

Identification of the Key Sustainability Issues to Develop New Decision Support Tools in the Spanish Furniture Sector

P. Cordero, R. Poler, R. Sanchis

Abstract—The environmental impacts caused by the current production and consumption models, together with the impact that the current economic crisis, bring necessary changes in the European industry toward new business models based on sustainability issues that could allow them to innovate and improve their competitiveness. This paper analyzes the key environmental issues and the current and future market trends in one of the most important industrial sectors in Spain, the furniture sector. It also proposes new decision support tools -*diagnostic kit, roadmap and guidelines*- to guide companies to implement sustainability criteria into their organizations, including eco-design strategies and other economical and social strategies in accordance with the sustainability definition, and other available tools such as eco-labels, environmental management systems, etc., and to use and combine them to obtain the results the company expects to help improve its competitiveness.

Keywords—Furniture sector, eco-design, sustainability, economical crisis, market trends, roadmap.

I. INTRODUCTION

THE global environmental problems caused by the consumption of natural resources and the pollution resulting from the life cycle of technical products have led to increasing political pressure and stronger regulations being applied, affecting both the manufacturers and users of such products [1]. Given this situation, plus the impact that the current economic crisis and the globalized market have on the European industry, which have been severe for the European industry with manufacturing output falling by around 20% and recovering only very slowly [2], changes toward new businesses models based on sustainability issues are required. Such changes would allow industry to innovate and improve its economic, environmental and social performance according to the sustainability concept by creating and maintaining long-

lasting competitive advantages [3].

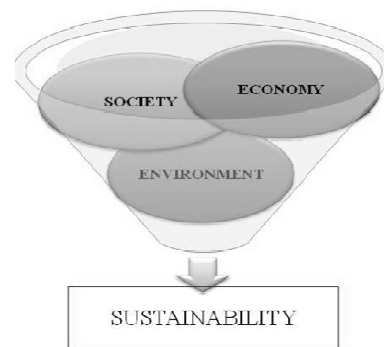


Fig. 1 The three pillars of sustainability

To achieve these objectives, eco-design is increasingly viewed by many authors as a key tool to sustainable and improved product development [4], and has tremendous potential in terms of not only reducing environmental impacts, but also achieving reduced company costs, developing innovative products, offering more competitive advantages in the market and improving the image of the company to society in general [5]. For this reason, a large number of eco-design tools, such as guidelines, checklists, and the material, energy and toxicity (MET) matrix, have been developed in recent years, some of which focus on a specific sector.

Despite the apparent benefits that eco-design offers, it is unclear whether these tools are actually being used and if they have any real effect on product system development. Thus, in some European countries such as Spain, the implementation of eco-design tools in enterprises is currently very limited, and the leading importance of environmental issues for strategic decisions and management is mainly due only to the evolution of the legislation framework that imposes very restrictive rules to manufacturers' and customers' requirements [6].

In the literature there are studies available that analyze the main constraints that limit the implementation of eco-design tools [4], [7], [8], [9]. According to these authors, some of the main constraints that limit the implementation of eco-design tools into businesses are the enterprises' poor understanding of sustainability and eco-design concepts and the fact that they are designer-oriented rather than business-driven with a

P. Cordero is with the CIGIP (Research Centre on Production Management and Engineering) in the Universidad Politécnica de Valencia, 46022 Valencia, Spain (corresponding author to provide phone: +34963879680; fax: +34963879682; e-mail: pcordero@cigip.upv.es).

R. Poler is with the CIGIP (Research Centre on Production Management and Engineering) in the Polytechnic School of Alcoy Universidad Politécnica de Valencia), 03801 Alcoy, Spain (corresponding author to provide phone: +34963879680; fax: +34963879682; e-mail: rpoler@cigip.upv.es).

R. Sanchis is with the CIGIP (Research Centre on Production Management and Engineering) in the Polytechnic School of Alcoy Universidad Politécnica de Valencia), 03801 Alcoy, Spain (corresponding author to provide phone: +34963879680; fax: +34963879682; e-mail: rsanchis@cigip.upv.es).

TABLE I
SELECTION OF OBSTACLES AND SUCCESSFUL FACTORS FOR THE SUCCESSFUL INTEGRATION OF ECO-DESIGN INTO PRODUCT DEVELOPMENT [7]

	Success factors	Obstacles
Relevance of disseminating eco-design information to the appropriate people in the appropriate departments	<p>Customized eco-design tools which are tailor-made for companies' needs</p> <p>In general, good contacts between departments in terms of environmental issues</p> <p>Good international network</p> <p>Good management commitment and support</p> <p>Clear environmental goals and vision</p> <p>Alignment of operational and strategic dimensions</p> <p>Use of environmental checkpoints, reviews, milestones and roadmaps</p> <p>Environmental design guidelines, rules and standards that are very specific to a given company</p>	<p>Available tools are too complex</p> <p>Organizational complexities, lack of appropriate infrastructure</p> <p>Lack of cooperation between departments</p> <p>Lack of environmental goals and vision for the development organization as a whole</p> <p>Lack of industrial context in general/not connecting environmental considerations with business ones</p>
Relevance of eco-design principles materializing in products brought into the market	<p>Market research</p> <p>Eco-design considerations early in the process development</p> <p>Inclusion of environmental issues in our company's technology strategy</p> <p>Adopting a strong consumer focus, good market research</p> <p>Goals and targets at managerial level</p> <p>Training consumers and customers in environmental issues</p> <p>Good involvement of supplier expertise in process development</p> <p>Environmental issues play a role in all business activities</p> <p>Good environmental education and training programs for all product development personnel</p> <p>We make good use of examples of good design solutions, also from other companies</p> <p>Use of environmental checkpoints, reviews, milestones and roadmaps</p> <p>Environmental design guidelines, rules and standards that are very specific to a given company</p> <p>Follow-up studies; learning from previous experiences systematically</p>	<p>Lack of life-cycle thinking</p> <p>Organizational complexities</p> <p>Lack of innovative thinking</p> <p>Lack of testing</p> <p>Lack of experience</p> <p>Lack of appropriate marketing studies</p> <p>Too many material-related issues</p> <p>Issues that address end-of-life or recyclability too much</p> <p>Too little involvement of sales and marketing departments</p> <p>No market demand</p> <p>Lack of time/too time-consuming</p> <p>Lack of (quality of) data</p> <p>Not enough legislative incentives</p> <p>Lack of environmental goals and vision for individual development projects</p>

limited focus on cost and time-to-market. Thus, it is necessary to improve these tools by considering the above main constraints to obtain more useful methodologies for businesses to adapt to their specific needs, that not only consider environmental issues, but other aspects like market strategies, optimization of production processes to cut costs or improve their corporate image, etc.

