BARRIERS AND OPPORTUNITIES FOR INTEGRATING SUSTAINABLE PRODUCT DESIGN INTO ANKARA SMALL AND MEDIUM-SIZED FURNITURE ENTERPRISES

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ABSTRACT

BARRIERS AND OPPORTUNITIES FOR INTEGRATING SUSTAINABLE PRODUCT DESIGN INTO ANKARA SMALL AND MEDIUM-SIZED FURNITURE ENTERPRISES

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The increasing impact of mass production and consumption behaviours have made sustainable product design an important issue in design literature in the last two decades. Studies in the early period focussed on research projects carried out in collaboration with multinational large-sized enterprises, owing to pressures from non-governmental organizations. However, recent studies about sustainable development have pointed out that small and medium-sized enterprises (SMEs) rather than multinationals have a greater share of manufacturing and employment in both industrialized and industrializing countries. Unfortunately, in spite of the important role of SMEs, there is inadequate data and literature relating sustainable design practices to these firms. A lack of information and collaboration, caused partially by communication problems, has resulted in an absence of proper sustainable product design tools for these companies.

Furniture enterprises in Ankara are the focus of this study because of the impact of product design in market possibilities and the spread of employment of product designers in the sector. Attitudes of staff and consultants of furniture SMEs regarding barriers and opportunities of sustainable product design are explored, and contrasted with overlapping points of existing product development methods and strategies in the literature. This work is intended to contribute to improved understanding and application of sustainable product design among furniture sector SMEs. To this end, interviews were conducted with 16 furniture manufacturing enterprises from the furniture industry, based in Ankara region and 5 freelance furniture designers cooperating with these enterprises.

According to the results of the study, furniture sector SMEs are interested more in economic opportunities of sustainable product design rather than environmental and social aspects. Furthermore, a lack of information about environmental issues is observed in micro and small-sized enterprises; to overcome this situation, it is recommended that training sessions are organized to bring together researchers and practitioners.

Keywords: sustainable product design, furniture industry, small and medium sized enterprises, product development, newly industrialized countries

ÖZ

ANKARA MOBİLYA ENDÜSTRİSİNDEKİ KÜÇÜK VE ORTA ÖLÇEKLİ İŞLETMELERİNİN SÜRDÜRÜLEBİLİR ÜRÜN TASARIMINA ENTEGRASYONUNA DAİR FIRSATLAR VE ENGELLER

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Günümüzün seri üretim ve tüketim alışkanlıklarının çevre üstündeki artan etkisi, son yirmi yılda sürdürülebilir tasarımı, ürün tasarımı literatüründe önemli bir konuma getirmiştir. Erken dönem ve yakın zamana kadar olan çalışmalar sivil toplum örgütlerinin etkisi ve ulaşılabilirlik gibi nedenlerden ötürü temel olarak uluslararası büyük ölçekli firmalarla beraber yapılan çalışmalara dayanmaktadır. Ancak yakın dönem sürdürülebilir kalkınma çalışmaları sanayileşmiş ve sanayileşmekte olan ülkelerdeki KOBİ'lerin üretim ve istihdam açısından büyük bir paya sahip olduğunu göstermektedir. Ne yazık ki; bu önemli rollerine rağmen ilgili literatürde, KOBİ'ler hakkında yeterli veri bulunmamaktadır. Temel olarak iletişim sorunlarına dayanaklı bilgi yetersizliği ve beraber çalışma konusundaki olanaksızlıklar bu firmalar için uygun sürdürülebilir ürün tasarımı araçları geliştirilememesine neden olmaktadır.

Bu araştırmada ürün tasarımının pazar olanaklarına olan etkisi ve tasarımcıların yaygın istihdamı nedeniyle Ankara mobilya endüstrisi seçilmiştir. Mobilya KOBİ'lerinin sürdürülebilir ürün tasarımının sunduğu fırsatlar ve önündeki engeller ile ilgili duruşlarının da incelendiği çalışmada mevcut ürün geliştirme çalışmalarının, literatürde yer alan stratejilerle örtüşen noktalarının ortaya çıkarılması, gelecekte mobilya KOBİ'leri arasında sürdürülebilir ürün tasarımının yaygınlaştırılmasını amaçlayan çalışmalara katkıda bulunacaktır. Bu amaçla mobilya üreticisi 16 KOBİ ve bu firmalara danışmalık yapan 5 serbest mobilya tasarımcısı ile mulakat yapılmıştır.

Çalışmanın sonuçlarına göre, sürdürülebilir ürün tasarımının çevresel ve sosyal getirilerinden ziyade ekonomik fırsatlarının önemsendiği tespit edilmiştir. Aynı zamanda mikro ve küçük ölçekli firmalarda çevresel konularla ilgili bilgi eksikliği gözlemlenmiş olup, bu sorunun çözümü için araştırmacılarla uygulayanların bir araya geleceği eğitim seminerlerinin gerektiği sonucuna ulaşılmıştır.

Anahtar kelimeler: sürdürülebilir ürün tasarımı, mobilya endüstrisi, küçük ve orta ölçekli firmalar,ürüngeliştirme,yeni endüstrileşmiş ülkeler

To my family...

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CHAPTER 1

INTRODUCTION

1.1 Problem definition

The increased consumption patterns supported by marketing strategies is causing serious environmental problems, such as deforestation, depletion of freshwater resources, air pollution, depletion of the ozone layer, heavy increases in landfills and more. The most serious problem in this issue is the fact that most of these environmental problems are irreversible and the recovery process of nature is not fast enough to catch up with the development rate of industrial production. Therefore, it is essential to call urgent solutions for negative impacts of the human race on the Earth's resources.

Sustainable development studies have been carried out since the 1980s and there has been great progress taken since then. However, most studies in the literature are about goals and definitions of the ideal sustainable world. Studies are mostly based on the projections and future steps of sustainable development strategies. In spite of the fact that sustainability and environmental issues will become even more serious problems in the near future, it is crucial to take immediate action against these problems in their current state.

Existing studies in this area have resulted in many contributions to the development of Sustainable Product Design (SPD), as one of the main responses that design researchers and practitioners are able to implement area of research and practice areas related to product design (Uribe & Lofthouse, 2006). However, product design is a complex activity dependent on various actors. Above all, product design is a profession with strong bonds to manufacturing industry. Therefore it is not possible for designers to take unilateral steps towards sustainable design, in the way that non-governmental organisations (NGOs) would like to see taken. Although designers are responsible for considering environmental issues, they still have to meet other requirements relevant to product features, the marketplace, consumer needs and company expectations. Thus for progress towards a more sustainable future, many obstacles and issues must be dealt with incrementally.

In addition to environmental problems, industry has a responsibility for other aspects of sustainability. The current dynamics of industry is causing social and economic problems,

such as income inequity, poor working conditions, high unemployment rates, child labour, and unfair trading practices. These are issues that are frequently mentioned in sustainable development literature (Crul & Diehl, 2006). The impact of industrial designers is a key factor in dealing with these issues, because designers can influence the interaction between industry and society by means of social innovations that impact on everyday life (Manzini, 2004).

Although the sustainability awareness of product designers is rising and it is now a topic that they discuss and mention opportunities about to their clients or employers, it is still far distant from a deeply embedded factor in product development processes. The main reason behind this is that the reach of product designers does not extend to all industrial sectors or operations. Also product designers cannot collaborate with small and medium sized enterprises (SMEs) frequently because the cost of providing professional design services is beyond their financial means. Therefore most case studies of SPD are collaborations with large-sized multinational companies, e.g. Herman Miller, 3M, Philips, capable of assembling large product development teams and paying for SPD experts and related expenditures. However, improving ecological performances just of large companies is not enough when dealing with sustainable development goals on an holistic, global scale. In most literature surveys it is estimated that SMEs are responsible for 70% of pollution generated in manufacturing industries, yet they are not exposed to pressures of NGOs or environmental legislation (Hillary, 2000). This should not be an excuse for SMEs to act irresponsibly or to ignore their environmental impact (Hillary, 2004).

In the current marketplace, SMEs have increasing share of added-value products and services, whilst the development of e-trade allows these companies to compete with large-sized companies in their commercial sectors. The penetration of large-sized companies into local niche markets, aided by their advanced distribution networks, gives incentive to SMEs to improve their product quality and enhance their brand to compete with rivals. Because of these factors, it is reasonable to state that product development and design projects will be more widespread in SMEs in the near future.

1.2 Aim and objectives of the study

One barrier against urgent action for sustainability is the fact that there is not adequate experience about the implementation of SPD amongst SMEs (Seidal et.al, 2009). Even though there are case studies and many successful examples, they are not accessible to the majority of design practitioners. The network for information sharing and training of SPD is not available to designers. In summary, the practice of SPD is a complex issue for companies willing to make a commitment. In other words, as Suzuki and Dressel (2002)

mention, “in fact, everyone does know what this word means [sustainability]; it’s just that no one knows exactly what it looks like in practice” (p.16).

Dealing with the implementation of SPD in SMEs is a greater challenge because there is insufficient data relevant to the relationship between the features of SMEs and SPD. In particular, the environmental impact of SMEs did not receive adequate attention until early 1990’s (Masera, 2003). Moreover, it is not possible to implement the same SPD strategies both in SMEs and large-sized companies. Also the features and operations of companies differ according to countries, economic systems, markets, and sectors, resulting in a need for various SPD approaches (Shrivastava, 1995). Therefore there is a need for the specific conditions of SMEs regarding SPD and SPD tools to be explored in a deeper manner according to geographic location, scale of production, and product sectors. In consideration of these interconnected points, this study aims to find answers to the following research questions. For this study, the furniture manufacturing industry is chosen because it is dominated by SMEs, yet is one of the most established Turkish industries with some successful examples of employing professional design services. In consideration of these connected points, this study aims to find answers to the following research questions.

1. Do SME furniture manufacturers in the Ankara region implement SPD; and if not, what barriers prevent them from doing so?
2. Which design strategies used by Ankara region furniture manufacturing SMEs have closest resemblance to SPD strategies?
3. Which external and internal opportunities of sustainable product design are influential on Ankara region SMEs operating in the furniture manufacturing sector?
4. How do the opportunities and barriers to SPD differ between (i) furniture companies employing no specific design-responsible staff, (ii) furniture companies employing design-responsible staff, and (iii) freelance designers providing design services to furniture companies?

To support investigation of these questions, it will also be necessary to establish the make-up of the furniture sector in Turkey generally, and in Ankara specifically, with regards to location, firm sizes and design capability.

1.3 Methodology

The study combines literature reviews and a field study. It begins with a literature review based on the three key terms of SPD, SMEs, and furniture manufacturing industry. First, the definition and evolution of SPD is discussed in a chronological approach. Existing SPD strategies are also explored in terms of their sustainability approaches and strengths and weaknesses. Barriers and opportunities are mentioned, so as to discuss with the analysis

of the field study data. After that, a brief explanation of SMEs and their impact on sustainability is mentioned. In this way, the importance of these companies and the necessity of research on their practice become more obvious. In addition, studies about the conditions of furniture manufacturing industry, both in Turkey generally and the Ankara region specifically, are explored in order to outline the conditions of the industry. The knowledge gained about the conditions in the region is fed into the preparation and sampling stages of the field study. The remaining section of the literature review offers an analysis of furniture examples designed by various SPD strategies.

The set-up of the field study was based on findings of the literature survey placed in the context of the research questions. A combined qualitative and quantitative approach was taken, with a statistical analysis made to compare aspects of SPD (barriers, drivers and strategies) in terms of their influence and frequency. Data were generated through interviews using both open-ended and multiple-choice questions. After conducting a pilot study, it was established that participants were not willing to participate if their voice was recorded. Therefore a preformatted interview record sheet was prepared to ease note-taking and analysis of the data from the interviews. After a preparation stage, the interviews were conducted with 21 furniture manufacturing SMEs in the Ankara region..

1.4 Structure of the research

The research activity and distribution of time was structured as shown in Figure 1.1. In the first phase of the study, the literature review was conducted. In the beginning, studies about SPD implementation in terms of drivers, barriers and strategies were analysed specific to manufacturing SMEs. Then, possible product sectors for fieldwork were checked against two criteria: availability and impact of SMEs. After the selection of furniture manufacturing industry in Ankara region as an appropriate and convenient sector for fieldwork, the writing stage of the literature review was carried out, in parallel with the set-up stage of the field study. During the application phase of the field study, the literature review and set-up stages were written-up. In the subsequent stages, analysis and findings of the field study data were conducted, leading to the conclusions of the study.

The thesis begins with a brief introduction chapter followed by a literature survey bringing together the topics of SPD, SMEs and furniture manufacturing industry. Following the literature survey, details of the field study are provided, covering the set-up, method of sampling, analysis, and findings. The study is finalized with discussion of the findings and conclusions.

