedures, job instructions, records, and auditor's reports, etc.) for their in-depth analysis.

As recommended in specialist literature on the subject (Yin, 2003; Maxwell, 2005), the validity of factors was guaranteed in the course of the research via the use of diverse sources of information (direct observation, consultation, interviews, documentary databases regarding UNE 150301 from the organizations and other internal and external documentary information). Internal validity was guaranteed via the search for common patterns that help to explain the phenomena subject to study, while reliability was ensured via the use of semi-structured interviews of the same type and with the same number of questions and with an assessment protocol of cases against each factor. To try to prevent any distortion in the course of the inductive research, an attempt was made to avoid using discourse that was deemed too "academic" or "specialized" in interviews and consultation.

Seven case studies were carried out in total in companies with at least three years' experience in the adoption and certification of UNE 150301. The work was confined to these seven case studies because, although the number could have been increased, it became clear as the field work was being carried out that increasingly fewer ideas were being gathered, thus giving rise to theoretical saturation phenomena. For this reason, only four cases were selected for this research because it was considered that sufficient information and data had been gathered in order to be able to achieve the objectives set out by the research work. The rest of the

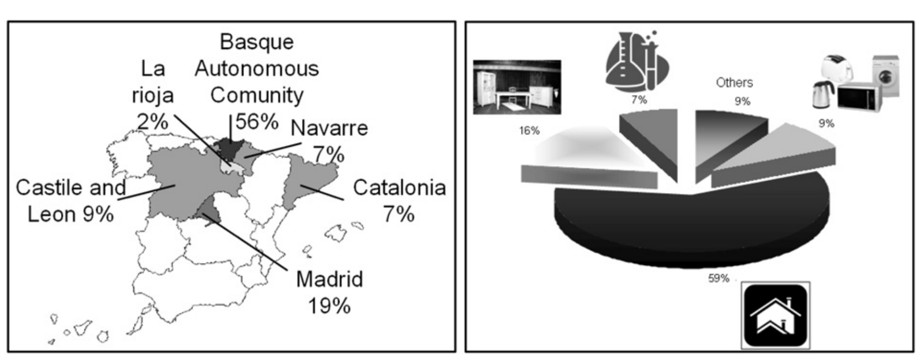

Fig. 2. Distribution according to sector and location of certified companies. Source: put together by the author from Aenor data.

cases were considered redundant because of the explanatory saturation (Maxwell, 2005). For reasons of confidentiality agreed upon with the companies that took part in the study, all names are fictitious.

Eleven semi-structured interviews were conducted with managers and, ten with technicians. Visits to organizations helped to find out first hand about the reality of the situation in which work is carried out, with over sixty documented consultations being made with personnel of an average duration of 10–15 min. Furthermore, 66 documents were analyzed in total, most of these being of an internal nature.

4. Analysis of cases

4.1. Alfa

This company was set up in 1956 and it has over the years become one of the leaders of the Basque industry. To prepare this case, we have focused on the washing division where mainly front-load washing machines are manufactured, as this is the division in which the UNE 150301 standard has been adopted.

In the year 2001, after becoming certified in accordance with ISO 14001, the standard was found to be based on a purely procedural approach at this company which did not focus to any great extent on the part corresponding to the product. This led them, for internal reasons, to try and reduce the environmental impact of their products and take advantage of the invitation by Aenor to take part in the technical committee involved in drafting the UNE 150301 standard.

In the course of the implementation process, their first main challenge was to analyze the initial situation, for which purpose they used the software EcoScan 3.0 as a tool based on the Ecoindicator model 1999. As it is noted in Table 2, this is a model promoted by Ihobe which enables the environmental impact of the product to be measured throughout its entire life cycle (Ihobe, 2000).

Table 2
Analysis of the environmental impact of a washing machine during each phase of production in milipoints (mPt).