After considering these approaches, this study proposes new decision support tools based on eco-design approaches to guide Spanish furniture enterprises in identifying the most appropriate directions and to advance in a sustainable manner by focusing on environmental issues and by considering economical and social issues in accordance with the sustainability definition, plus future economic and market trends in the sector.

The decision support tools proposed in this study are the following:

- 1) *Diagnostic kit*: Tool to help furniture enterprises to identify the key sustainability strategies to be considered to improve their environmental, economical and social performance, as well as the key stakeholders that participate in the furniture supply chain to identify areas for improvement.
- 2) *Roadmap*: Scheme that schematically visualizes the

directions to be taken by the company in the near future according to the sustainability strategies chosen in the diagnostic kit.

- 3) *Guidelines*: Report that describes the strategies and tools identified in the diagnostic kit and roadmap in a schematic and simple way, plus interesting contact information from universities, research centers, public administrations and other institutions to support them in R&D projects, initiatives by Spanish and European institutions to promote more sustainable development in the industrial sector, R&D funding programs for SMEs, etc.

These are intended to achieve the following objectives:

- 1) Expand the number of Spanish furniture companies that are actively engaged in identifying and adopting more responsible business practices to improve their economical, environmental and social performance
- 2) Contribute to improve the economic situation in the Spanish furniture sector
- 3) Consider the different options that furniture companies would choose to improve and, where necessary, refine the tools available to promote responsible business practices across all levels of business management.

- 4) Promote the use of tools for management and eco-design systems, environmental management systems, environmental eco-labeling, green public procurement

Therefore, the key environmental aspects, the economic and market trends in the Spanish furniture sector, the possible future scenarios for the sector in the near future, as well as social aspects, have all been analyzed to obtain general support information to be considered as a basis for the development of new tools proposed for the Spanish furniture sector.

This paper is split into six sections. The first offers an overview of this study; the second section shows the key environmental impacts in the furniture sector, environmental legislation and the current implementation of some environmental tools or methodologies such as eco-design, environmental management systems, eco-labels, green public procurement in the furniture sector; the third section provides an overview of the economic and market trends in the Spanish furniture sector and identifies possible future scenarios for the sector; the fourth section identifies some examples of social aspects to be considered in the development of support tools; the fifth section describes the tools proposed in this study; finally, the sixth section presents the main conclusions drawn in this study.

II. ENVIRONMENTAL ASPECTS IN THE FURNITURE SECTOR

In this section an overview reviews the key environmental aspects in the furniture industry: key environmental impacts of furniture, environmental legislation and voluntary tools such as environmental management systems, eco-label, green public procurement, etc. and their degree of implementation in Spain.

A. Key environmental impacts in the furniture sector

The environmental aspects of furniture are many and varied, and depend on the nature of the furniture and the raw materials used in furniture manufacturing. In general, the most important environmental impacts of furniture considering a life cycle approach are [10]- [13]:

- 1) *Energy and raw material consumption.* Production processes include activities such as drying, machining, assembly, pre-finishing, coating and finishing, which may have environmental impacts in different forms.
- 2) *Emission of chemical substances.* Materials used in the manufacturing, treatment, installation and final cleaning of fabrics can contain volatile organic compounds (VOC), which may be absorbed by furniture fabrics to later become secondary sources of VOC emissions. On the other hand, other potentially harmful chemicals causing emissions of chemical substances while the product is being used are formaldehyde resins.
- 3) *Waste generation.* Furniture production generates waste; for example, waste from wood processing and the production of panels and furniture, wood preservation waste and waste from the use of paints and varnishes that may cause an environmental impact if not managed

correctly.

To minimize the environmental impact associated with a particular activity or industrial sector, different legal and voluntary instruments have been developed by legislators and researchers, respectively, and some apply to the Spanish furniture sector. The following sections describe the most relevant environmental legislation for the Spanish furniture sector and the application of some voluntary instruments in the sector such as environmental management systems ISO 14001 and the EU Eco-Management and Audit Scheme (EMAS) or the Spanish standard of eco-design and the communication or marketing tools such as eco-labels and green public procurement.

B. Environmental legislation

In Spain there is no specific legislation for furniture, although some Spanish horizontal legislation has an impact on the furniture sector, most of which stems from the transposing European Directives, like those relating to industrial emissions or to waste pollution in relation to the use of organic solvents, coating materials, paints and other chemical substances in the production process, packaging, etc.

The most relevant environmental legislation applicable to the Spanish furniture sector relates to the following environmental issues [13]:

- 1) *Integrated Pollution Prevention and Control (IPPC)* that aims to minimize pollution from various industrial entities such as installations set up for the surface treatment of substances, objects or products using organic solvents, particularly for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating. A consumption capacity has been set for more than 150 kg per hour or more than 200 tones per year, and involve some furniture enterprises that use coating materials to help make materials resist chemical, mechanical and climatic impacts, products used for staining, and organic solvent-based preservatives to protect against fungi, insects and weathering.
- 2) *Emissions of Volatile Organic Compounds (VOCs)* due to the use of organic solvents in certain activities and installations such as adhesive, metallic and plastic coatings, wood surfaces, surface cleaning, wood impregnation, manufacture of coatings preparations, varnishes, inks and adhesives, wood and plastic lamination.
- 3) *Waste.* As in many other industrial processes, furniture production generates waste (e.g., waste from wood processing and the production of panels and furniture, wood preservation waste, and waste from using paints and varnishes). The main objectives of waste legislation are to protect the environment and human health by preventing or reducing the adverse impacts of waste generation and management and by reducing the overall impacts of resource uses and improving the efficiency of such uses.
- 4) *Use of chemical substances.* The furniture industry is a downstream user of chemicals and, as such, is subject to legislation on the use of chemical substances among

which the Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) is included.