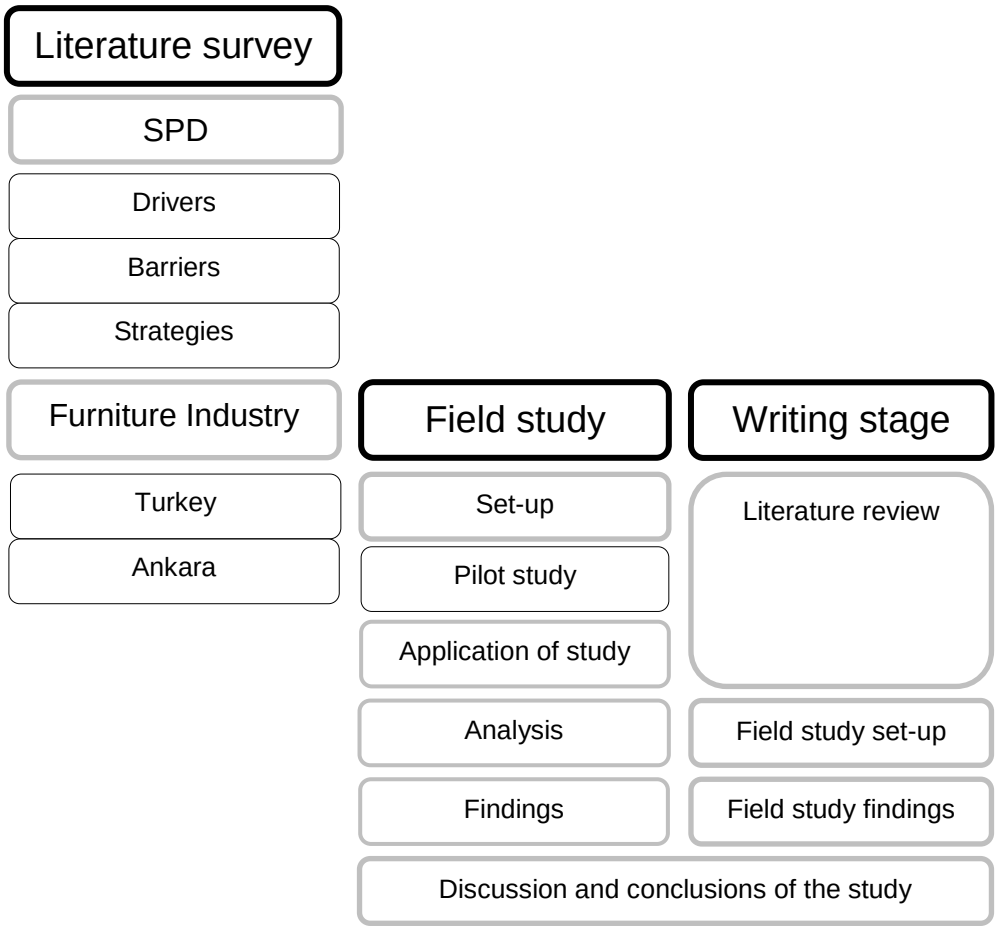

Figure 1.1: Components and structure of the research activity

CHAPTER 2

OVERVIEW OF SUSTAINABLE PRODUCT DESIGN AND SMEs

2.1 Brief Introduction to Sustainable Product Design (SPD)

Sustainability or sustainable design is now a frequently mentioned term in product design. Roots of SPD dates back to 1980's and is something raised not only by industrial designers but also by a wider group of disciplines and institutions. During 1980's sustainability was studied by many authors and the subject gained ground as a literature subject. In 1987, the Brundtland Report or "our common future" was published (Brundtland, 1987). The study is regarded as the most popular publication in the early stages of sustainability literature. It was an interdisciplinary research from both industrialized and industrializing countries. The aim was to point out various radical changes that needed to be made, mostly in economic approach, in order to deal with environmental problems and poverty, which was mentioned as a consequence of environmental problems. The sustainable development definition in the report is one of the most cited amongst the literature: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987)

Unfortunately, in the following years, the definition provided in the Brundtland Report was criticized as being too general and inadequate for implementation. The radical changes offered in the study were not feasible, given the inadequate knowledge available at that time. Moreover, these changes could not be made as mandatory regulations. Stakeholders in sustainable development should volunteer for it. In the 1990's, research activity structured sustainability into three key aspects, namely environment, society and economy. The approach was referred to with two different names: in the early stages "triple bottom line" (Elkington, 1998) and in the later stages "P3 concept" (Kemp & Martens, 2007). In the "triple bottom line" approach the relationship between the three aspects (planet, people, & profit) is described in two structures (see Figure 2.1). The first one was mentioned as 'weak sustainability', which defines the three elements independently. For the second structure, 'strong sustainability' the focusing was in the relation and dependencies of these three elements. Briefly, the idea is that there would be no society without an environment; subsequently the quality of life is strictly related to the quality of the environment in which people live. Furthermore sustainable development goals regarding economy cannot be achieved without finding appropriate solutions to problems related to society.

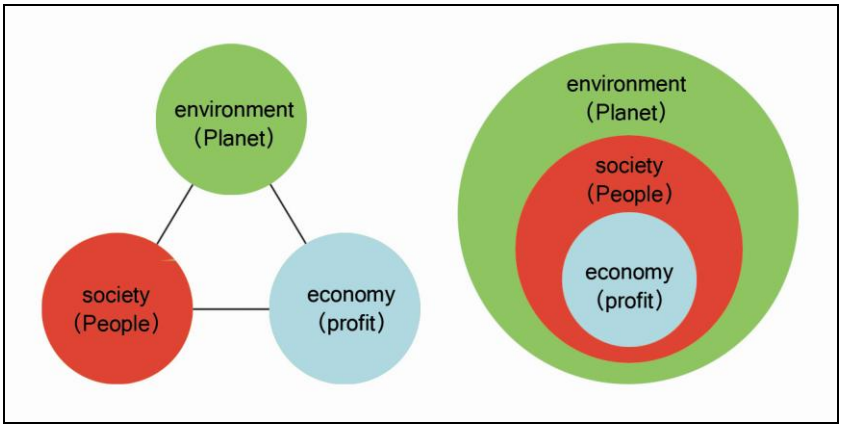

Figure 2.1: Weak and strong triple bottom line structures (adapted from Crul & Diehl, 2008)

After the revelations of the triple bottom line approach, industrial design researchers focussed on positioning and defining the effects of sustainability on the product design process. The studies grouped in two different issues. The first is defining relations between product design process and the key elements of sustainability. In this issue, the P3 approach is shifted into 4Ps approach (Crul & Diehl, 2006). They claimed that they upgraded the concept of ecodesign into design for sustainability (D4S). They mentioned the main focus of ecodesign as designing “green products” with low environmental impact, while, in D4S, the aim was mentioned designing products offering solutions and meeting consumer needs related to all 3Ps systemically, as illustrated in Figure 2.2 (Crul & Diehl, 2008) .

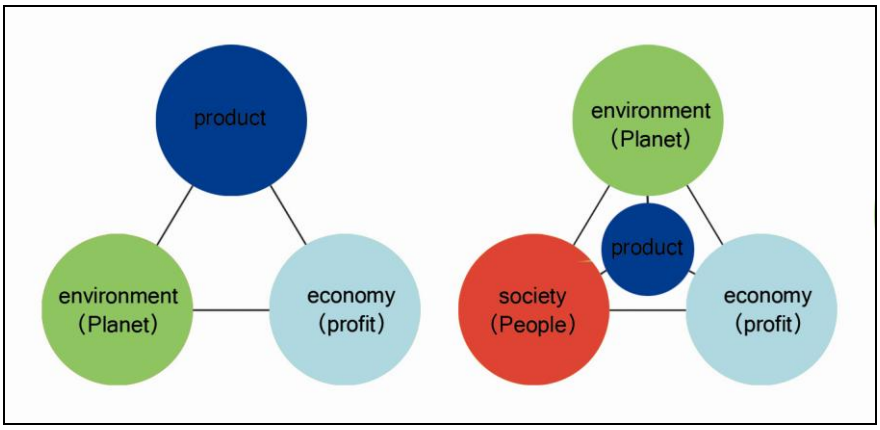

Figure 2.2: Contrast between ecodesign (left) and D4S approach (right) related to triple bottom line of sustainability (adapted from Crul & Diehl, 2008)

2.2 Practice of Sustainable Product Design

Since the beginning of the sustainability literature, researchers and design practitioners have developed various sustainability approaches and tools in order to ease and guide sustainable product design (SPD) projects. In order to distinguish the difference between various terms and implementations of SPD, it is first necessary to provide some definitions and the hierarchy between them, represented in Figure 2.3.

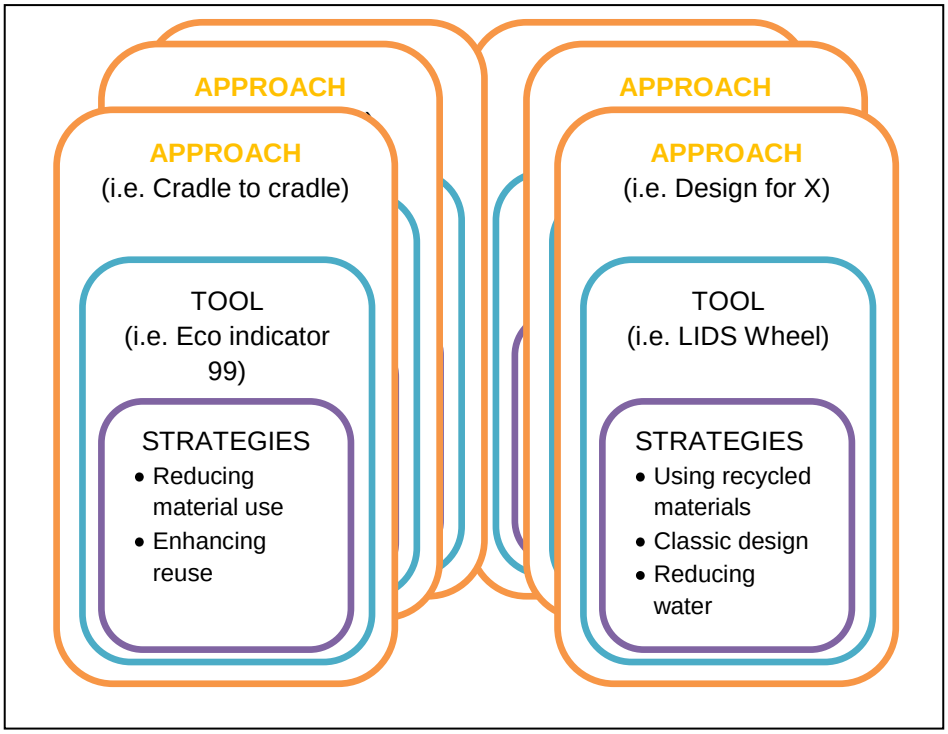

Figure 2.3: Hierarchy of SPD terms: approaches, tools and strategies of SPD

2.2.1 Approaches to sustainable product design

Sustainability approaches are usually developed by researchers and generally promote an 'ideal' definition of sustainability. In other words, concepts that fall into scope of approaches draw the overall layout of a researcher's sustainability vision. A set of most well-known SPD approaches are collated in Table 2.1.

Table 2.1: Approaches to sustainable product design

Biomimicry:
Biomimicry is a concept developed to use nature as a model, and imitates its solutions in order to develop new sustainable products and systems (Biomimicry Institute, 2007).

Cradle to Cradle:
The Cradle to Cradle concept (C2C) was developed by Mc Donough and Braungart (2002). In the study, two life cycle thinking approaches are mentioned. The first is the existing "cradle to grave" open loop systems in industrial ecology. The second is a new shift in life-cycle thinking, based on the natural material flow cycles. These closed loop systems were inspirational for industry to reduce their environmental impact by reducing waste. The developers also patented their tool in order to cooperate with industry and register products with C2C certificate.

Design for X:
This is a group of concepts concentrating on designing for different criteria. However this group of strategies are not totally concerned with sustainability. The purposes can be related to cost management, manufacturing, ergonomics, use or other aims (Pahl & Beitz, 1996). Regardless of engineering roots of this concept, this approach is currently being developed for sustainability purposes.
Design for X approaches:

Sustainability	Other topics
Design for environment	Design to cost
Design for disassembly	Design to standards
Design for remanufacturing	Design for assembly
Design for recycling	Design for manufacturing
Design for biodegradability	Design for logistics
Design for social behaviour	Design for safety
Design for biodiversity	

Ecological footprint:
This concept was developed by Mathis Wackernagel and William Rees in 1996. The idea is based on the use of environmental resources at an individual or national level. In the study, the researchers pointed out that productive land on Earth is less than one quarter of the whole surface (Wackernagel & Rees, 1996). In the following years this approach has resulted in the development of LCA tools in order to provide feedback for both companies and individuals about the environmental effect of their production and consumption behaviours.

Factor X:
Factor X is divided in two hypotheses, Factor 4 (Weizsäcker, 1997) and Factor 10 (Hinterberger & Schmidt-Bleek, 1999). Factor 4 is a widely adopted approach for achieving sustainable industry. The main focus is reducing the resources for manufacturing and distribution by half and creating prosperity double than was previously obtained. It is estimated that 20% percent of the world's population, living in developed countries, are responsible for the use of 80% of total resources on Earth. Therefore, production and consumption patterns should be changed and reduced by 5% every year for the next 30-50 years. In spite of the fact that this approach is developed in the late 1990's it is still being studied because of the time period it requires.

Slow design:
Slow design is a new design paradigm, developed against the existing "fast" industrial world. Slow design is coupled with slow consumption, to achieve well-being (Fuad-Luke, 2004)

2.2.2 Tools for sustainable product design

SPD tools can be defined as the enabling technologies for the implementation of SPD approaches. Some tools help companies selecting appropriate SPD strategies (definition to be given shortly) for product development, while others enable measurement of the environmental impact of companies and their products. The most commonly used SPD tools are mentioned below.