Stage	Significant aspects	Impact (mPt)	Impact of phase (mPt)
Materials and production	Cement	520	8767
	AA steel	3185	
	EPDM rubbers	540	
	ABS	400	
	Cables	497	
	Steel	516	
	Copper	1400	
	Other	1709	
	Cement	520	
Transport	Lorry	827	827
Usage	Electricity	39,000	39,000
	Water	nd	
Waste	Recycling of FE metals	−1540	−1720
	Recycling of stainless steel	−245	
	Other	65	

	Amount	Unit amount (mPt)	Total (mPt)		Amount	Unit amount (mPt)	Total (mPt)
Cement	26 kg	20	520	Lorry 28 t (470 km)	37.6 tkm	22	827
AA steel	3.5 kg	910	3.185	Impact of transport phase			827
EPDM rubbers	1.5 kg	360	540	Electricity BV	1500 kWh	26	39,000
ABS	1 kg	400	400	Water	nd	nd	nd
Cables	0.5 kg	994	497	Impact of usage phase			39.000
Steel	6 kg	86	516		22 kg	−70	−1540
Copper	1 kg	1400	1.400		3.5 kg	−70	−245
Other			1.709				65
Impact of production phase			8.767	Impact of waste phase			−1720

Source: put together by the author from data obtained from the company.

Table 3
Objectives, actions and results of each phase of the process.

Stage	Actions	Results
Materials	Replacement and modification of technical specifications.	Avoiding mixture of plastics. Facilitating the simple separation of bulky internal elements. Reduction in weight of the washing machine. Elimination of heavy metals and non-recyclable materials.
Transport	Using reusable packaging with suppliers and customers.	The impact of production and end of life cycle of packaging has been eliminated.
Usage	Technical modifications related to insulation and loss in performance.	Increase in energy efficiency. Reduction in consumption of water.
Waste	Marking of plastic components. Drafting of a component recycling manual.	No objective has been achieved (recycling of 90%), but recycling has been increased by 40%.

Source: put together by the author from data obtained from the company.

An important aspect for this company was that in the MET matrix, which shows the materials used (M), the energy consumed (E) and the toxic emissions (T) generated during the different stages of the life cycle of a product (Tischner and Dietz, 2000), it was clearly observed that the greatest impact of washing machines occurs during the usage phase (see Table 2). Around approximately 80% of the impact occurs during this phase, and is especially caused by the consumption of water, electricity and detergent. For the company, being able to measure this impact has proved fundamental, as it has enabled them to set out objectives and actions for improvement and measure the results (see Table 3).

Once this tool was developed, it was then integrated into the engineering and design process in such a way that, when developing a new product, the reduction in environmental impact of the model replacing the old one would be taken into account as well as the innovation involved in that product, and the cost, quality and safety aspects.

On a supplier level, a study was first carried out into all the components of their products – not only the materials, but also the substances that were produced in the course of their manufacture. They then went on to train their most significant suppliers so that they would understand the tools they were going to use in the ecodesign in order to measure the impact of their products.

On the other hand, they set out the launching of specific ecodesign projects as an objective. For instance, one of the activities on which they are working, together with recycling centres, is to create and disseminate documentation so as to be able to recycle their products as far as possible at the end of their useful life.

Ecodesign is an aspect that is highly regarded by distributors albeit, however, not so much by the end customer, who is now starting to take into account only specific aspects such as the energy efficiency of the appliance.

For them, it is necessary that there should be an international standard which enables them to certify their products which can have a repercussion on all markets. For this reason, they consider the UNE 150301 standard thus far to have been a tool that enables them to improve their internal efficiency, rather than being an external tool. Externally, it is useful to them to take advantage of plans that encourage the purchase of efficient products, and in order for them to be prepared for any changes in the law.

4.2. Beta

The company came into being in 1996 with the signing of a 50% joint venture between two important companies that manufacture general electrical household appliances and jointly produce gas water heaters. The company currently has 304 employees, 216 of whom are responsible for production work and the rest carrying out indirect labour.

The main motivation behind the company deciding to implement the standard was internal, as the environmental impact of the product was highlighted as an area for improvement in the EFQM self-assessment carried out in 2006. Moreover, the fact that there was aid being made available by public administrative bodies to adopt this standard also had a major influence.