- 5) *Formaldehyde emissions*. Spanish legislation on formaldehyde emissions in the furniture industry establishes the emission limit values for this compound. The classification of the panel is in accordance with EN 13986:2002 (E1 and E2 boards), whose requirements are described below, are both cases fulfilling the specifications in Spanish legislation.

C. Voluntary tools

There are currently various voluntary instruments that can help companies in the Spanish furniture sector to improve the environmental performance of their product and production processes, such as eco-design, environmental management systems, or to encourage the purchase of products that are environmental-friendly like eco-labeling or green public procurement. Next the application of these voluntary tools in the Spanish furniture sector is analyzed.

1) Environmental management systems

Environmental Management Systems are a management tool for companies and other organizations to evaluate, report and improve their environmental performance. They may be defined as a self-correcting, continuous improvement system that seeks to reduce the environmental impacts associated with an organization's activities while helping to ensure compliance with environmental regulations. As regards the environmental management systems in Spain, there are currently two systems which fulfill these requirements: the International Organization for Standardization (ISO 14001) and the EU Eco-Management and Audit Scheme (EMAS)

Regarding the implementation of each environmental management system, it should be noted that the level of penetration of EMAS regulation in the Spanish furniture sector is rather low and ISO 14001 is more well-established. In fact according to the last EMAS register [14], there are only 5 wood- (NACE 16) and furniture- (NACE 31) related companies which are EMAS scheme accredited, and around 177 furniture enterprises have standards ISO 14001 and ISO 9001 [6].

2) Spanish eco-design standard

The Spanish eco-design standard, UNE 150301, "Environmental Management of the design process and development. Eco-design" was approved in 2003 to acknowledge those companies that implement eco-design criteria in their organization and establish an Environmental Management System design and develop process requirements of products and/or services in an organization with a systematic continuous improvement product/service scheme established through an environment management system. Despite the advantages of certification according to the Spanish Eco-design Standard, which is currently applicable to any product type in Spain, there are only 45 certified enterprises, 6 of which are included in the furniture sector [15].

The international version of the Spanish eco-design

standard, whose current status is a "Draft International Standard, will be called ISO 14006 Guidelines for incorporating eco-design into environmental management systems. These are currently being developed and is intended to provide "how to guide the product and service organizations in incorporating eco-design into any environmental, quality or similar management system". ISO 14006 is based on quality management system ISO 9001, environmental management system ISO 14001 and ISO/TR 14062:2002 Environmental management – Integrating environmental aspects into product design and development, and IEC 62430:2009 Environmentally conscious design for electrical and electronic products. Currently, the draft document has the status of a "Draft International Standard", and will be revised this year to be ready in 2011.

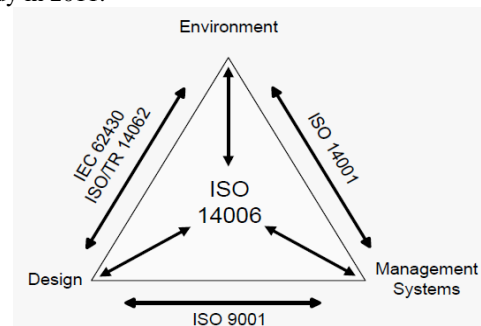


Fig. 2 Relationship of ISO 14006 with other ISO standards [16]

3) Eco-labels and environmental product declaration

Consumers can play an important role in protecting the environment through the choices they make when buying products. Buying green is easier than many people think. There are a number of eco-labeling systems that help consumers as they provide details about the environmental performance of certain products [17].

A large number of environmental labels and declarations is currently in use for products and services. The International Organization for Standardization (ISO) distinguishes among three different types of eco-labeling programs: Type I programs, a voluntary, multiple-criteria based, third-party program that awards a license which authorizes the use of environmental labels on products indicating a product's overall environmental preferability within a particular product category based on life cycle considerations; Type II, informative environmental self-declaration claims and Type III, voluntary programs that provide quantified environmental data of a product, under a pre-set categories of parameters set by a qualified third party and based on life cycle assessment, and verified by that or another qualified third party. Among these typologies, there is a wide variety of eco-labeling programs: for furniture in general, some of them are very comprehensive and reflect criteria that apply to many materials, while others focus more on wood materials and by-products. In general, however, all these eco-labeling systems aim to promote the reduced impact of these products on the environment and on human health throughout their life cycle and more specifically to [19]:






TABLE II
COMPARATIVE TABLE OF ECO-LABELLING PROGRAMS OWN ELABORATION BASED ON [18]

Type	Eco-labels Type I ISO 14024	Eco-labels Type II ISO 14021	Eco-labels Type III ISO TR 14025
Name	Eco-labels	Self-declaration	Environmental Product Declaration (EPD)
Approach	Reasoning / Life Cycle Assessment	Reasoning in life cycle	Life Cycle Assessment (LCA)
Criteria	Criteria for environmental excellence	Mono-specific criteria on environmental characteristics	LCA data on continuous improvement
Certification / Certifying body	Compulsory certification by a third party / Private or public approved institution)	Possible certification / Manufacturer	Possible certification / Validation by a private or public approved institution
Information for consumers	Quality assurance of use and environmental characteristics	Ecological arguments under the company's responsibility	Comparison of the level of excellence of the product

- 1) Use of recycled fibers or virgin fibers from sustainably managed forests.
- 2) Limitation of substances harmful to health and the environment.
- 3) Design for higher product durability, easy disassembly and recycling.
- 4) Use of recycled packaging.
- 5) User instructions for correct environmental use.