Life-cycle analysis:

LCA is widely adopted tool for measuring the effects of products in the phases of their life-cycles; however it requires extensive research and time. The most common used phases in life-cycle thinking are material extraction, manufacturing, recycling and disposal (Joshi, 2000). Along with studies on LCA, new definitions and tools have been developed. In terms of definition, LCD (life-cycle design) and LCM (life-cycle management) were developed for specific purposes. LCD is concerned with considering life-cycle thinking in product design, whilst LCM is focussed on the decision making processes related to LCA results. In addition to all these, companies should be critical while applying LCA because in some cases the results are surprising. For instance, Coca-Cola Company executed one of the first LCA studies in the world and the result was the fact that plastic bottles were more sustainable than glass ones in terms of manufacturing. However through the study the last phase (end-of-life) was excluded and now industry and NGO's are dealing with the problem of extreme use of PET bottles in packaging industry while encouraging the use of glass packages (Duda & Shaw, 1997).

Ecodesign Strategy Wheel:

Hemel and Brezet developed this tool to classify the levels of ecodesign available in enterprises. It also helps companies to select appropriate ecodesign strategies for their company structure and their sector (Van Hemel & Brezet, 1997). The strategy wheel contains 33 design strategies under 8 topics (see figure 2.4). Different levels of ecodesign give opportunities of different levels of innovation and environmental improvement for both new and existing products.

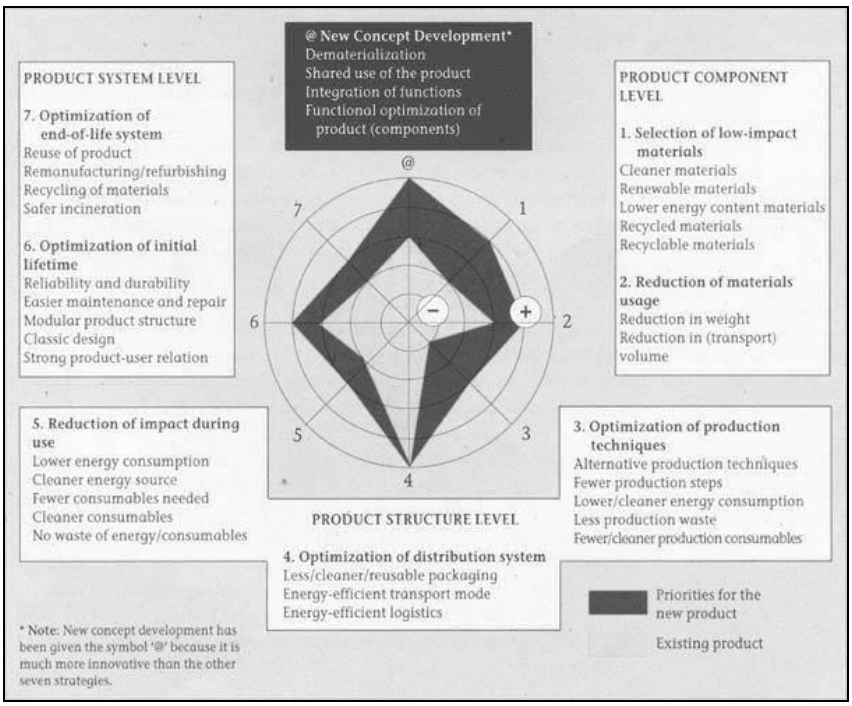

Figure 2.4: Ecodesign Strategy Wheel (Downloaded from http://www.ivt.ntnu.no/ipm/und/fag/TMM4145/ecodesign/theory/moduler/moduleA.htm)

Table 2.2: Strategies in Ecodesign Strategy Wheel

Product component level	
1. Selection of materials • Cleaner materials • Renewable materials • Lower energy content materials • Recycled materials • Recyclable materials	**2. Reduction of material use** • Reduction in weight • Reduction in volume
Product Structure Level	
3. Optimization of production techniques • Alternative production techniques • Fewer production steps • Lower/cleaner energy consumption • Less production waste • Fewer/cleaner production consumables	**4. Optimization of distribution level** • Less/cleaner/reusable packaging • Energy-efficient transport mode • Energy-efficient logistics **5. Reduction of impact during use** • Lower energy consumption • Cleaner energy source • Fewer consumables • Cleaner consumables • No waste of energy/consumables
Product System Level	
6. Optimization of initial lifetime • Reliability and durability • Easier maintenance and repair • Modular product structure • Classic design • Strong product-user interaction	**7. Optimization of end-of-life system** • Reuse of product • Remanufacturing/refurbishing • Recycling of materials • Safer incineration
New concept development	
• Dematerialization • Shared use of products • Integration of functions • Functional optimization of product	

2.2.3 Sustainable product design strategies

SPD strategies generally overlap with general product design strategies (see Table 2.3). However, SPD strategies aim to reduce negative environmental and social impacts of companies.

Table 2.3: Sustainable product design strategies

Strategies related to material choice
Using recycled/recyclable material: Use of both recycled and recyclable materials in product design enables a reduction in the environmental impact of products.
Using low energy content material: Every material has a different energy content and it is closely related with the renewability of those materials.
Using reclaimed material: Besides recycling, manufactured product parts which are no longer being used can be used for manufacturing new products. By this means, the economic and time costs of recycling can be skipped.
Using local material: The origin of materials used in products is another factor affecting their impact in the triple bottom line. Circulation of material across continents or countries increases the environmental impact of industry. Also, localization of industries can result in regional development in parallel with social goals of sustainability.
İncreasing material efficiency: Material efficiency strategy is widely used in product design, regardless of sustainability, in order to reduce costs. However, it also helps to save non-renewable resources and reduce environmental impact.
Using sustainable packaging: In addition to materials used in products, packaging materials are also another important issue to be addressed in SPD because most packages are usually thrown away.
Reducing material variety: Using fewer kinds of materials eases both supply chain management at the manufacturing phase and recycling at end of life stages.
Avoiding toxic materials: Toxic materials not only have environmental affect by damaging biodiversity and ecosystem but also cause serious health problems for both users and employees.
Strategies related to manufacturing
Minimizing transportation distances: The distribution phase of the product life cycle also has an environmental impact. Therefore the distance between raw material supplies, manufacturing and sale should be addressed.
Reducing manufacturing stages: Products which can be manufactured with fewer manufacturing stages helps companies to reduce costs and is strongly related to enabling easier recycling.
Reducing waste: Reducing waste is a parallel concern with improving material efficiency. However manufacturing techniques can produce other waste such as manufacturing materials, emissions, etc.
Selecting low-impact transportation: Although it requires serious arrangements in companies' networks, companies can lower their environmental impact by using different transportation means (using electricity rather than foil resources).
Reducing energy use: Manufacturing techniques can require different levels of energy use. Product designers can reduce the energy consumption during manufacturing stages by considering the environmental impact of these manufacturing processes.

Table 2.3 (continued)

Strategies related to product features
Reducing energy/resource use: The amount of energy and resources consumed in use life is another issue to be addressed in SPD because energy and resource consumption of durable goods can surpass the environmental impact of the manufacturing phase.
Enhancing renewable energy use: The type of energy used by products is another issue to be dealt with in SPD. Sustainable energy sources can help users to reduce their ecological footprint. However, designers should be sensible in their design process. On the one hand, replacing fossil fuel use with electricity in the automotive industry is one of the most well-known examples of this strategy. On the other hand concepts using photovoltaic solar panels in electronic goods do not always have positive outcomes because of their short life spans and low power provision.
Integrating functions: Designing multifunctional products can help to reduce the number of individual products that people purchase. However multifunctionality can lead to failure and more rapid replacement of products unless evaluated correctly.
Modular products: Modular products can be repaired and refurbished easily. Moreover, modularity allows products to be upgraded easily.
Life time optimization strategies
Increasing durability: Designing more durable products can help extend the use life of products. Unfortunately, it is not always possible to achieve long life in products because of the impact of new technologies or trends. Therefore designers should be aware of the estimated life-time of their designs.
Ease of maintenance: Replacing worn out parts or refurbished products can help users to benefit from their products for longer periods of time.
Classic design: Without considering technologic developments and improvements, products can be replaced simply because of changes in trends. Designers are responsible for the outcomes of these changing trends because they play a role in transformation and development of them. Therefore achieving classic designs independent from trends helps to extend the life time of a product.
Enhancing reuse of products Apart from recycling or remanufacturing, reusing also provides a way to use products for longer. The advantage of the reuse concept is the fact that there is no recycling or re-manufacturing tool required for this concept.
End of life strategies
Enhancing remanufacturing: Remanufacturing (refurbishing) refers to renovating any non-functioning parts of used products at the end of their life and reintroducing them to the market. Although it seems parallel with the definition of maintenance, it requires new strategies for marketing because of changes in the manufacturer-customer relationship (Östlin et al, 2008)
Recycling via ease of disassembly: After products complete their use life, there is still work to be done in order to reduce that product's impact and gain benefit from it. Disassembled product components without mixed material and little material variety can be recycled and become a resource for new products to be manufactured.

2.3 Sustainable product examples in the furniture sector

In this section, five product examples from the furniture sector are presented from different countries throughout the world. The products are chosen according to the criteria below.

- During the product development process, various issues linking marketing, manufacturing and expenditure are taken into account. Therefore, product examples are chosen from amongst those that are manufactured and put on the market rather than concept projects developed by designers or design researchers.
- Product examples are chosen from different scales of companies ranging from small workshops to leading multinational companies in order to show possible outcomes of SPD at different scales within the furniture sector.
- Beyond company size and capabilities, the national development level (industrialized, newly industrialized, industrializing) has effect on the sustainability awareness of companies. Therefore products are chosen from different regions in the world with different development levels.
- Products are chosen both that case studies collaborated with research institutes and design projects carried out in companies. In this way, the difference between manufacturing companies and research institutions in terms of sustainability approaches and tools could be expected.

Table 2.4: Sustainable furniture examples

Company/product/year/ manufacturing method	Sustainability strategy	Strengths	Weaknesses
Herman Miller Aeron/Mirra chair 1998/2003 Repetitive production	Design for disassembly Using recyclable material Using recycled material Reducing volume Eco labeling	Great amount of improvement can be achieved	Only available in large-sized companies
Mexican furniture workshops Casas Blancas Chair 1998 Batch production	Reducing weight Increasing material efficiency Reducing material variety Using local materials	Wider share of population can benefit from SPD in SMEs	Only incremental improvements can be achieved
Maria Yee BambooTimbre 2008 Serial production	Using low embodied material Reducing material variety Eco innovation Eco labeling	Material innovation enables a reduction in environmental impact	Long distance distribution channel of furniture still has environmental impacts.
Hammer & Hand Upcycled furniture 2010 Project-based manufacturing	Using reclaimed material	Use of reclaimed material reduces material costs Reclaiming material reduces recycling material	Non standardized production is not suitable for serial production
Vitsoe Universal Shelving System 1960 Serial production	Design for disassembly Design for upgradability Enhancing reuse Classic design	Classic design enables long-life manufacture and use Design for upgradability allows users to transform system according to changing needs	Online sale network is available for niche market

2.3.1 Herman Miller

Herman Miller implemented one of the first examples of sustainable product design studies in the furniture industry. The company started emphasizing environmental goals as a corporate strategy at the beginning of 1990's. In 1989, the company started its sustainability studies through a project carried out by its environmental department, to reduce formaldehyde emissions caused by finishing processes applied to wooden furniture (White et al, 2008). Since then, the company has focused on sustainability issues at a deeper approach. Now, Herman Miller aims to achieve a zero ecological footprint in 2020.

After the success of the first project, the company shifted into a more systematic approach to SPD. The sustainability team started to classify all materials used in their products. In 1990, the company teamed up with McDonough Braungart Design Chemistry (MBDC) to improve their capability in testing their materials and transferring this knowledge into their design process. In the mid 1990's, the company used their material knowledge and emphasized design for the environment at the beginning of their design process. The result was the Aeron Chair (Figure 2.4). The chair was made from 94% recyclable materials and more than the half of the materials used was already recycled.

Figure 2.5: Aeron Chair (Downloaded from: http://www.hermanmiller.com/DotCom/jsp/designResources/imgSearchResults.jsp?prodId=8)

In the latter projects, the company improved their products' environmental performance. To achieve this, they adopted the MBDC Cradle to Cradle Design Protocol. Also they have

certificated their products with eco labels, including Cradle to Cradle and LEED certifications. These were:

- Material Chemistry: Materials should be the safest available.
- Design for Disassembly: All the parts should be easy to disassemble with common tools.
- Recyclability: Materials should contain recycled content and more importantly they should be recycled at the end of use-life. (White et al, 2008)

With the help of these regulations, Herman Miller introduced new products to the market. The Mirra chair (Figure 2.6) is a good outcome of Herman Miller's sustainable product design process. The product has cradle to cradle gold certification and is designed according to the cradle to cradle design protocol.

Features of Mirra Chair in terms of sustainability:

•Contains no polyvinyl chloride (PVC)

•96% recyclable

•Takes 15 minutes to disassemble with common tools.

Figure 2.6: Mirra Chair (reproduced from White et al, 2008)

In these studies, Herman Miller asked its suppliers and other stakeholders to transform their practices according to the sustainability goals of the firm. They needed to be trained about sustainability and intellectual properties related with material chemistry. In the end, not all of the suppliers were ready to change. Herman Miller continued to cooperate with the ones who could commit the necessary improvements in their firms (White et al 2008).

The sustainability studies of Herman Miller are mostly fundamental innovation stories. Material chemistry studies, new technology developments and cooperation with research institutions require a great deal of investment and very large business networks. Therefore, this product innovation study is not a possible strategy for SMEs in the furniture industry.

2.3.2 Diego Masera's case study in Mexico

In 1999, Diego Masera published the outcomes of a SPD case study carried out in the Purepecha region in Mexico. In the first part of the study, he focuses on the reasons for choosing the furniture sector in a developing country. The reasons can be categorized with reference to the P3 Concept (people, planet, profit).