Prior to the implementation process, an assessment on the environmental impact of their products during their entire life cycle was carried out at the company, measured in millipoints using an ecoindicator panel based on ecoindicator'1999. Firstly, they analyzed the impact of all the components that form part of the heaters, taking into account variables such as weight, material, transport and packaging, etc. To this impact they added those referring to the manufacturing process, the impact the product has at the end of its useful life and, lastly, the impact it has at the end of its life. To minimize the impact of the heater at the end of its useful life, they added the composition of the heater's materials and, based on this, put together a recycling manual (see Table 4).

In this sense, the MET matrix enabled them to check the environmental impact of each phase, by means of which they were able to ascertain that the greatest impact occurs during the useful life of the appliance, mainly as a result of smoke emissions and gas and electricity consumption (Table 5).

Based on the above, their objectives were not achieved in the first project, which is why they felt the need to redesign the product, which meant a delay of around seven months (Fig. 3).

Since then, they have integrated all the ecodesign activities into the launching of new products by analyzing the environmental impact of all the new designs made within the company and demanding that this be less than the impact of the product they replace (see Fig. 4).

The following environmental objectives are pursued, specifically in the launching of new products (Fig. 4):

- To identify and assess significant environmental aspects associated with the different stages of the product's life cycle.
- To facilitate a reduction in the environmental impact of significant aspects via the selection of ideas for improving the product.
- To identify the legal requirements.
- To set out objectives for improving the environmental behaviour of the product.

Table 4
Analysis of the environmental impact of the heater during each phase.

Stage	Significant aspects	Impact (mPt)	Impact of phase (mPt)
Materials and production	Boiler casing	3538.18	4617.90
	Burner	164.36	
	Gas valve	267.95	
	Water valve	132.85	
	Ignition	442.24	
	Packaging	72.32	
Transport	Transport	18	18
Usage	Emissions and noise	429	1,383,366
	Gas and water consumption	1,382,937	
Waste	Material recycling	1130	1130

Source: put together by the author from data obtained from the company.

Table 5
A summary of the main results.

Stage	Actions	Results
Materials	Eliminating CC paint	9% improvement
	Replacement of burner branch with stainless steel one	100% improvement
	Replacement of gas valve with an aluminium one	8.5% improvement
	Replacement of sheet metal water valve with a plastic one	No improvement
	Circuit with built-in battery holder	21.5% improvement
	Weight reduced	No improvement
Transport	Collection of end product directly from the warehouse itself	Improved 100%
Usage	By increasing performance, gas consumption is reduced	Significant 3% improvement
	Use of a quieter burner	80% reduction in CO emissions
Waste	Use of a greater number of recyclable materials	Significant 27% improvement

Source: put together by the author from data obtained from the company.

A special aspect of this ecodesign is, according to the company, the fact that no commercial advantage is taken of it, as the products marketed by the company bear no type of environmentally-friendly labelling.

By integrating ecodesign into their products, they have obtained small reductions in costs, although it should be taken into account that the reduction in some essential types of impact such as NOx and CO2 emissions and energy make the product far more expensive. In this sense, the EuP 2005/32/EC directive, which came into force in January 2010 and which defines the design requirements products that use energy need to meet in terms of environmental impact throughout their life cycle, is bringing about a change in the concept of the heater. The new types of heater available compel manufacturers to make major investment that significantly increases manufacturing costs (Table 6).

4.3. Gamma

Gamma is an architects' studio which employs 11 workers that carry out the design, development and monitoring activities in building construction, property development, restoration, demolition, town planning and health and safety projects and quality control programmes, among other areas. They adopted the ISO 9001 standard in 2001 due to motivation of an internal nature. Later, in 2007, they implemented the ISO 14001 standard. In this case, the main cause of motivation was external, as it was expected that this would be increasingly taken into account in public tenders for projects.

When the ISO 14001 standard was first implemented, the consultancy firm recommended that they adopt it together with the UNE 150301:2003 Ecodesign standard, as this was also going to be highly regarded in the tenders referred to above which, with the threat of the crisis, were becoming increasingly competitive.