The Table III summarizes the eco-labeling systems. Types I and III in Spain include environmental criteria for wooden furniture products.

TABLE III
ECOLABELLING SYSTEMS IN SPAIN WITH ENVIRONMENTAL CRITERIA FOR WOODEN FURNITURE PRODUCTS. OWN ELABORATION

Type	Logo	Eco-labeling system
Type I Programs		European Ecolabel
		Emblem of Guarantee of Environmental Quality
Eco-labels similar to Type I		Forest Stewardship Council
		Program for the Endorsement of Forest Certification schemes
Type III Programs		Environmental Product Declaration

The ecological criteria of the European Ecolabel, for the product group *wooden furniture*,¹ has been recently published, so their application in Spain and in the European Union is presently limited. On the other hand, the Emblem of Guarantee of Environmental Quality certification is not widespread in the furniture industry. Thus in both cases, it is necessary to focus government and businesses efforts on promoting the use of these eco-labeling schemes [20], [21].

On the other hand, we should note other eco-labels similar to eco-label Type I Forest Stewardship Council (FSC) and the Program for the Endorsement of Forest Certification schemes

¹The product group "wooden furniture" shall comprise free-standing or built-in units, which are used for storing, hanging, lying, sitting, working and eating of domestic furniture, whether for indoor or outdoor use, or used indoors for business purposes. Business purposes shall include office and school furniture as well as furniture for restaurants and hotels.

(PEFC). The Chain of Custody label certifies that the product has been made with wood from sustainable forests. In recent years, the representative organisms of FSC and PEFC in Spain have developed standards based on international principles and criteria adapted to the situation in Spain. The development of Spanish standards and the involvement of the wood sector in sustainability issues have led to an increase of the FSC and PEFC chain of custody certificates.

According to FSC and FSC-Spain's most up-to-date information, there are 43 furniture companies in Spain that have obtained the FSC Chain of Custody certificate² [22], and most of them are included in the pulp and paper, graphic arts and wood sectors. Ten Spanish furniture enterprises have obtained the PEFC chain of custody certificate³ [23].

On the other hand, the main objective of the eco-labeling system Type III, the international Environmental Product Declaration (EPD) system, is to help and support organizations to communicate the environmental performance of their products (goods and services) in a credible and understandable way. The EPD System has developed the Product Category Rules (PCR) for the product category "Furniture". Presently, no Spanish wooden furniture enterprise has obtained this eco-label. Thus efforts to promote it in the Spanish furniture sector are necessary [24].

In accordance with these results, it should be noted that the degree of implementation of eco-labeling schemes in Spain is low, so it is necessary to encourage the use of these tools by both companies and end consumers toward more sustainable production and consumption in the sector.

4) Green Public Procurement (GPP)

Over the last decade, green public procurement (GPP) has become a promising tool to foster the demand for greener products due to the enormous purchasing power of public organizations that represent 16% of the GDP. Considering that office furniture is one of the most interesting products for the GPP policy, GPP could indirectly affect the eco-design of furniture [25].

Furthermore, on 11 January 2008, the Minister Council approved the Green Procurement Plan whose main objective is to gradually implement environmental-friendly practices in public procurement Public Administrations. The plan offers several goals for eight groups of different products:

² Information as of 31/08/2009

³ Information as of 10/05/2010

construction and maintenance, transportation, energy, office equipment, paper and publishing, furniture, cleaning and events. This Plan is reflected in Order PRE/116/2008, of 21 January, which publishes the agreement by the Minister Council to approve the Green Procurement Plan of the Public

Administrations and its public bodies.

The objectives and measures established for the product group Furniture are based on the environmental criteria of the EU Ecolabel for Wooden Furniture, as shown in Table IV.

TABLE IV
SPECIFIC OBJECTIVES AND MEASURES ESTABLISHED FOR THE PRODUCT GROUP FURNITURE [25]

Objectives	Measures
Purchases of furniture made of wood from sustainable forests, in products with a wood content up to 10%.	Virgin solid wood shall not originate from illegal harvesting, genetically modified trees or high conservation value forest. The virgin wood and wood derivatives shall not be treated with substances or preparations containing substances classified as pesticides 1A and 1B according to the WHO classifications. In the case of derivatives, the formaldehyde content in glues and adhesives shall not exceed 0.5 % of the total. As valuation criteria, the applicant shall provide the appropriate certificate together with the supporting documentation, verifying that the above requirements are met.
25% and 50% of office furniture and wood derivatives should be purchased under guarantee and with availability of spare parts, before 31 December 2010 and 31 December 2015, respectively.	Inclusion as award criteria that furniture should be purchased under guarantee and with availability of spare parts for five years.

As in the case of eco-labels, the application of environmental criteria to public purchases in Spain is currently poor. Some examples of public institutions in Spain that are implementing green procurement criteria into purchases of furniture can be found in the literature [26].

According to some authors [26], the most common obstacles when applying GPP are the possible perception that green products can be more expensive, lack of knowledge about the recruitment bases, lack of managerial and political support, lack of tools and information and little training for both buyers and sellers regarding the use and knowledge of eco-labels, as well as the stimulation of tools such as Life Cycle Assessment. For this reason the European Commission's future prospects are to create a database with all the information obtained to offer practical solutions and to clarify what can be implemented at any time and without hindrance, specifications, explanations and restrictions regarding the use of eco-labels.

III. ECONOMIC AND MARKET TRENDS IN THE SPANISH FURNITURE SECTOR

The furniture sector in Spain is one of the most important economic sectors nationally and in the European Union. It is made up of 18,476 firms [27], of which 99% are small and medium-sized enterprises (SMEs). According to the most recent data provided by Eurostat, Spain is one of the main producers of furniture (in production value terms) and generates an added value of around €4 million, the equivalent of 10.5% of the EU-27 sectors' added value, and employs around 140,000 people [28].