I. People:

In terms of the social motivations behind the study, SMEs are the key element to achieve social equity and reduce poverty. SMEs employ 50%-60% of labour in worldwide private sector and studies show that a larger portion of small enterprises in the economy helps to achieve more homogeneous and distributed income (Raynard & Forstater, 2002).

II. Planet:

The natural resources in developing countries such as rain forests and fresh water resources, are very important not only for these countries but also for the global ecosystem (Lentz, 2001). The small enterprises in these countries have their local networks on a national level. They use local materials and sell their products in local markets. Thus, SMEs in developing countries also play an important role for environmental goals of sustainability. The furniture companies in Mexico are also supplied wood from local forests in the region and their use of timber is mentioned as a good indicator of their environmental impact at the production phase (Masera, 2001).

III. Profit:

The economic motivations behind the study are closely related with the social motivations. In the region, most people are employed in furniture SMEs and the improvement in these enterprises would affect the region both in economic and social aspects. In an economic aspect, SPD in these companies would:

- give new market opportunities
- promote export
- enhance employment of artisans

At the beginning of the study, SPD training was carried out with the artisans. Training was in the artisans' native language and it was planned to minimize the negative effect on on-going production. Groups were formed in sub-sectors and participants were informed about market opportunities. Training was practical and focused on SPD gains.

As a result of the SPD training, participants produced new chair models. These products reflected the considerations of SPD training. One of these examples is the Casas Blancas chair (Figure 2.7). The design process of the new model was managed according to the considerations of both the SPD trainers and the furniture producers. The considerations were: reducing the volume during transportation; ease of repair and disassembly; using local resources; no chemical finishing; and regional distribution.

Figure 2.7: Casas Blancas chairs (adapted from Masera 2001)

To recognize the improvement gained through SPD, the new product was compared to other products already manufactured in the region. According to the results, the new design was manufactured by using four times less timber compared to the existing Opopeo model and half to two-thirds than other models. Also the profit margin with Casas Blancas was 65%, while the average margin of the other models was 41% (Masera, 2001). In other words, the Casas Blancas was at least 50% more profitable compared with the other models.

This study is an example of cooperation between research institutions and production facilities. In the literature, the most common barriers mentioned for SMEs are the lack of funding and scarcity of new technologies (Hillary, 2003).However, it is obvious that companies do not need huge investments or high technology to reduce their environmental impact while improving their competitiveness. The key element is to select correct SPD strategies appropriate for companies. Furniture is a labour intensive industry, for which most companies use low technology manufacturing techniques (Ozturk Şengül, 2009). Therefore, designing new products based on the capabilities of local artisans is more feasible than duplicating foreign companies' design strategies. For example, the previous Herman Miller case required environmental management departments or developing new low impact materials, which are way beyond competitors of furniture sector SMEs.

2.3.3 Maria Yee Inc.

Maria Yee is a furniture company in California, USA. The company was founded in the United States but the story of the firm began in China. During the Cultural Revolution in China, the destruction of historical monuments motivated Maria Yee to penetrate the furniture industry. She gathered a team with expert craftsmen and began to reproduce traditional Chinese furniture models. In the early years, she used reclaimed wood and travelled to destructed sites to obtain good quality wood pieces. (Maria Yee Inc., 2011)

After locating to the United States, the company developed and introduced their sustainable material, BambooTimbre^{TM}. Use of bamboo in the furniture and construction sector is not a new idea and there are lots of bamboo furniture examples in the market. However, BambooTimbre^{TM} is an alternative for hardwood and is renewable compared to hardwood. The material is made of 100% moso bamboo, which can be harvested after five years. The physical properties of bamboo make BambooTimbre^{TM} lighter and more durable than ordinary hardwood. With the help of this technology, craftsmen in the company could augment their tacit knowledge on hardwood manufacturing towards products developed with (Figure 2.8, 2.9, 2.10).

Figure 2.8: Arial horn chair with BambooTimbreTM (downloaded from http://www.mariayee.com/index.php?sku=210104802&material=5&products_newfurnishing#pic1)

Figure 2.9: Arial horn chair with hardwood (downloaded from http://www.mariayee.com/index.php?sku=210104994&material=20&products_newfurnishing)

As well as innovating new materials, company developed new joining techniques with this new material. The joining methods (BambooJoinery™, BreathingJoinery™, AirFrame™) are used to join BambooTimber™ material (figure 2.10). These joining techniques are inspired by the traditional furniture production techniques and it enables to have joining with no visible lines and no fasteners.

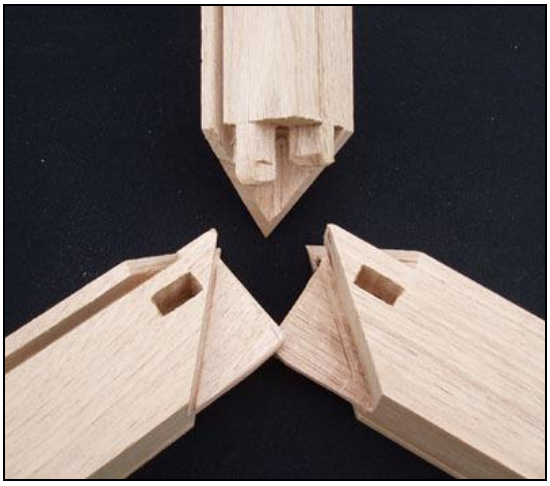

Figure 2.10: BreathingJoineryTM (downloaded from http://design-4-sustainability.com/case_studies/54--made-in-china-developing-sustainable-furniture)

In short, Maria Yee improved their products at a level of radical innovation. Their patented material and production techniques gave the company new market opportunities in transoceanic countries. Also these improvements were based on the tacit knowledge of the craftsmen working in the company. They revaluated their experience related to traditional

Chinese carpentry. Moreover, the company obtained certificates including Forest Stewardship Council (FSC), ISO 9001, and ISO 14001 with their SPD approach.

2.3.4 Hammer and Hand

Hammer and Hand is a small scale construction company specialized in the renovation of old buildings in Portland, USA. They reconstruct old buildings which are built for different purposes and transform them into the needs of a present-day home and 21st century households (Hammer and Hand, 2011). The firm considers the environmental impact of its construction sites and projects. They still pay attention to life standards of their clients and provide high quality living spaces for them while reducing their ecological footprint. To reduce their waste, the firm enhance use of locally-sourced, salvaged, recycled and non-toxic materials and use wastes generated in construction sites. They stock materials which are longer than 1.2 meter and in good condition from their project sites. As well as constructing buildings, they produce unique pieces of hand crafted furniture by using reclaimed wood and other materials in their local network. (Figure2.10)

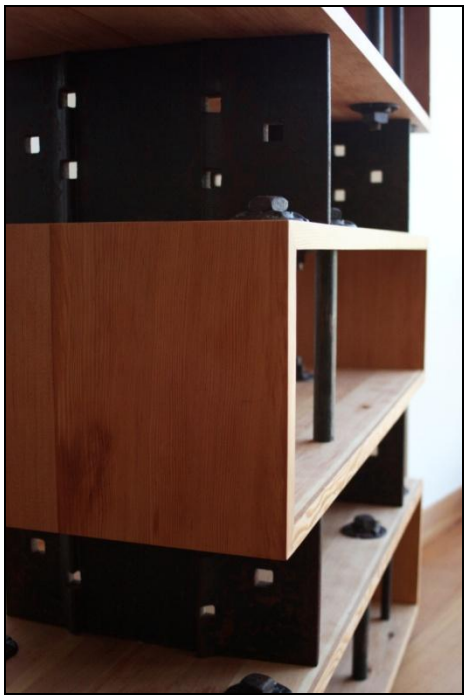

Figure 2.11: BARcode Shelf (downloaded from http://hammerandhand.com/portfolio/furniture)

'BARcode' is one of the company's 'upcycled' furniture models. All parts of the furniture are constructed from reclaimed materials. The wooden shelves are old desks which are no longer used in schools. The metal parts providing the structure are steel railroad plates and trusses. The materials are sourced locally and they exemplify the SPD approach of the

company. As well as having a differentiated appearance, BARcode helps the company to reduce material costs. The firm use scrap materials which would most probably end up in dumpsites or landfill. Moreover, considering reclaimed material as an almost finished product components, allows the firm to eliminate manufacturing methods.

2.3.5 Vitsoe

Vitsoe is a furniture company established in England. The company has been manufacturing and selling its 606 Universal Shelving System (figure 2.12) designed by Dieter Rams since 1960. Manufacturing a model and still being able to sell it for over 50 years is a very rare case in the furniture industry. In the market, most firms revise and update their models according to changing trends. However Vitsoe announces that it is against planned obsolescence and states its motto as “living better, with less, that lasts longer” (Vitsoe, 2011). In addition to its design management approach, the company has a manufacturing system different to regular furniture companies. They do not manufacture large quantities of products, nor use stock management as a sale strategy. They mention that manufacturing heaps of products and putting them onto the market is a reason for the overburden on landfill sites. Therefore the company sells its shelving systems directly to customers, with the help of sketching software accessible via its website. Customers draw the shelving system for their indoor environment and the company manufactures the required parts, shipping them directly to the customer with necessary drawings and tools.

Figure 2.12: 606 Universal Shelving System (downloaded from http://en.wikipedia.org/wiki/File:606-Universal-Shelving-System.jpg)

The 606 Universal Shelving System is based on simple design details. The system consists of: shelves in two width and four depth options, six types of drawer, and nine accessories. With these alternatives, customers can customize their furniture for home, work or public

use. Moreover, users can expand their system by adding components. They can transform their TV unit into a child's room furnishing or expand their bookshelves into their personal library in time (Figure2.13). Thus the furniture is highly adaptable to changing needs and circumstances.

Figure 2.13: Different uses of 606 Universal Shelving System (downloaded from http://www.vitsoe.com/en/gb/gallery)

Another interesting feature of Vitsoe is its sustainability approach. In short the company evaluates recycling as a failure. Mark Adams, managing director of Vitsoe, states their sustainability approach as follows:

> "... The concept is to reuse your furniture, not to have furniture that you can recycle at the end of life. We see recycling as a defeat and the news currently is all of the problems of the recycling is that there is too much to recycle. What we try to do at Vitsoe is put you in the position when you can reuse so you never have to throw away, so you never have to recycle." (Vitsoe, 2011)

2.4 Barriers to implementing sustainable product design

Barriers are mentioned as the obstacles or road blocks that companies encounter during the implementation phase of SPD in their product development processes. The barriers mentioned in the literature have direct relationship with drivers for SPD. Most of the time, the absence of the drivers also acts as a barrier to SPD. In SME cases, disadvantages or impossibilities of small enterprises turn some drivers, even if they are intended as a means of stimulus, into barriers for them. To examine these obstacles, classifying them into groups as in Table 2.4, will ease our work.

Table 2.5: Barriers to implementing SPD

SPD Studies	Organizational	Market	Product
• Complexity of SPD systems • Gap between SPD developers and practitioners • Lack of information about feedback	• Lack of top management commitment • Lack of information about SPD • Lack of experienced staff • Lack of financial resources • Lack of environmental awareness • Lack of time	• Lack of consumer demand • Commercial disadvantage • Lack of commercial benefit of SPD	• Conflicting functional requirements • No alternative solutions

2.4.1 SPD studies:

Although SPD strategies or environmental management systems (EMSs) are developed to encourage industry to adopt SPD, their structure or requirements may prevent companies doing so, especially SMEs.

- Complexity of SPD systems: EMS's or SPD guidelines are designed to deal with a range of sectors and different companies which need to concern themselves with different possible returns from sustainability implementation. As a result of these complex studies, SPD guidelines transform into huge systems with too many variables and factors to be easily actionable. This complexity makes these studies too difficult to be obtained and understood by companies with little technical capabilities.

- Gap between SPD developers and practitioners: One of the most frequently mentioned barriers in studies is this gap (Boks, 2006). Most standards or projects carried out in the literature are cooperated with research institutions, where research staff played a crucial role in product development and design,. However,

in practice the technical possibilities of research institutions are not adequate to reach the majority of SMEs in their regions. They can only achieve to execute some experimental projects with a few large companies to showcase the benefits of radical innovations rather than ecobenchmarking or ecoredesign of existing products. These 'inside the box' approaches should be available to be applied by companies on their own independently, without external help. The possible solution for this barrier is to prepare proper guidelines which are sector specific and easy to understand by people who have no experience about SPD.

- Lack of information about feedback: One of the main drivers for companies to agree to improve their environmental performance is the possible feedback resulting from the change in companies' market success (Hillary, 2004). Unfortunately, the studies over this issue are mainly focused on the implementation phase and are generally material focused. They usually mention the material efficiency or cost reductions being achieved in their results. However the studies do not give feedback about the latter stages of the project. Most of the time, researchers or companies do not give additional information about the success rate of their improved products. Yet this missing information about the market success of these products would be used to convince new companies to adopt this environmental approach.

2.4.2 Organizational barriers:

The main organizational features of companies are also another significant group of barriers. The attitude, structure or environmental culture of an organization plays an important role in decision making processes.

- Lack of top management commitment: This approach is also mentioned as a major driver for SMEs (Hillary, 2004). Most SMEs are family businesses. They are usually managed by owners or their relatives and they do not have a structured management board for their companies. Therefore the decision making process in SMEs is different from large-scale multinationals. They do not receive reports from finance or product development departments, because there are none existing in the company. However, it does not mean that managers take decisions independently. They consider their own management capabilities and technical capabilities of their companies and definitely do not let their personal beliefs to interfere organizational decisions (Ünver, 2009).