Other major factors were also existing grants (for the implementation of these systems via the Eraikal programme (Eraikal, 2010)), the sensitivity existing in the company towards environmental aspects, and the fact that the environmental impact of the products that produce their designs is far greater than the residues generated by the studio.

They adopted the standard in a project involving 196 state-subsidized houses to be constructed on urban land. To this end, in the first phase – the preliminary phase of the project – environmental aspects were analyzed in each of the phases of the life cycle of the product as shown in Table 6, in addition to carrying out an

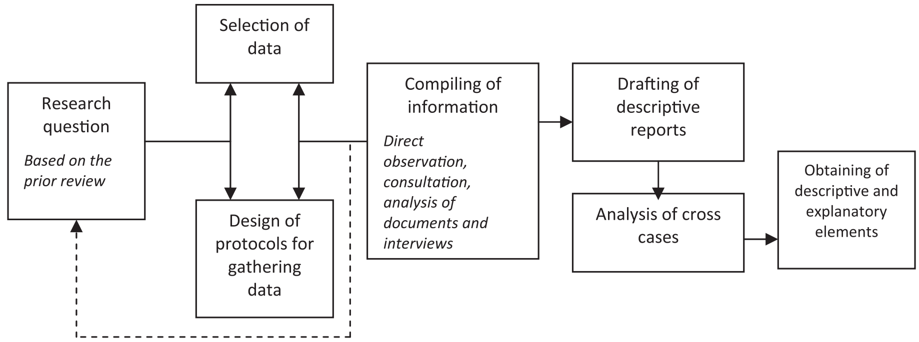

Fig. 3. Research process carried out. Source: put together by the author, based on Yin (2003).

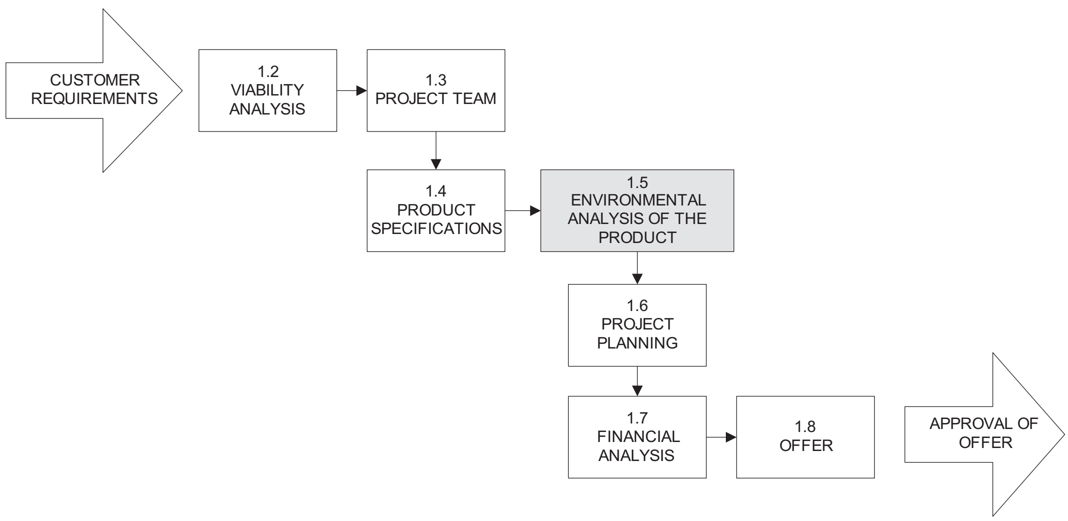

Fig. 4. Sequence of activities involved in the launching of new products. Source: put together by the author from data obtained from the company.

analysis of the programme for needs and an analysis of the approach and regulations to be adhered to. A proposal for measures was subsequently put forward and the environmental objectives to be attained were set out. Following this, the environmental objectives were arranged in order of importance. These focused essentially on the following aspects:

- Reducing energy consumption.
- Reducing water consumption.