In 2009, the main destination countries for exports were in the European Union, which represents 85% of total exports, with France and Portugal holding a greater market share. On the other hand, the main countries of origin of Spanish imports are China, which covers holds most of the market share, followed by Portugal, Italy and Germany.

The opening of the international furniture trade, plus the

current economic crisis, have led to some adverse effects in the Spanish furniture sector [29]. The effects of the current economic crisis, coupled with the growing influence of Asian countries which have become the main source of imported furniture worldwide, have caused a growing deficit. In recent years, this deficit in the sector has led to a decline in both exports and imports of Spanish furniture and a growing deficit of trade balance as furniture imports exceed exports, implying a progressive decline in businesses

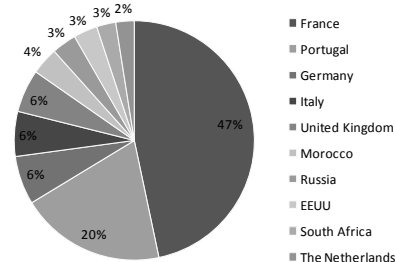


Fig. 3 Main exports destination countries in 2009 [30]

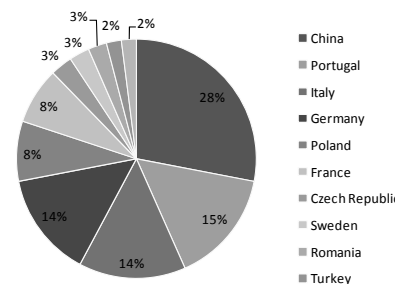


Fig. 4 Main countries of origin of Spanish furniture imports [30]

In the literature, different studies can be found that identify possible future scenarios for the furniture industry being high production cost countries in the near future, and which show the directions that could be taken by the furniture industry in

the next decade according to the evolution of certain economic factors, consumer behavior and distributor strategies [2], [29], [31].

According to these authors, the most optimistic scenario for the furniture sector of high production countries like Spain includes new businesses models based on sustainability issues. This scenario reveals an industry characterized by a more personalized customer service which will play a key role in the furniture market as it will demand new products based on new values: ecological, esthetics, safety, quality, etc.); that is, a furniture market where the differentiation of competitive advantages will be achieved by placing more innovative products on the market with more initiatives for furniture manufacturers in distribution and retailing, as well as furniture sector awareness on environmental issues to lead to new more sustainable materials being developed and a rational use of natural resources.

So, the future scenario to ensure progress and innovation in companies should consider a business model with the

following characteristics:

- 1) Generalized Eco-consumption. Demand of products based on new values: ecology, safety, quality, esthetics
- 2) Further guidance for consumer needs and demands for added value in furniture purchases (more service and information)
- 3) Companies focusing on sustainable activities (from the economical, social and environmental viewpoints)
- 4) Innovation based not only on technology development but also on business management processes
- 5) Concentration on furniture distribution and the co-existence of large international players in the development of organized business with smaller manufacturer initiatives in distribution terms
- 6) Networking and partnership for innovation with other furniture enterprises and with all the supply chain stakeholders in general, as well as universities and other research centers

TABLE V
FURNITURE MANUFACTURE (NACE 36.1): STRUCTURAL PROFILE: RANKING OF THE TOP FIVE MEMBER STATES IN TERMS OF ADDED VALUE AND PERSONS EMPLOYED, 2006 [28]

Highest added value				Highest number of persons employed			Most specialized: share in non financial business economy (%)	
	Country	EUR million	% of EU-27	Country	Thousands	% of EU-27	Country	Added value
1	Germany	7,702	20.3	Italy	202.8	15.1	Lithuania	1.7
2	Italy	6,763	17.8	Germany	162.0	12.0	Estonia	1.4
3	United Kingdom	5,117	13.5	Poland	160.7	11.5	Romania	1.3
4	Spain	3,995	10.5	Spain	139.8	10.4	Poland	1.3
5	France	3,589	9.4	United Kingdom	110.2	8.2	Slovenia	1.3

IV. SOCIAL ASPECTS IN THE SPANISH FURNITURE SECTOR

The recent publication of the Social Life Cycle Assessment Methodology (S-LCA), which sets the guidelines for the identification and evaluation of social and socio-economic impacts associated with the life cycle of a specific product or service and complements Life Cycle Assessment (LCA) and Life Cycle Cost Assessment (LCC), will the momentum to develop support tools. Such tools include databases, software, etc., for the implementation of this methodology and the publication of studies that will assess the social impacts associated with a particular product or activity.

The S-LCA methodology proposes a two-fold classification of social impacts: stakeholders categories (workers, consumers, society at large, as well as others involved in the supply chain) and impact categories associated with all these actors [32].

Although the literature has no information available about the most significant social impacts in the Spanish furniture sector, the following section proposes some aspects of social improvements to be considered in the improvement of sustainability in the Spanish furniture sector that complement other environmental and economic aspects.

V. THE ROAD TO SUSTAINABILITY.

Based on the key environmental issues, future economic

and market trends and social aspects in the furniture sector analyzed in previous paragraph, this study proposes new decision support tools -*diagnostic kit, roadmap and guidelines*- which aim to improve the competitiveness of the

TABLE VI
STAKEHOLDER CATEGORIES AND SUBCATEGORIES. [32]

Stakeholders	Some examples of subcategory impacts
Worker	Freedom of association and collective bargaining Working hours Equal opportunities/discrimination Health and safety
Consumer	Social benefits/social security Health and safety Feedback mechanism Consumer privacy Transparency
Local community	End of life responsibility Access to material resources Access to immaterial resources Safe and healthy living conditions Community engagement Local employment
Society	Public commitments to sustainability issues Contribution to economic development Technology development
Value chain actors (not including consumers)	Fair competition Promoting social responsibility Supplier relationships

Spanish furniture enterprises and to guide them to

implement sustainability criteria into their organization, including eco-design strategies and other economical and social strategies according to the sustainability definition, plus other available tools such as eco-labels, environmental management systems, etc, and how to use and combine them to obtain the results the companies expect.