- Lack of financial resources: In spite the fact that SMEs are defined as the backbone of the economy because of their share in employment in manufacturing industries, there are serious financial problems for them to participate in

innovative processes. According to studies about OECD (Organisation for Economic Co-operation and Development) countries, SMEs are responsible for approximately 76% of total employment and 26.5% of value added in the economy, but their share in export is 10% (OECD, 2004). In the light of this data, it can be estimated that the profit margins and financial capabilities of SMEs are lower than multinational companies. Therefore it is not easy to cover the costs of SPD studies. In literature, employing a consultant or expert with SPD experience is strongly recommended but with financial impossibilities it is not feasible for SMEs to employ an expert only for sustainability issues. Moreover financial support for SMEs is scarce and companies do not have adequate information about supports services. The reason behind this barrier is the difficulty of communicating with small companies. Getting in touch with, and instructing these enterprises is expensive and requires proportionally more staff than for larger ones.

- Lack of time: Even if this barrier seems as a weak excuse at first, it is actually a critical barrier for SMEs (Pimenova and van der Vorst, 2004). Because time factor for SMEs differs from the perception of large companies. The rapid changes and crises in the economy prompts SMEs to change their goals and strategies to survive. Especially in developing and newly developed/industrialized countries economic instability leads companies to suspend their product development projects because these projects are perceived as an extra financial burden in their hard times. Moreover the time period necessary for product innovation is too long for SMEs to wait for outcomes. Therefore most enterprises are encouraged to adopt modest SPD or ecobenchmarking in the first steps rather than executing radical innovations in their companies (Crul & Diehl, 2009).

2.4.3 Market barriers:

Market barriers are significantly important for SMEs because those firms do not have the opportunity to shift markets or penetrate new markets in the way that large companies can. Most SMEs in manufacturing industries cannot export their products due to the absence of required networks to act in foreign countries. Therefore they need to act according to the requirements of their local markets.

- Lack of consumer demand: Consumer demand is a crucial factor for companies' decisions to commitment to SPD projects. On one hand, surveys in industrialized countries shows that consumer demand for sustainable products is an external driver for companies. On the other hand, in industrializing countries the absence of consumer demand for these products inhibits companies from adopting SPD. The surveys in these regions show that consumer demand is not adequate for

companies to carry the responsibilities or requirements of SPD. In these surveys, (Hillary, 2003; Seidel et al, 2009) consumers were more interested in products with lower costs or improved performance and durability. Therefore for the time being, consumer demand is not an appropriate topic to draw companies' attention to sustainability.

- Commercial disadvantage: This driver is one of the most influential driver in the surveys both in industrialized and industrializing countries (Hemel & Cramer, 2002). It is very natural for companies to refuse SPD strategies because their main aim is to continue trading and improving their commercial success.

2.4.4 Product barriers:

Unfortunately some industry sectors or products are not easy to deal with using SPD approaches. Due to the nature of some sectors or products, companies do not have options to improve their environmental performance.

- Conflicting functional requirements: Sometimes functional requirements or technological capabilities leave companies no choice of alternative manufacturing techniques or material choices. For instance, companies supplying rubber components for automotive or motor industries do not have much choice in terms of product design in their products. They have strong boundaries to safety regulations and performance expectation of their clients and they are dealing with a specific kind of material which is petroleum based with no financially feasible sustainable alternatives. Nevertheless, against all these problems, it is still possible to reduce environmental impact of products in different aspects like resource use in use life, or distribution phase in a holistic approach.

- No alternative solution: This is the no-go barrier which is a dead end for SPD projects. It is only mentioned in the survey carried with Dutch SMEs (Van Hemel, 1998). However it is the most influential barrier that even the possibility of this barrier makes companies to abandon sustainability issues inside the company.

2.5 Opportunities afforded by Sustainable Product Design

In literature, opportunities are defined in most case studies as the key elements motivating companies to implement SPD in their product development. They mostly aim to point out the strengths of companies. They are commonly referred to as motivations, opportunities or drivers. Researchers have classified them in two groups: internal and external drivers.

2.5.1 Internal drivers:

These are the factors related to the internal dynamics of companies. Their goal is generally strengthening the competitiveness of companies, and allows the company to get a stronger position in their sector. Crul and Diehl (2006) has examined drivers in the 3P approach and classified them as in Table 2.5.

Table 2.5: Internal drivers of sustainable product design (reproduced from Crul and Diehl, 2006)

People Aspect	Planet Aspect	Profit Aspect
• Social equity • Strong social policy • Governance and management systems on social aspects	• Green marketing • Environmental awareness	• Reach new consumers • Product quality improvement • Saving costs • Boost brand image • Product innovation • Brand differentiation • New opportunities for value creation

It is obvious from Table 2.5 that internal drivers are more dominant when profitability is in question. Most companies are willing to adopt SPD if they are convinced that they are going to make more money with more sustainable products.

Social equity: One of the common options of SPD is adoption of total quality management systems. With the help of these systems, companies can accommodate the requirements of companies acting in developed economies. Also SPD can help SMEs to provide better life standards for their employees. As with in Masera's case study mentioned earlier in the chapter, SPD can increase income of local artisans working in local small enterprises. In this way, SPD can reach the majority of a population who are relevant to these SMEs and maintain social equity.

Green marketing: Implementing SPD in companies and producing more environmentally friendly products can help these companies shift into new market segments with fewer competitors and increased profit margins. Moreover, green marketing can help companies to enhance their brand image in the eye of stakeholders.

Environmental awareness: This is one of the most frequently mentioned drivers in case studies with SMEs. Most SMEs in both Turkey and foreign countries are family businesses and they do not have a structured management policy. Generally top managers are also the owners of these companies and their influence is felt by having the last word in many areas of decision-making. Thus the success of SPD in these enterprises is closely related

with the environmental awareness of owners. In 2009, Ünver prepared his thesis on the managerial attitude of Turkish SMEs regarding environmental issues. The study showed that the personal attitude of manager is not a significant factor. In fact, managers' educational background helps them to be more aware of the possible benefits of SPD for their companies and convince them to trust in the capabilities of their firm (Ünver, 2009).

Reach new consumers: This driver has two basic options. The first is new market opportunities in developed countries, where higher environmental expectations are to be found. SPD can help firms to collaborate with large-sized companies from foreign countries and use their partners' distribution network in order to export their products. The second option is to reach new niche markets at a local level. Surveys show that an increasing number of consumers demand products with lower environmental impact on ethical grounds (Crul et al, 2009).

Product quality improvement: Manufacturing better quality products is a common goal among all companies because it will help them to get a fixed market share, with a large constituent of loyal customers. Structured product development strategies are useful for most large-sized companies to improve product quality (Ulrich & Eppinger, 2008). Fortunately, SMEs have the opportunity to adopt SPD with relatively low SMEsinvestments.

Boost brand image: Brand management is widely considered by large-sized companies rather than SMEs. The main reasons behind this can be stated as:

- Absence of brand formation in SMEs
- Absence of public pressure
- Lack of financial resources for promotion of brand

It is common among SMEs that they may not have a strong brand formation and it may result in inadequate benefit from corporate responsibility projects (Jerkins, 2004). Also public pressure is concentrated on actions of large corporations rather than SMEs (Hillary, 2003).

Saving costs: Cost reduction is the most attractive internal driver for companies. To achieve this, companies use different strategies according to their stakeholders, markets or products. In general, material reduction is one of the most applied strategies to reduce production costs. It has effect on both the environmental impact of a product and the profit margin generated through SPD. In Masera's case of the Casas Blancas chair; material reduction both improved the profit margin and reduced the use of local timber resources, which is essential for maintaining the ecosystem. Another way of saving cost is revaluating the distribution system of the company. Hammer and Hand is a good example: the company reclaims material from local building sites and discarded items. In this way, they

reduce costs of both material and production costs and they reduce financial end environmental costs of transportation. If the company used untapped timber, these resources would originate from timber exporting countries such as Canada or Brazil.

Product innovation: Generally the term 'innovation' is perceived as a combination of large investments and the presence of R&D departments. However, innovation can be achieved by many companies which are willing to commit. Crul et al. (2009) graded product innovation levels in three groups (incremental, radical and fundamental innovation).

Incremental innovation: Also known as ecoredesign, is the lowest level of product innovation in SPD. In this approach, a firm makes small changes in their existing products. It helps companies to improve their products in terms of sustainability. Incremental innovation is also known as "bread and butter" for product development in many firms (Crul & Diehl, 2006). Due to a low risk factor and investment requirement compared to other innovation levels, companies prefer to carry out redesign projects rather than radical changes.

Radical innovation: This innovation approach is based on changing existing products and processes. It bears more risk and requires more investment, both financially and with respect to qualified labour investment. Also it takes more time to achieve a result from these projects. Therefore companies are not so open to execute radical innovation, even if they have adequate equipment and resources to do so. The uncertainties of this approach jeopardize companies' motivation, but the greater risk factor also has a greater return possibility.

Fundamental innovation: This innovation level is achieved by new scientific knowledge and creating new industries resulting in a paradigm shift (Crul & Diehl, 2006). The success rate of fundamental innovation is related with scientific and technological capabilities of an enterprise. A good example for this approach is the case of Herman Miller. Herman Miller cooperated with the McDonough Braungart Design Chemistry (MBDC) to improve their products' environmental performance. After classifying materials that they use, the firm made incremental changes in its supply chain. They have carried out new material researches. After five years the company introduced the Aeron chair and was granted more patents with that product than any product they had designed before. It is not easy to implement a project that changes the whole supply chain over a period of many years. Therefore fundamental product improvements are generally made only by large scale multinational companies.

2.5.2 External drivers:

These factors are related to the motivations caused by actors or stakeholders outside of a company. (Table 2.6) In developed countries external drivers have more impact because of the fact that outsourced actors (governments, NGO's, consumers, etc.) are more active in these economies.

Table 2.6: External drivers of sustainable product design

External Drivers		
People Aspect	Planet Aspect	Profit Aspect
• Public opinion • NGO pressure	• Legislative requirements • Disclosure requirements • Ecolabelling schemes • Consumer organization requirements • Pressure from dedicated environmental groups • Direct community neighbour pressure	• Norms and standards • Subsidy schemes • Suppliers competition • Customer demand • Market competition

Public opinion: Beyond customers, society in general is concerned with environmental and social problems and they expect enterprises to play their roles in these contexts. The attention of enterprises' against environmental issues helps them to enhance their brand image and gain reputation in the eyes of society. In other words, by implementing SPD, companies can reach new consumers and increase their market shares.

NGO pressure: Apart from governmental agencies, nongovernmental organizations are focused on social and political issues related to many subjects. They have influence both on governments and enterprises. Generally people understand NGO's as non-profit associations, however NGO's can also be profit-making agencies such as industry lobbies, chambers of commerce, etc. These organizations have impact on enterprises via their public relations. They can harm companies' reputations by boycotts or press declarations. The influence of NGO's on public opinion makes them an important driver for companies. The Forest Stewardship Council (FSC) is a good example of how NGO's and companies cooperated to find a solution for an environmental problem. In 1999 IKEA, which is one of the largest furniture companies in the world, adopted a FSC certificate (a global ecolabel for sustainable timber management) because of the pressure from Greenpeace and other environmental NGO's (IISD, 2010). Unfortunately, most NGO's are concerned only with large companies or associations. They do not pay adequate attention to SMEs in manufacturing sectors.

Legislative requirements: Governments of both industrialized and industrializing countries are studying their legislation about sustainability. They are designing their policies in order to reduce environmental problems and related outcomes. However in most newly industrialized countries, as in Turkey policies are rehabilitating but still it is not adequate for prevention (UNIDO, 2001). The introduction of new environmental policies is a challenge for companies and SPD can help companies to achieve successful results while dealing with these new policies.

Ecolabelling schemes: Generally ecolabels are used to encourage enterprises to improve their environmental performance by NGO's. However, in order to adopt ecolabelling standards in products, a company should be active in a market where consumers are willing to pay for ecological products. For instance, lack of customer demand is mentioned as the main obstacle against the success rate of ecolabelling for the furniture sector in the European Union (Bärsch, 2001). In other words, these labels function as a medium to ease communication between consumers and companies and also enhance their corporate image. Another example for a global ecolabel is the FSC certificate (Forest Stewardship Council) which is related to sustainable management of forestry. In the early 1990's, NGO's from different regions in the world were concerned with sustainability issues when the United Nations organized its Rio Summit in 1992. Between 1990 and 1993 the FSC worked to find support and structure for a FSC certification system in ten countries. In ten years, 40 million hectares of forests have been FSC certified.

Norms and standards: Standards considering sustainability are becoming more severe and a must for companies to compete in their markets. Therefore enterprises are committing to the requirements of standards related to their sectors. If we scan most common standards related to sustainability, we can classify them as related to working conditions, environmental and public health. The most common standard adopted by companies are generic ISO standards. These standards are applicable for all companies regardless of their size or sector. ISO 14000 is a family of standards constituting an Environmental Management System (EMS), which is focused on the environmental impact of companies. It is a developed version of ISO 9000 in terms of sustainability and still it is continuing its development progress. Although the main motivation behind the development of this standard is the awareness of enterprises about their environmental impact, reality shows that companies adopt these standards mainly to get business advantages and to protect themselves from legislative pressures (Gelber, 2009). The standard has been developed according to important points mentioned in literature studies. Now the ISO 14000 family of standards includes additional guidance concerning materials for SPD, as shown in Table 2.7.