Table 6
Main environmental aspects in each stage of the life cycle.

Stage	Significant aspects	Other aspects to be taken into account
Extraction and manufacture	Raw material consumption Energy consumption	
Construction of the building	Energy consumption Atmospheric emissions	Water emission Generation of residues Noise emissions
Use and maintenance	Energy consumption Water consumption Atmospheric emissions Visual impact Use of land	Generation of residues Dumping into water Noise emissions Biodiversity
Deconstruction	Energy consumption Generation of residues	Atmospheric emissions Noise emission

Source: put together by the author from data obtained from the company.

- Minimizing atmospheric emissions.
- Minimizing the generation of residues.

To this end, they took into account environmental aspects related to the building trade which in the Basque Autonomous Community is responsible for 40% of CO_2 emissions, 60% of raw material consumption, 50% of water consumption, and 35% of residues generated (Eraikal, 2010).

Some of the environment proposals were rejected by customers, mainly owing to financial aspects. This led the company in the basic project phase to identify possible new measures and to adapt already-accepted measures. Once this phase in the project had been overcome, accepted measures were then adapted to the project and these were verified with structures and installations.

Adoption of the UNE 150301 has given them a great deal of satisfaction, as they consider the results to have been good despite the fact that the customer failed to accept 39% of the proposals put forward. Table 7 shows a summary of the courses of action taken and the results obtained in comparison to those initially envisaged in each phase of the product's life cycle. Among these results, attention should be drawn to the emissions generated, water consumption and, mainly, the energy consumption in all phases of the life cycle.

Furthermore, they think the true benefits are still to come, as ecodesign is going to become increasingly important in the building trade. This is because, in many cases, it enables them to previously adapt to certain changes taking place in the sector.

As far as integration is concerned, they point out that the ISO 14001 and UNE 150301 standards have been implemented together

Table 7
Table summarizing the main actions and results obtained.

Stage	Actions	Stage results
Extraction and manufacture	Use of materials with environmentally-friendly labelling Use of recycled materials Use of recycled materials at the end of their working life Use of contaminant-free products Design that is able to facilitate future installations Use of materials of great durability Use of materials with low energy consumption	50% reduction in weight of materials 5% energy saving
Construction of the building	Elimination of building work electrogen groups Irrigation of land to prevent dust from being generated Removal of debris on completion of the work Avoidance of painting with *in situ* spray gun	80% energy saving 30% reduction in emissions
Use and maintenance	Optimization of artificial light necessary Choice of material and colour for façades Façades adapted to weather conditions Natural cross ventilation Greater thermal resistance of enclosures and gaps Absorbent glass with low emissivity Increase in solar panels for ACS Use of high-temperature thermal solar panels Low-consumption lighting Use of presence sensors in areas of occasional use Fitting of high-performance installations Double discharge lavatories Taps with aerators Low-emission NO_x and CO_2 heating system Parking for bicycles Creation of roofing using plant matter Maximum advantage taken of suitability for building Minimal occupancy on ground floor	20% energy saving 30% water saving 20% reduction in emissions
Deconstruction	Use of recyclable materials Non-contaminant products at the end of their working life	50% energy saving 30% reduction in generation of residues

Source: put together by the author from data obtained from the company.

with the ISO 9001 quality control manual. This integration has, however, failed to bring about major changes in the manual.

4.4. Delta

Delta is an architects' studio that is divided into four sections – Building, Urban Development, Town and Country Planning and Consultancy – and has 15 employees.

This company fully integrated the ISO 9001, ISO 14001 and UNE 150301 Ecodesign standards in 2006, although the scope of the latter only affects the Building section.

The main motivation that led them to introduce the UNE 150301 was an attempt to improve their commercial capacity, as there are certain tenders for which this certificate is highly regarded. Prior to adoption of the UNE 150301, they introduced the ISO 14001 which did not involve any major effort on their part, as the studio has neither great consumption nor does it generate much residue, and it has helped them as a tool for adapting the ecodesign standard. However, the UNE 150301 adoption process turned out to be a very laborious challenge for them, as the product they design has a major environmental impact throughout its life cycle and its design and the environmental measures put forward need to be approved by the customer.