A. Diagnostic kit

The diagnostic kit is a tool that can help furniture enterprises to identify the key sustainability strategies to be

considered in order to improve their environmental, economical and social performance, and the key stakeholders that participate in the furniture supply chain, with a view to identifying areas for improvement, and tools that can assist them in increasing responsible business practices by considering the key environmental issues and the current and future economic and market trends identified in this study

TABLE VII

SUMMARY OF THE KEY ENVIRONMENTAL ISSUES AND FUTURE ECONOMIC AND MARKET TRENDS IN THE SPANISH FURNITURE SECTOR

Key environmental issues	Future economic and market trends
Less dependence on external supplies of raw materials and energy, and the wise use of renewable resources and successful efforts to create alternative renewable products	Generalized eco-consumption. Demand of products based on new values: ecology, safety, quality, esthetics
Reduction of environmental impacts associated with the emission of pollutants such as VOCs and formaldehyde	Further guidance to consumer needs and demands for added value in furniture purchases (more service and information)
Reducing hazardous and non hazardous waste generation	Companies focused on sustainable activities (from the economical, social and environmental viewpoints)
Promotion of sustainable consumption through communication tools such as eco-labels, environmental product declaration and green public procurement	Innovation based not only on technology development but also on business management processes
	Concentration on furniture distribution and the co-existence of large international players in the development of organized businesses with smaller manufacturer initiatives in distribution
	Networking and partnership for innovation with other furniture enterprises and with all the supply chain stakeholders in general, as well as universities and other research centers

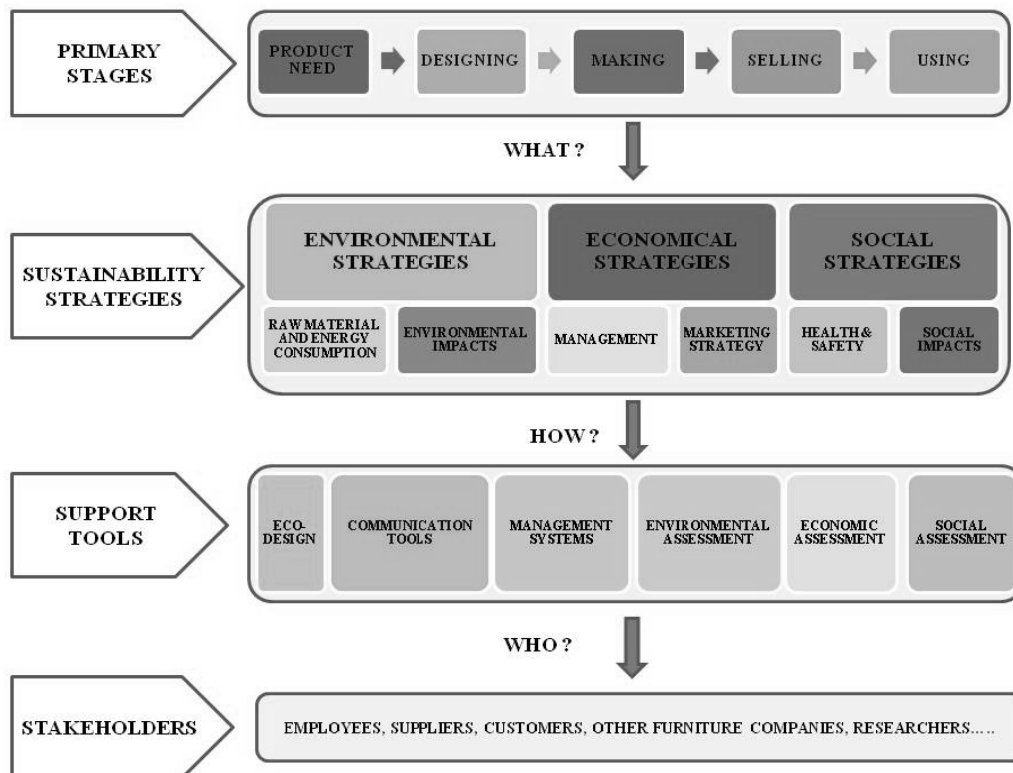


Fig. 5 Diagnostic kit approach

According to the diagnostic approach (Figure 5), the following considerations have been made:

Primary stages toward sustainability. In the diagnostic kit, five primary stages throughout the product's life cycle in

which the following considerations are made [33]:

- 1) *Product need*- what is the purpose of the product, the target market and the main customer’s requirements?
- 2) *Designing*- how do you select the product, what is the main criteria to be considered in the design?
- 3) *Making*- how is the product manufactured and distributed?

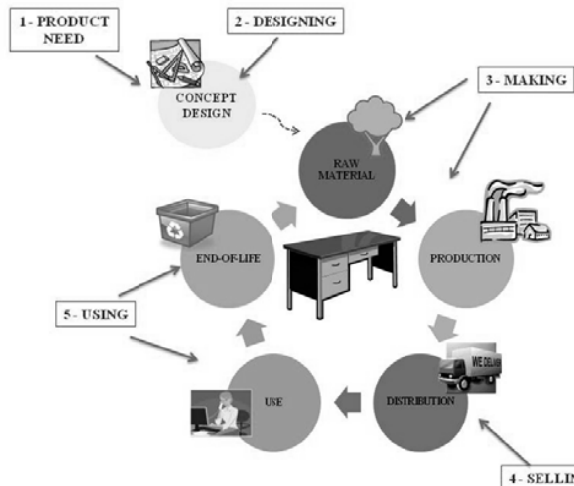


Fig. 6 Relation between each primary stage and the product life cycle phase. Own elaboration based on [33]

Types of sustainability strategies. In each primary stage, the sustainability strategies have been divided into the following categories and subcategories:

TABLE VIII
SUSTAINABILITY STRATEGIES CONSIDERED IN THE DIAGNOSTIC KIT. OWN ELABORATION BASED ON [34]

Category	Subcategory	Topics
Environmental	Raw material and energy consumption	Energy use, material intensity, water use
	Environmental impacts	Air emissions, solid waste
Social	Health & Safety	Toxic reduction, hazards, process safety
	Social impact	Workers’ well-being, local and/or global societal impacts
Economic	Management	Internal process, regulatory drivers, stakeholder engagement
	Marketing strategy	Core values and competencies, market drivers

Some examples of the sustainability strategies proposed in the diagnostic kit are shown in Table XI:

Support tools. The number of tools and approaches to develop sustainability is growing rapidly. Sometimes they are presented as if contradictory or in competition. However, a systems approach that is consistent with basic principles and the requirements of sustainability shows that these tools are complementary and can be used in parallel for strategic sustainable development [35].