Table 2.7: ISO 14000 family of standards (ISO, 2009)

Standard number	Standard topic
ISO 14001: 2004	Guidelines for generic EMS
ISO 14004: 2004	Additional guidelines for implementing ISO 14001
ISO 14005: 2010	Guideline for implementation of EMS particularly for SMEs
ISO 14006: 2011	Guideline for implementation of ecodesign
ISO 14020: 2000	Principles of ecolabels and declarations
ISO 14031: 1999	Guide for evaluating and reporting environmental performance of products and services.
ISO 14040: 2006	Guideline for Life-Cycle Assessment (LCA)
ISO 14045: (upcoming)	Principles and requirements for eco-efficiency assessment
ISO 14064: 2006	International greenhouse gas accounting and verification

As well as general standards there are specific and regional standards for different purposes. For instance, the UK has its own environmental standards and ISO has specific standards for specific industries. ISO has 24 furniture specific standards generally about the safety, strength and durability of products.

2.6 SMEs and sustainability

2.6.1 Definition of SMEs in EU and Turkey

The term Small and Medium-Sized Enterprises (SMEs) is a widely used term in the classification of company size and capability. There are different definitions of SMEs in national economies. These differences result from the diversity of economic structures, market size, industrial sectors, levels of industrialization or manufacturing patterns (Cansız, 2008). The most commonly used parameters in the definition of SMEs are the number of employees, annual turnover and annual balance sheet.

According to the statistics, the definitions show differences in different regions (Table 2.8). These differences are necessary to develop policies about SMEs. The differences in manufacturing sectors may require different standards for SMEs. For instance in USA, the definition is stated as small businesses rather than SMEs. Besides the number of employees, they consider the industry sector as a parameter to define the size of a small business.

Table 2.8: Definitions of SME in different regions of the world (EC/ENTR, 2005; U.S. SBA, 2010)

Country	Definition of parameter	Micro enterprise	Small enterprise	Middle enterprise
Turkey	Number of Employee	≤10	≤50	≤250
	Annual Turnover	≤1 million TL	≤ 5 million TL	≤ 25 million TL
	Annual balance sheet	≤ million TL	≤ 5 million TL	≤ 25 million TL
EU	Number of Employee	≤10	≤50	≤250
	Annual Turnover	≤ 2 million Euro	≤ 10 million Euro	≤ 50 million Euro
	Annual balance sheet	≤ 2 million Euro	≤ 10 million Euro	≤ 43 million Euro
USA	Number of Employee	≤ 500 (For manufacturing industries) ≤100 (for trade industries)		
	Annual Turnover	≤ 7 million (retail and service industries) ≤ 33.5 million (General industries) ≤ 14 million (special trade contractors) ≤ 0.75 million (*agricultural industries*)		

2.6.2 Role of SMEs in sustainable development

The main focus of SPD is generally related to the environmental outcomes gained by product design. Therefore one of the critics about these studies is the fact that they are focused on materiality too much. However, most of the tangible effects of unsustainable industries are generally related to their environmental impacts. These impacts are not only related to nature. In a deeper sense, it is related with a wider range of issues which turn into social and economic impacts in time. However, it is not true that SMEs always have a greater ecological footprint than large-sized companies. It is related to the sector and the level of industrial development. SMEs in newly industrialized countries produce more pollution than large-sized companies while in under industrialized countries the results are the opposite (Hillary, 2000).

2.6.2.1 Environmental impact of SMEs

The environmental impact of SMEs can be classified as follows: (Crul & Diehl, 2006)

- Resource depletion
- Ecological damage
- Public health damage

Resource depletion is one of two most frequently mentioned environmental impacts of industry and consumption. NGO's usually focus on this issue (fresh water shortage, scarcity of fossil fuels for the future, deforestation, etc.) in their social media projects. For SMEs, resource depletion results in high material costs, which is an economic disadvantage and makes SMEs to seek new ways to purchase low cost materials. Sometimes these tactics

may be even illegal. For instance, in furniture industry, SMEs can purchase timbers harvested from tropical forests, which is forbidden by legislations.

In terms of ecological damage, SMEs in industrializing and under industrialized countries are crucial because untouched natural resources (rainforests, freshwater resources, etc.) in these regions play an important role in global ecologic balance and the majority of the world population lives here by consuming very little resources (Lentz, 2001).

Also because of the financial problems and lack of support, SMEs prefer materials and manufacturing processes with the lowest financial burden. These companies cannot reserve money for waste treatment equipment or use high quality and more expensive materials. This results in water and air pollution and use of carcinogen releasing materials in products.

2.6.2.2 Economic impact of SMEs

The goals of sustainable development were always set and mentioned with general terms and at macro scales. Therefore, at the early stages of sustainable development studies, most regulations and pressures were focussed on multinational companies. Dealing with large scale companies was easier to follow and analyze due to their number and qualifications. However, the cumulative impact of SMEs on national economies was realized to have more effect than multinational large-scaled companies (Table 2.9).

Table 2.9: The role of SMEs in countries (reproduced from KOSGEB, 2011)

Country	Share in total number of enterprises	Share in total number of employee	Share in total added value
USA	98,9[b]	57,9[b]	50[h]
India	97,3[e]	66,9[e]	
Japan	98,2[b]	66[b]	49,3[b]
S. Korea	99,9[f]	87,7[f]	49,2[f]
Brazil	99,9[e]	67[e]	
Malaysia	99,9[e]	65,2[e]	31,2[e]
EU 27	99,8[c]	67,4[c]	57,7[c]
England	99,6[b]	54,1[b]	51[b]
Germany	99,5[b]	60,4[b]	53,6[b]
Italy	99,9[b]	81,1[b]	71,3[b]
Turkey	99,9[a]	78[a]	55[a]

a: TurkStat, 2009; b: OECD SMEs, entrepreneurship an Innovation 2010 (data of Japan is related to industry sectors); c: European Business Facts and Figures, 2009; d: OECD SME and entrepreneurship Outlook, 2005; e: International Finance Corporation, 2007; f: Small and Medium Business Administration – Korea, 2008 (added value is related to manufacturing sector); g: SME Corp Malaysia, 2009; h: Journal of ınternational Business and Economics, 2008

2.6.2.3 Social impact of SMEs

The social objectives of SPD are closely related to the sustainable development literature and this literature aims are holistic improvements related to society. As with economic

impacts, the fact that SMEs cover a great deal of share in manufacturing industries makes their social impact crucial. The general social impacts of SMEs can be traced to the following (Crul & Diehl, 2006):

- Reduction of local unemployment
- Reduction of income inequity
- Enhancing local economic growth
- Development of communities

In the literature it is mentioned that SMEs can use both high and low level technologies. The flexible structure of SMEs makes them appropriate for the trial of new technologies and specific manufacturing technologies. However, manufacturing SMEs are usually active in labour intensive industries, like furniture industry is one example. They use low-level technologies and employ more people than large sized companies in their manufacturing facilities. The traditional manufacturing techniques and craftsmanship give these companies an opportunity to differentiate and compete with large sized companies. In spite of the fact that it can result in low labour incomes, SMEs still provide employment opportunities for a wider share of society.

The higher employment rate in regions helps to achieve more homogenous income distribution. The income equity is crucial for fighting poverty, which is a serious problem in industrializing countries. If we consider the rate of SMEs in both employment and manufacturing in these regions, and the fact that the majority of large-sized enterprises are dependent upon foreign investments, SMEs are the key element for creating economic stability. Moreover, SMEs are potential firms to become tomorrow's large-sized companies. The growth of these local enterprises will probably result in higher income rates and better quality of life for people employed in these institutions.

2.6.3 SMEs and the Turkish furniture industry

2.6.3.1 Influence of SMEs in Turkish economy

Between 1954 and 1970, developed economies focussed on supporting large-sized companies for economic development and wealth creation. By 1985, the unemployment rate in the EU had risen up to 12% and European Commission began seeking a solution to the unemployment problem (Çınar Ay, 2008). The results of the research have revealed that SMEs can be a key factor for generating employment and since 1980's SMEs have been supported to create job opportunities. This strategy has been adopted too much later in developing economies, especially in neo-liberal economies. Today, both in developed and developing economies, SMEs generate the majority of employment and manufacturing.

Besides employment generation, SMEs have various advantages compared to large-sized enterprises in developing countries. In the first place, SMEs require less investment and their less bureaucratic structure allows them to adapt to economic fluctuations. Also SMEs are key factors for developing new sectors or markets, especially in manufacturing industries. Most new manufacturing techniques are carried out by SME entrepreneurs in industry.

Table 2.10: Share of SMEs in Turkish economy (TÜİK, 2008) (TÜİK, 2009) (BDDK, 2011)

	SMEs
Share in employment	78%
Share in added value	55%
Share in sales	65,5%
Share in investments	50%
Share in exporting	59%
Share of SME support credits	24%

As shown in Table 2.10, besides constituting 99.9% of all enterprises Turkish SMEs employ 78% of the workforce. Unfortunately; despite their share in employment, the share of support credits for them is only around 24%. From these numbers, it can be estimated that it is possible to improve wealth generation of SMEs by developing better support programmes.

2.6.3.2 SMEs in the Turkish furniture industry

The Turkish furniture industry can be analysed in structure and regional distribution. According to studies and statistics from the State Institute of Statistics, the Turkish furniture industry consists of 99.9% micro and small-sized enterprises and 0.01% medium and large-sized enterprises (Demirci & Efe, 2006). The distribution of furniture companies across the country (Table 2.11) is related with market concentration and raw material procurement.

Table 2.11: Distribution of furniture companies in leading cities (Ministry of Industry and Trade, 2011)

City	Number of firms	Number of employee
İstanbul	6458	35.633
Ankara	5361	30.062
İzmir	2379	14.142
Bursa	2130	16.096
Kayseri	740	16.096
Others	12278	42.000
Total	29346	158.213
Retail trade	32.382	100.000
Total	61728	258.213

According to Table 2.11 İstanbul is the leading furniture industry centre both in number of companies and employees which is followed by Ankara. However, the average number of employees per company is 2.7 (in Ankara) the lowest average above other leading cities while Kayseri firms employ 11.7 personnel each, the highest number in the industry (Ministry of Industry and Trade, 2011). According to these numbers, it can be estimated that the furniture industry in Ankara is constituted by mostly labour intensive small enterprises while large scale enterprises are more dominant in Kayseri. Besides, it is stated that Kayseri is the centre of export of the Turkish furniture industry, fulfilling one third of total exports in the sector (Küçükaslan, 2010).

In the last decade, the share of medium and large-sized enterprises is increasing because of the promising future economic benefit. The reason of the dominant share of small companies in the industry is the fact that furniture manufacturing is based on traditional craftsmanship techniques. The tacit knowledge of craftsmen reduces the investment requirement and allows use of low-level technology.

Unfortunately, SMEs are regarded as one of the main barriers against the economic growth of the furniture industry because exporting to foreign markets is stated as the main growth factor whilst the export potential of SMEs is relatively low than large-sized companies (Okşak, 2009). However there is a dilemma in this argument because the importance of the furniture industry is elevated from using low imported materials and the employment ratio in manufacturing. The low cost of imported materials is resulted from the performance of SMEs in subsidiary industries. Most product details and parts in furniture manufacturing do not require high-tech facilities and are produced by SME suppliers. Also the main barrier against exporting is mentioned as the absence of design departments in SMEs. Branding and trend management are other weaknesses of the Turkish furniture industry and a solution is to extend design projects in the market and improve R&D support (Söğütlü&Eroğlu, 2009).

CHAPTER 3

FIELD STUDY

3.1 Introduction

In this chapter, the preparation phase of the field study is explained in terms of selection of the industry sector, selection of participant groups and individual participants, selection of the data collection method, and design of the interview question sheet. Then, following an account of the data analysis method, the remainder of the chapter presents the results of the field study structured according to participant groups A, B and C, alongside cross-group comparisons for each of the topics covered during the interviews.

3.2 Selection of industry sector

The selection of the industry sector (furniture) is based on two reasons. The first is that the furniture industry is one of the sectors with a large representation of SMEs, capable of fulfilling product requirements and manufacturing products in their own facilities with no outsourced support. The second reason is that design, different from other sectors, is a dominant element in differentiating furniture products and obtaining market share. Additionally, in most sectors high product quality is dependent on high technology and new manufacturing system, whereas small furniture companies can manufacture high quality furniture by means of product design combined with the tacit knowledge of their crafts based workforce.

After Istanbul, Ankara is the second most concentrated region for furniture design and manufacture in Turkey (Ministry of Industry and Trade, 2011). Within the city of Ankara, Siteler is one of the largest furniture industry clusters in Europe, with the majority of enterprises classified as SMEs. The findings from this study may help to boost the commercial activities of the enterprises in this cluster. Furthermore, product designers in Ankara frequently cooperate with these furniture manufacturers. For these combined reasons, the furniture industry, and in particular enterprises based in Ankara, were considered ideal subjects for the study of SPD within SMEs.

3.3 Selection of participants

Participants for the field study were selected from amongst furniture manufacturing SMEs and freelance designers collaborating with furniture manufacturing SMEs. The following parameters were set to guide participant selection.