The project they selected to adopt the UNE 150301 was a rectangular industrial pavilion with a surface area of 1080 m^2, located on a 2640 m^2 estate. The pavilion is shaped like a rectangular prism with a height ranging from between 7.1 m and 10.8 m. The purpose of these premises is to centralize the vehicles and offices of a county council district.

Once the needs of the project had been analyzed, as shown in Table 8, the environmental aspects were identified that needed to be taken into account during the course of the project. It was also ascertained that the most significant environmental impact occurred during the use and maintenance phase and were due to water and energy consumption.

An indicator panel was developed to measure environmental impact, the aim of which was to be able to quantify the extent of environmental improvement that would be obtained if each of the measures put forward were to be implemented.

As far as energy consumption was concerned, the minimum needs to develop the activity in the building started to be analyzed, taking into account the fact that the cleanest and least contaminant source of energy is in fact saved energy.

With this aim in mind, a study was then carried out of the determinants outside the pavilion that might influence final demand, such as the plot's microclimate and the evolution of shade throughout the day. The layout and position of the building

Table 8
Main environmental aspects in each stage of the life cycle.

Stage	Significant aspects	Other aspects to be taken into account
Extraction and manufacture	Consumption of raw materials	Energy consumption
Construction of the building	Energy consumption Generation of residues	Water consumption Noise emissions Atmospheric emissions
Use and maintenance	Energy consumption Water consumption Generation of residues	Dumping into water Noise emissions Biodiversity Atmospheric emissions Use of soil Visual impact
Deconstruction	Generation of residues	Energy consumption Atmospheric emissions Noise emissions

Source: put together by the author from data obtained from the company.

were subsequently designed in order to reduce demand. The rooms used continuously for work were to face south-east and those used in passing and for storage or occasional use were to face north. The south-east façade was also designed with large windows and double-closure, the aim of which was to take advantage of the natural light and maintain the temperature of the building.

Once the energy consumed had been minimized, means of generating and taking advantage of clean energy were then sought. Among these, special mention should be made of the use of the following:

- Photovoltaic solar panels for generating electrical energy.
- An air conditioning system using fan coils, which regulates a maximum-performance condensing boiler that works with low-impulsion temperatures and is supported by solar thermal panels to minimize its consumption, and an absorption machine to generate cold by taking advantage of the heat produced by solar thermal panels.

The second objective was to reduce water consumption. To this end, a double water collection system was designed with a capacity to collect 170 m^3 of rain water from an area of 2000 m^2 on the plot on the one hand and, on the other, a system for taking advantage of water used in showers and washbasins. This water is used to fill the cisterns of baths and to clean containers and lorries.

The company considers the implementation of the standard to have been a very interesting challenge from which good results have been obtained – these are summarized in Table 9. Specifically and as regards initial forecasts, the energy consumption of the building has managed to be reduced by 45%, mainly thanks to the absorption machine that enables 18% to be saved, the thermal panels that provide 14% of the energy consumed, and the condensing boiler that entails a saving of 10%. On the other hand, the collection of rain water and reuse of water from showers and washbasins enable water consumption to be reduced by 75%.

Furthermore, they consider that adopting the standard has helped them to improve their image and that of their designs, as well as improving reflection in their creative process. Despite all this, however, they had hoped for better results, especially in terms of the effort made. In this respect, they point out that the problem with architects' studios is that at the end of the day the ecodesign decisions that entail an increase in costs do not tend to be approved by property developers, as the end customer does not hold ecodesign in sufficiently high regard as to assume the increase in price – especially now in these times of crisis.

Table 9
Summary of objectives and actions.