- 4) *Selling*- what is the process for marketing and selling the products?
- 5) *Using*- how do consumers use, re-use and recycle products?

Figure 6 shows the association primary stage –the product life cycle phase- proposed in this study:

Table IX presents the support tools proposed in the diagnostic kit which can be used in parallel and can improve the company’s overall sustainability because they consider environmental, economic and social aspects.

TABLE IX
THE SUPPORT TOOLS PROPOSED IN THE DIAGNOSTIC KIT. OWN ELABORATION

Type	Support tool
Eco-design tools	Eco-design guidelines
Marketing tools	Eco-label
	Green Public Procurement (GPP)
Management systems	Quality management systems (ISO 9001)
	Environmental management systems (ISO 14001 and EMAS)
	Eco-design (UNE 150301 and future ISO 14006)
Environmental assessment tools	Life Cycle Assessment (LCA)
Economic assessment tools	Life Cycle Cost Assessment (LCC)

Key stakeholders in the implementation of sustainability strategies. The company should work to collaborate with all the actors involved throughout the supply chain and with other actors such as researchers, public administrations, etc. which support companies both technically and financially in the development of new materials and the identification of more sustainable production processes [36].



Fig. 7 Key stakeholders throughout the furniture supply chain. Own elaboration based on [36]

The key stakeholders that could play an active role to better manage sustainability issues in the furniture sector in each primary stage have been identified.

TABLE X
THE KEY STAKEHOLDERS INVOLVED IN EACH PRIMARY STAGE. OWN ELABORATION

Stage	Key stakeholders involved
Product need	Employees
	Customers
Designing	Employees
	Customers
Making	Public administration
	Employees
	Suppliers
	Researchers
Selling	Other furniture companies
	Employees
	Distributors
Using	Employees
	Customers
	Waste management firms

TABLE XI
EXAMPLES OF THE SUSTAINABILITY STRATEGIES PROPOSED IN THE DIAGNOSTIC KIT. OWN ELABORATION

Primary stage	Category / Subcategory	Specific measures
Product need	Economic / Marketing strategy	<i>Identify marketing opportunities for a innovative and sustainable products</i>
		Product type
		Target market
		Similar products offered by the competence
		<i>Identification of the product needs/requirements of the target market</i>
		Environmental aspects (recyclable, made with recycled materials, etc.)
		Packaging specifications
		Products made with recycled/recyclable materials
		Meet specific legislation
		Quality or environmental management systems certificate
Eco-label / Green public procurement criteria		
Quality and esthetic aspects		
Functionality		
Designing	Economic / Management	<i>Collaboration with universities and other research centers, external designers</i>
		<i>Analyze the technical and economic viability of the solutions adopted in design</i>
		<i>Identification of the legislation requirements and technical standards</i>
		<i>Investigate R&D finding's programs for SMEs</i>
		<i>Innovative design with a style tailored to the needs and preferences of the market</i>
	Economic / Marketing strategy	<i>Identify the most suitable marketing tool to inform consumers of the environmental benefits of the product</i>
		Eco-label
		Environmental product declaration
		Other marketing strategies:
		<i>Selection of the environmental, quality and esthetic criteria in product design</i>
Environmental / Environmental impacts	Use materials made partly or totally from recycled materials and/or renewable materials (such as wood).	
	Generation of alternative and renewable materials	
	Minimize the number of materials and components used in the manufacture of furniture	

Primary stage	Category / Subcategory	Specific measures
Making	Social / Social impact	Easy-to-maintain products
		Procure durable, fit for use and ergonomic furniture
	Economic / Management	<i>Promote social responsibility and more participation of employees in sustainability issues</i>
		<i>Improvement of the professional skills of those employees involved in design, production, marketing</i>
		<i>New business models based on management processes</i>
		<i>Homogeneous territorial clusters strategy (industrial ecology, etc.)</i>
	Environmental / Raw material and energy consumption	<i>Analyze the technical and economic viability of the solutions adopted in the production process</i>
		<i>Improvement of energy and resource efficiency</i>
		Adoption of high-energy performance machinery
	Environmental / Environmental impacts	Waste re-use as secondary raw material or biomass to produce renewable energy
Alternative production techniques to optimize raw materials and energy consumption		
Fewer production steps		
<i>Optimization of production processes to minimize environmental and economical impacts</i>		
Social / Health & Safety	Adoption of the best available techniques to reduce environmental impacts	
	Correct management of wastewater, waste and emissions	
Social / Social impact	Avoid certain hazardous substances in materials production and surface treatment	
	Limit the organic solvent content and formaldehyde in adhesives and surface treatment substances.	
Selling	Social / Health & Safety	<i>Improved safety, health and working conditions of employees</i>
		<i>Promote social responsibility and more participation of employees in sustainability issues</i>
	Economic / Management	<i>Improvement of the professional skills of employees involved in production processes</i>
		<i>Increased collaboration with retailers in selling activities to promote the consumption of sustainable furniture</i>
		<i>Provide consumers information about the environmental benefits of the product</i>
		<i>Develop processes to optimize production processes</i>
Environmental / Environmental impacts	Less / cleaner / reusable packaging	
	Energy-efficient transport	
	Use of cleaner fuels	
	Energy-efficient logistic	
Social / Social impact	<i>Contribution to safe, healthy living conditions</i>	
	<i>Improvement of the business image, strengthening brand image</i>	
Using	Social / Health & Safety	<i>Increased collaboration with waste managers for correct waste management e</i>
		<i>Implementation of added value services</i>
	Economic management	Maintenance, repair and care services
Environmental / Environmental impacts	Leasing/ renting products	
	<i>Information to consumers relating to correct waste management</i>	

B. Roadmap

The roadmap is a tool to schematically visualize the directions to be taken by the company in the near future according to the sustainability strategies chosen in the diagnostic kit.