- Firstly, companies in the field study had to fit in the definition of an SME for Turkey, as provided in the literature. The common parameter in the definition of an SME is the number of employees of the enterprise. Therefore this was the most important factor for deciding whether or not an SME could participate in the study. The annual turnover of an enterprise is second in the SME eligibility evaluation, because profit ratios and earnings differ according to industry sectors and there is no specific regulation related to annual turnover in different sectors in Turkish institutions' definitions. Moreover, as revealed through the pilot study (see section 3.5), most micro and small sized enterprises would have problems mentioning their annual turnover during interviews because of confidentiality problems.
- Secondly, in relation to product development, participant companies were required to have their own product development departments, or at least one expert or responsible individual dealing with product development. In short, candidate companies were required to be developing their own product lines and putting them on the market.
- The third parameter took into account the decision-making processes of the candidate companies, and was highly related to the second parameter. Besides developing their own products, companies were required to use their firm's own brand name(s) for their products. In other words, they were not permitted to be a subcontractor supplying to large-sized companies. The reason behind this criterion was the fact that most SMEs collaborating with large-sized companies are influenced by contract requirements offered by their clients. Many SMEs are supplying product components or finished products and total quality standards hold all manufacturing stages and stakeholders responsible for quality control. The holistic approach of these standards is useful to governmental institutions for controlling and reaching further companies. However, candidate companies were not permitted to fall into this profile because data derived from such sources may distort the findings over the motivations of SPD for SMEs.

Accordingly, as shown in Table 3.1, personnel from sixteen furniture manufacturing SMEs (participant groups A and B) and five professional furniture designers (participant group C) were secured as participants. The participant groups reflected differences in the presence of a design responsible person(s) within the enterprise.

A mix of 'convenience sampling' (choosing the participants according to their availability) and 'snowball sampling' (choosing additional samples with reference of prior participants) was used to source the participants, mostly because networking resources related to the

furniture industry in Ankara were found inadequate. For example, websites of industrial clusters or sector organizations related to furniture manufacturing in Ankara were mostly not up to date and information about the enterprises in these websites did not include data about their numbers of employees or product design capabilities.

Table 3.1: The definition and number of participant of the groups in the field study

	No. of participants
Group A: Without personnel solely responsible for design	10
Group B: Employing personnel solely responsible for design	6
Group C: Freelance designers collaborating with furniture manufacturing SMEs	5
TOTAL	21

3.4 Data collection method

Interviewing was chosen as the data collection method because it promises advantages regarding the quality of the data. Firstly, compared to distributing questionnaires, presence of the researcher during the interviews (either telephone or face-to-face) allows researcher to interfere during the interview sessions more easily.

To ease implementation of the study, interviews were executed with participants using face-to-face communication rather than telephone or e-mail interviewing. Only furniture designers were communicated by e-mail after the interview sessions because they were available by internet sources (web page, e-mail address, etc.) compared to furniture manufacturing SMEs. In order to ensure that interviewees understood the meaning and intent of the questions correctly, interview sheets were used as a guide during the interviews (See Appendix A & C).

3.5 Pilot study

A first-generation of pre-formatted interview sheet was designed and produced for use during a pilot study, conducted with two furniture manufacturing SMEs located in the Siteler region of Ankara. The pilot study helped reveal ways in which sections of the interview could be revised, as well as some adjustments to the interviewing technique. For example, in order to save time, open-ended questions that appeared in some sections of the interview were shifted to ‘yes/no’ or multiple choice questions. Furthermore, some of the ‘yes/no’ questions were required to be supported by a passage of text to provide a brief explanation on the purpose of the questions and their role within the field study. For the sections of the interview asking participants to rate SPD drivers, barriers and strategies, it

was found necessary to add a brief description for some SPD terms and strategies, to improve participants' understanding.

3.6 Finalized design of pre-formatted interview sheet

Two interview sheets were prepared: one for designers and one for furniture manufacturing SMEs. Appendices A, B, C and D contain the two interview sheets presented in both the original language (Turkish) and translated language (English). In the designers' version, the first four sections concerning connections, proficiency and feedback of furniture enterprises are altered. Questions specific to enterprises' connections and organisational structures in the first and second part of the interview are removed, whilst in the third and fourth sections, questions on design activities are revised to reflect a designer's perspective. The following sections, greater details about the individual parts of the interview are provided.

3.6.1 Information about the firm

The interviews were carried out after providing a brief introduction about the aim of the study. In the first part of the interview, questions were based on the overall qualities of the firm, mostly to confirm that it was indeed eligible to be classified as an SME. However, personnel of the furniture manufacturing SMEs were not willing to disclose their company's turnover; therefore, the number of employees, as previously mentioned, was considered as the main criterion for confirming companies' SME status.

3.6.2 Connections of the firm

In the second part, the questions are targeted to find out the relations of the firm with business organizations and other companies with which they cooperate. By analysing studies, news and web sites related to woodworking industries, it was possible to construct the list of business organizations related to manufacturing industries generally, and furniture industry specifically. The motivations behind the membership of firms to these organizations were also investigated through the interview.

3.6.3 Proficiency of the firm

In the third part, the proficiency of the firm in relation to SPD is questioned. Firms were asked whether they have any environmental standards or if they received any training about SPD. Additionally, the importance of tacit knowledge was probed; however, it was necessary to provide a brief definition and explanation of tacit knowledge.

3.6.4 Industrial design activities in the firm

The fourth section of the interview is based on the product design activities of the participating firms. The first questions were set to confirm that product development projects are indeed carried out within the participant firms. Subsequently, questions were posed to find out details about the firms' product design process. The existence of a product designer was queried because experts from different disciplines usually carry out product development (e.g. industrial design, engineering, architecture etc.), or sometimes the owner of the enterprise takes on responsibility for design – referred to as "silent design" in the literature (Walsh et al, 1992). The presence of silent design in the furniture industry can be traced to the fact that the creation of furniture is mostly evolved from crafts skills, whilst the economic limitations of SMEs force them to apply dematerialization in order to reduce expenditures related to product development in the company (Öztürk Şengül, 2009). The influence of designers on product development, manufacturing and supply was also enquired, because in most studies the influence of design is used as a motivation for SPD. If it possible for design responsible personnel to have an influence on these issues, then most SPD strategies related to the manufacturing phase of a product can be implemented.

3.6.5 Consumer/client feedback

In the fifth part of the interview, two questions relating to consumer feedback are asked, to find out whether firms use their advantage of being in touch with their consumers.

3.6.6 Drivers of sustainable product design

The sixth part of the interview deals with drivers of SPD. Before asking for ratings of the drivers, participants were informed briefly about what the role of drivers is within SPD. If we consider all of the drivers in the literature, there are too many to evaluate or rate during a single interview. Therefore, the most frequently mentioned drivers were selected from amongst the total of possibilities. Additionally, participants were asked to name any drivers that were not mentioned during the interview, to try to elicit any missed interesting drivers specific to the furniture industry. The 'drivers' part of the interview was divided into 'internal' and 'external' drivers, in an attempt to uncover which broad category of drivers was most influential. Data generated from this part of the interview was anticipated to be useful for uncovering possible reasons behind the presence or absence of these drivers. The external and internal drivers mentioned in the interview, gathered from previous studies, are listed in Tables 3.2 and 3.3.

Table 3.2: External drivers of SPD (van Hemel & Cramer, 2002; Hillary, 2003; Boks, 2006; Crul et al., 2009)

External drivers of sustainable product design
• Public opinion • Legislations • NGO pressure • Norms and standards • Customer demand • Supplier demand • Market competition

Table 3.3: Internal drivers of SPD (van Hemel & Cramer, 2002; Hillary, 2003; Crul et al., 2009)

Internal drivers of sustainable product design
• Export opportunities • New market opportunities in local market • Cost reduction • Improving brand image • Improving product quality • Environmental awareness of the company • Long term innovation opportunities

3.6.7 Barriers to implementing sustainable product design

In the seventh part of the interview, the topic is barriers to implementing sustainable product design. The mentioned barriers were selected based on their high frequency of mention and influence within the literature (Table 3.4). Participants were informed about barriers with a brief definition , such as that in section 3.6.6 referring to the drivers. Participants were asked to rate the influence of the mentioned barriers and to highlight their specific obstacles. Data on the barriers was collected so as to complement the data collected on drivers.

Table 3.4: Barriers to implementing SPD (van Hemel & Cramer, 2002; Hillary, 2003; Boks, 2006; Crul et al., 2009)

Barriers
• Economic stability of the country • Financial limitations • Insufficient financial support • Lack of time • Not to have long-term strategy in the organization • Not to have top management commitment • Lack of information • Lack of used tools • Complexity of sustainability tools • Gap between the developers and practitioners of SPD • Lack of consumer demand • Not to be seen as a commercial benefit • Conflicting with product features • No alternative solutions

3.6.8 Sustainable product design strategies

In the last part of the interview, participants are asked to rate the frequency of use of SPD strategies in their product development projects. The majority of the SPD strategies were sourced from the Ecodesign Strategy Wheel (as presented in p10). Having analysed the SPD strategies in the LiDS Wheel (lifetime Design Strategies), some changes and additions were made to the presented SPD strategies so as to be easily implemented in the study (Table 3.5).

SPD strategies related to material selection / diversity and consumables repeat for different levels and stages of SPD. In most furniture SMEs, no specific materials or manufacturing techniques are being used for later stages in product lifecycle such as maintenance, end of life. In other words, most SMEs are using common production methods in their facilities for both production and maintenance (Söğütlü & Eroğlu, 2009).

The use of local resources is mentioned as a strategy outside of the LiDS Wheel, because availability of local resources in furniture manufacturing is more plausible than for most other industries. Use of local resources is a strategy for both reducing environmental damage (arising from distribution and supporting economic development at a local level by strengthening local suppliers) and forming local networks (in order to spread SPD knowledge among SMEs).

Another topic revaluated amongst the strategies is the environmental impact of products during their useful life period; this is an important issue dealt with in many sectors, especially in consumer electronics and automotive industries. The water and energy use of a washing machine or television, for example, is influential on that product's ecological

footprint. Another example, for the automotive sector, is the use of fuel and maintenance costs, both financial and environmental. These factors are important not only in sustainability but also they influence consumers' purchasing preferences. However, there is no use of resources or energy during the lifetime of furniture, unless repair or maintenance is required. For this reason, resource use during the product lifetime is shifted to maintenance requirements.

Another important strategy is for a product to gain value in time; this is mentioned as "classic design" within the LiDS Wheel. However, there is a difference between these two concepts. While classic design helps companies to continue manufacturing their models for a longer period of time, gaining value in time also extends the life-time of their products. This strategy is not widely adopted by companies because product development is influenced by marketing factors, which in turn are an influential factor for the rapidly changing trends in decorative products. Most companies regenerate their products and manage their stocks according to these trends. Moreover, many household products, including furniture, find themselves in dump trucks and landfill sites because people have a tendency to change their belongings more rapidly to catch trends or fashions. However achieving a classic product status, or even a collectible status, can help companies to deal with planned obsolescence and build a stronger stand in the marketplace. In addition to lowering manufacturing costs and increasing profit margins, firms can survive without any negative environmental impact arising from changing manufacturing equipment rapidly. In other words, gaining value or classic status can help companies achieve "sustainable business".

In addition to the strategies mentioned above, product development strategies related to product functions are moved into the product features section, and replaced with two new strategies: 'adapting to new technologies' and 'developing know-how'. Unfortunately, a problem was noticed relating to these two strategies. In the pilot study, participants mentioned these topics as being essential, in an ideological sense, regardless of their actual consideration during product development considerations. It was realized that participants perceive these concepts as tools for constructing a good corporate image. With this in mind, these two new strategies were transferred to the 'drivers' section of the interview, so as to examine their validity.

Table 3.5: SPD strategies mentioned in the interview sheet, divided by subheadings

Material Use
• Using materials harmless for the environment • Using recyclable materials • Using recycled materials • Reducing material use • Reducing material diversity • Reducing material weight • Reducing product dimensions • Using local raw materials • Using environmental friendly materials for packaging
Manufacturing Stage
• Reducing manufacturing stages • Reducing energy consumption • Improving transportation efficiency • Selecting transportation type with lesser effect on the environment • Shortening transportation distances • Reducing wastes • Using clean energy resources
Product Features
• Manufacturing durable products • Designing multifunctional products • Designing modular products • Ease of disassembly of the product/s • Ease of transportation of the product/s
Extending Life-Time of Products
• Reusing the product/s • Ease of maintenance • Gaining value in time • Remanufacture of disassembled parts • Recycling via ease of disassembly • Renewing components of the product
Product Development
• Adapting to new technologies • Developing know-how at the company

CHAPTER 4

FIELD STUDY FINDINGS

4.1 Introduction to field study findings

As mentioned before, the field study was conducted with three different groups formed on the basis of their different perspectives about the furniture industry and product development. From this point forward, the groups will be labelled as in Table 3.7:

Table 4.1: Description of participant groups

Group name	Description
Group A	Furniture manufacturing SMEs employing no design responsible personnel
Group B	Furniture manufacturing SMEs employing design responsible personnel
Group C	Freelance furniture designers

In the following sections, the results of the interviews will be reported in detail. The broad approach taken was to first analyse the data group by group, and then to make cross-group comparison to evaluate differences among groups compared to others.

4.2 Participants' connections

In this section, furniture manufacturing SMEs' connections in their industry are analysed. Therefore the results are gathered from interviews conducted with Group A and B only.

Group A – no designer

In Group A, participants were mostly members of organizations which are obligatory by legislation. In detail, organizations mentioned by participants were Chamber of Commerce (100%), Chamber of Furniture Makers and Carpenters (90%), Small and Medium Enterprises Development Organization (50%), Chamber of Industry (30%), Turkish Exporters Assembly (10%). None of the participants was a member of sectorial organizations such as Association of Turkish Furniture Manufacturers, Association of Furniture Industry Businessmen, Office Furniture Industrialist's and Businessmen Association. Reasons of participants for their membership in these organizations are illustrated in Figure 4.1.