Stage	Actions	Stage results
Extraction and manufacture	Use of dual-purpose building materials	5% reduction of materials
Construction of the building	Use of pre-industrialized materials	15% energy saving 70% water saving
Use and maintenance	Photovoltaic solar panels Air conditioning system using fan coils Maximum-performance condensing boiler Solar thermal panels Absorption machine to generate cold Rain water collection Reuse of water from showers and washbasins Elimination of use of oils in lift machinery	45% energy saving 75% water saving 100% reduction in oil consumption of lift machinery
Deconstruction	Use of recyclable materials	90% reuse of int. part. materials

Source: put together by the author from data obtained from the company.

5. Discussion and conclusions

In modern-day society an increasing need is noted to reduce the environmental impact of the products we consume. Along these lines, ecodesign standards such as the UNE 150301 standard are of great help in systemizing actions aimed at controlling and generating measures to reduce the environmental impact of the product throughout the different phases of its life cycle. This is one of the main reasons that has led the ISO/TC 207 committee to work on drafting the future ISO 14006 ecodesign standard, which uses the UNE 150301 as a reference. It seems clear that a standard, such as ISO 14006, which may foreseeably be passed in 2011, launched by an experienced and well-legitimated institution, such as the International Organization for Standarization (ISO), will be more useful and will have a higher potential for International dissemination than the Technical Report ISO/TR 14062.

The implementation of the UNE 150301 standard has been analyzed in this article in two industrial companies and two architects' studios. On a management level, all of them share similarities, as they are equipped with quality control, environmental and safety systems that have been introduced in accordance with the most widespread international benchmarks available (generally speaking, ISO 9001, ISO 14001 and OHSAS 18001). Furthermore, three companies of the four companies can be considered to be innovative in this aspect, as they have adopted these standards in very early phases.

As a basic guide for implementing the UNE ecodesign standard, the companies started using ecodesign indicators in order to carry out an initial diagnosis so as to then get underway with the continuous improvement process. Once the continuous improvement process has been carried out, the new product should have less environmental impact than that of the product it replaces or, in the case of architects' studios, less than that of the initial project. Furthermore, by reducing environmental impact, more economical products can be designed with the process, not only in terms of their manufacture, but also in terms of their usage by optimizing the energy or the water they consume.

The four companies analyzed seem satisfied with the implementation of this standard, as they consider it to have helped them to improve – mainly, by reducing the environmental impact of their products, but also by improving other aspects such as their cost and quality. This point is shared by previous studies that have been carried out in companies that manufacture electrical household appliances (Viñoles et al., 2008; Justel-Lozano, 2008), and in companies working in the building trade (Chen et al, 2010).

The four organizations analyzed have set out an improved reduction in energy consumption as their main objective, as this is their greatest source of environmental impact. In this respect, all four have obtained major improvements, and attention should therefore be drawn to some recent research that analyzes the adoption of other standards related to energy efficiency – albeit via a more procedural approach. In addition to helping to reduce environmental impact, these also help to reduce energy costs (Mahlia and Yantia, 2010; Sanchez et al., 2007).

Lastly, one of the aspects that the four companies consider essential is the relationship between the reduction in environmental impact and cost. The companies point out that they have obtained reductions in cost via ecodesign actions. However, when the reduction in environmental impact entails an increase in cost, it would seem that, in general, customers – both end and intermediate ones – are unwilling to meet this. That is why, in some cases, it is not possible to tackle certain instances of environmental impact, as this would reduce competitiveness. This aspect coincides with previous studies (for instance, that of Luttropp and Lagerstedt, 2006), which point out that although everyone wants products that are sustainable, very few are willing to pay more for them. Moreover, a sustainable and environmental protection perspective may even have negative effects, if the price does not vary.

To solve these problems, the companies point out that the different public administrative bodies play a fundamental role in establishing standards that must be complied with. In this respect, numerous regulations have been approved in recent years such as the EuP 2005/32/EC directive, which have come into force gradually and help to reduce the environmental impact of products throughout their life cycle. However, in relation to the demand from certain sectors of society, in some cases administrative bodies tend to act too late in introducing regulations that are going to entail direct costs (of implementation) and indirect costs (of adaptation of the end product), especially in times of economic crisis such as the current one.

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