Therefore, the roadmap is a useful tool for furniture companies to graphically see the steps and the factors to consider, and for the actors who support them to achieve more sustainable development in the company. Moreover, this tool

would be an interesting communication tool to inform end consumers and society in general where the product comes from and the related sustainability issues associated with their supply chain in order to inform them about the sustainable benefits of the product and to promote a more sustainable consumption of furniture. Figure 8 illustrates an example of the roadmap proposed in this study which is based on the roadmap scheme developed by [33] with the sustainability strategies chosen in each primary stage, plus the stakeholders involved and the key factors to be considered throughout the

roadmap, e.g., legislation:

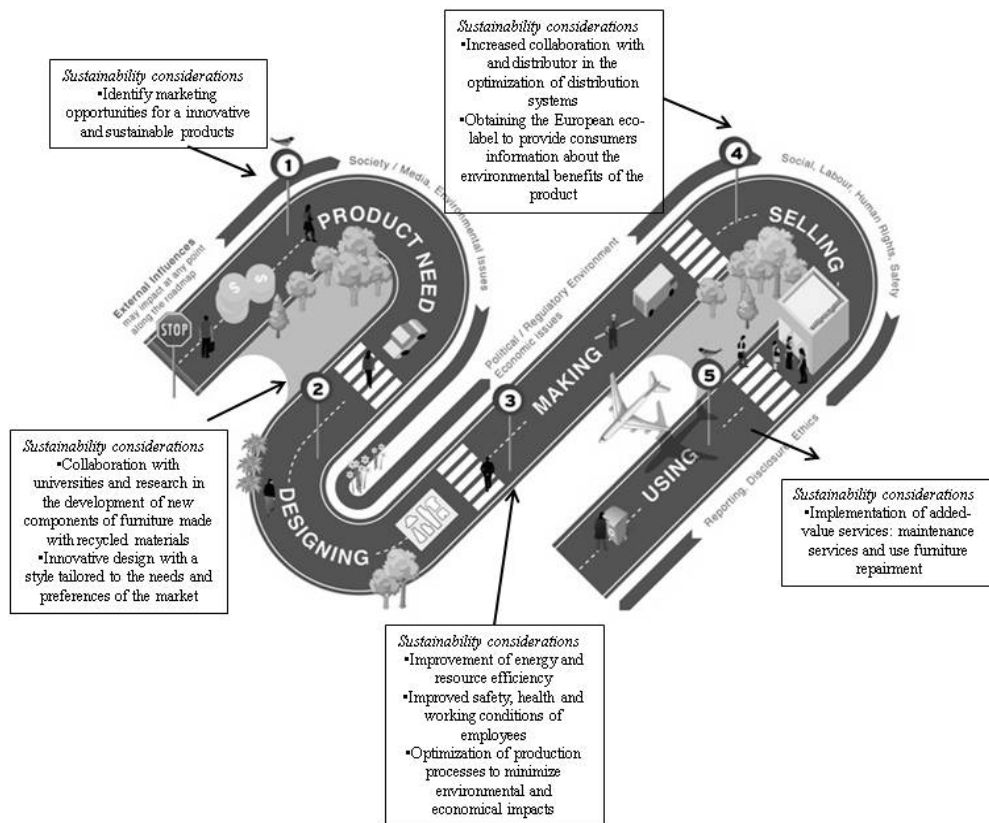


Fig. 8 Example of a roadmap. Own elaboration based on [33]

C. Guidelines

In a schematic and simple way, the guidelines describe the strategies and tools identified in the diagnostic kit and other useful tools that furniture enterprises could consider to improve their sustainability. They also include interesting contact information from universities, research centers, public administrations and other institutions that can support them in R&D projects, initiatives by Spanish and European institutions to promote more sustainable development in the industrial sector, R&D funding programs for SMEs, etc., so that companies have all the information required to implement sustainability issues.

VI. CONCLUSIONS

The analysis of the key environmental issues in the furniture sector reveals that the most important environmental impacts of the furniture sector relate to the consumption of raw materials such as wood and energy, the use of chemical substances containing volatile organic compounds (VOC) and/or formaldehyde, and waste production. Regarding the analysis of the application of some environmental tools, such as environmental management systems, Spanish eco-design, eco-labels and green public procurement standards are currently limited. For this reason, efforts made by both companies and governments are required to encourage the use

of these tools given the benefits they offer to companies to enhance their image and competitiveness.

On the other hand, the analysis of the current economic and market trends demonstrates how the effect of the current economic crisis, together with market globalization, have proved negative for the Spanish furniture sector, thus revealing the need for them to change their business models. According to the authors who have analyzed the possible future scenarios for the sector in the near future, there is a general consensus that changes toward new business models based on sustainability issues could help improve the sector.

By considering these approaches, this study proposes new decision support tools –*diagnostic kit, roadmap and guidelines*– based on eco-design issues which not only focus on environmental issues, but other economical and social strategies in accordance with the sustainability definition, along with other available tools such as eco-labels, environmental management systems, etc. These tools aim to guide not only furniture companies as to the steps and factors they should consider, but the actors who support them in order to achieve more sustainable development in the company. To analyze the successful implementation of these tools in the Spanish furniture sector, this study will be followed by an empirical research work into the furniture enterprises' attitudes and perceptions about sustainability and if they believe these tools are useful for them to improve their

competitiveness in accordance with their needs and the current market situation.

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