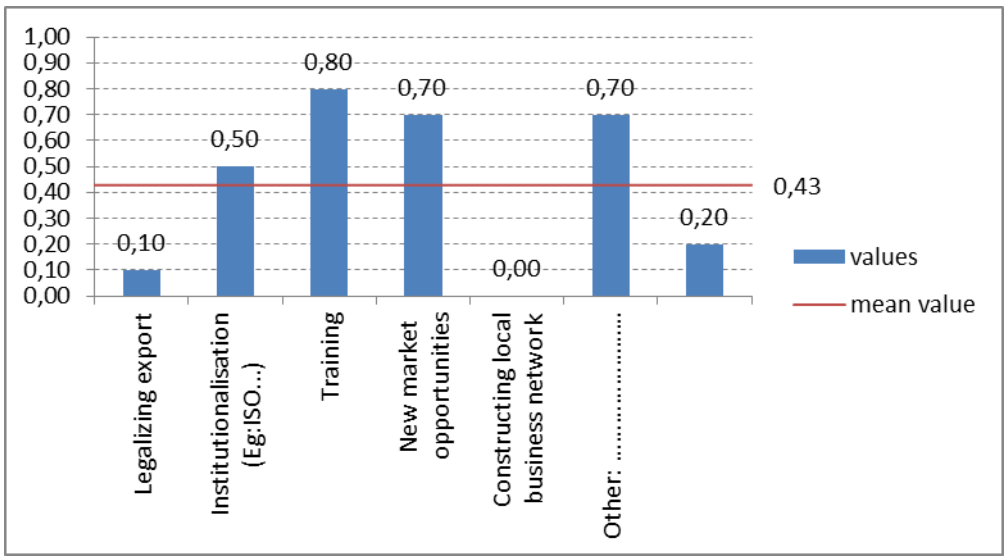

Figure 4.1: Reasons of membership to industrial organizations (Group A)

Three reasons have high values in the study: training (80%), new market opportunities (70%) and consultancy, which was mentioned in the "other" category. Although training was mentioned as the most common reason, participants mentioned they cannot get adequate training possibilities. However, they mentioned visiting furniture fairs, with the help of these organizations also helps them to follow current trends in the market. According to participants, organizations should lead SMEs in their path and function, as an equivalent for consultancy firms which cooperate with their large scale competitors. "New market opportunities" had the second highest score in the study and it is again closely related with the sectorial fairs. These events are mentioned as helping furniture manufacturing SMEs to get in contact with other actors in the market.

Group B – in-house designer

In Group B, the distribution of participants' membership was as follows: Chamber of Commerce (100%), Chamber of Industry (83%), Small and Medium Enterprises Development Organization (67%), Turkish Exporters Assembly (50%), Chamber of Furniture Makers and Carpenters (33%), Association of Furniture Industry Businessmen (33%) and Furniture Industrialists Importers and Exporters' Social Aid Association (17%). As in Group A, organizations which are obligatory by legislation still have contact with SMEs that is wider than sectorial organizations. However, the increasing share of sectorial organizations should not be ignored because they increase their connection with furniture manufacturing SMEs in parallel with the increase in scale. The reasons of participants for their membership in these organizations are illustrated in Figure 4.2:

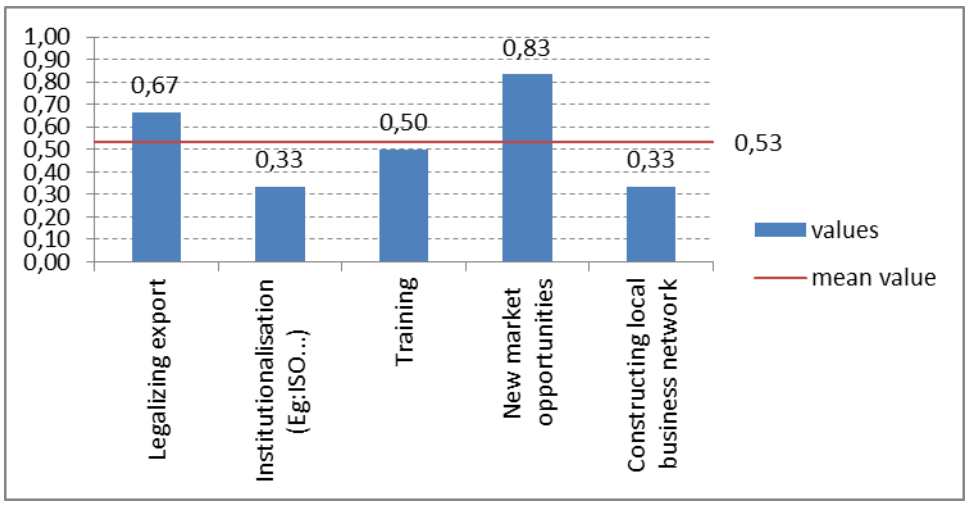

Figure 4.2: Reasons of membership to industrial organizations (Group B)

4.3 Proficiency of the participants

Cross-comparison of groups

In terms of the proficiency, three issues are analysed, namely 'obtaining certificate' (0.55/1.0), 'training about SPD' (0.19/1.0) and 'importance of tacit knowledge' (0.83/1.0) (Figure 4.3).

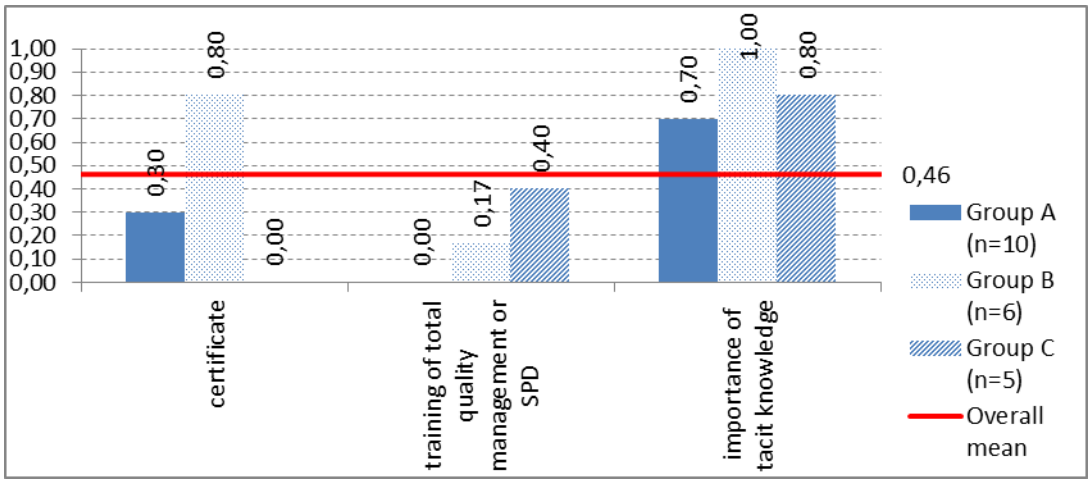

Figure 4.3: Cross-comparison of proficiency of the participants in terms SPD

According to the results mentioned in Figure 3.3, training of SPD and total quality management is scarce in the Ankara furniture İndustry. None of the participants, in the profile of Group A, have training related to SPD. In addition to this only one participant of Group B mentioned that they had a training related to total quality management. However,

freelance furniture designers in Group C got trainings during their undergraduate education and educational projects in which they attend.

An important point in this section of the study is the fact that all participants agreed upon the fact that tacit knowledge is important for their firms. In fact, they mentioned that the capabilities of their crafts are extremely important for them. Otherwise they do not have chance competing large-sized manufacturers.

4.4 Designers' involvement in the product development process

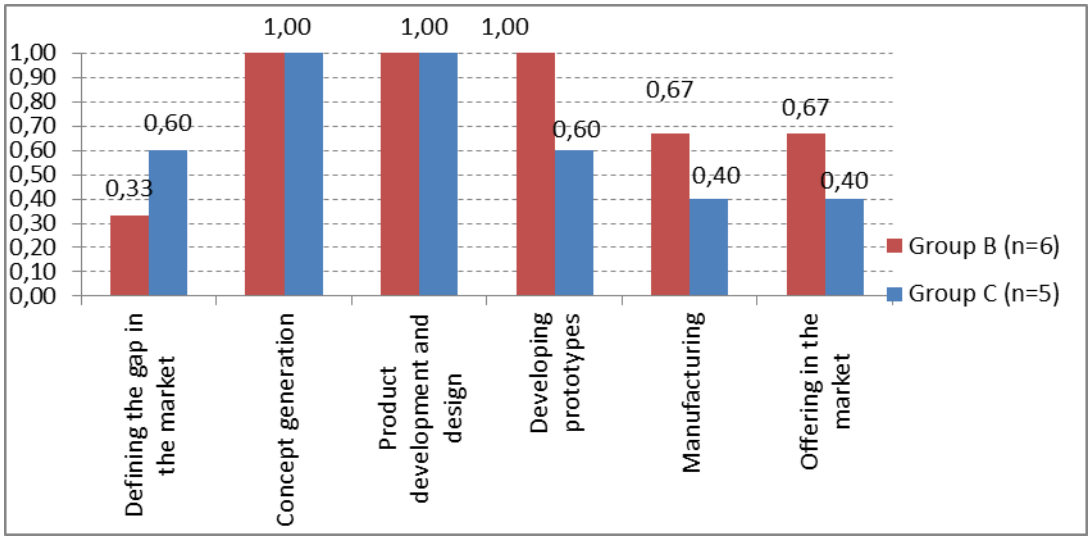

Figure 4.4: Designers involvement in the project phases

According to results in Figure 4.4, furniture designers in Group B have higher involvement in product development than Group C (except 'defining gap in the market'). On the one hand; while designers encounter predefined briefs in Group B, Group C can help their clients to define the possible target markets in preparation phase of project briefs. On the other hand; in-house designers (Group B) participate in the stages after product design, namely: 'developing prototypes', 'manufacturing', and 'offering in the market'.

Another issue analysed in the field study is the influence of in-house and outsourced designers in three topics, which are stated as: 'material selection', 'supplier selection' and 'manufacturing process selection'. According to the results; all designers, regardless of their employment type, have complete influence on the material selection of their designs. However, the supplier selection is very different from this issue. In fact, in-house designers (group B) have more influence than freelance designers (group C) in the supplier selection. Participants of Group C claim that supplier networks and relations are not in their job description and therefore they do not consider this topic during their project process.

Although in-house designers attend meetings with suppliers and have a role in their cooperation, they claim that they do not have so much influence as their managers (especially in family-owned companies). In terms of the manufacturing technologies, both in-house and freelance designers mention the same reasons as in ‘supplier selection’.

4.5 Drivers for SPD

In this section, drivers for SPD are analysed in two groups: internal and external drivers. These drivers help companies to take sustainability into consideration in their product development processes, so long as they are in parallel with their own business strategies and priorities.

4.5.1 Internal drivers for SPD

Group A – no designer

In the overall view, the grading for internal drivers can be divided into two groups. While three drivers have high scores, two drivers share low scores, with reference to the mean value. The grading of internal drivers is illustrated in figure 4.5:

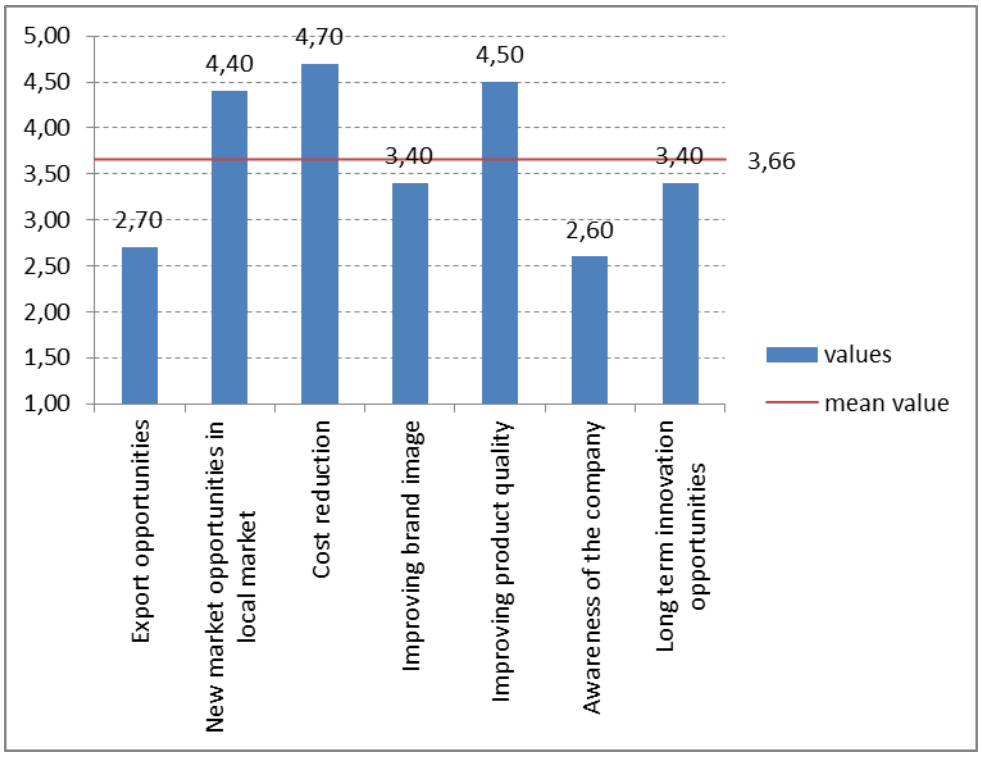

Figure 4.5: Internal drivers for SPD (Group A)

According to the results, cost reduction (4.5/5.0) has the highest influence for participants in Group A. In other words, cost reduction can be a starting point for designers who wish to carry out SPD in projects cooperated with companies fitting the profile of Group A. Improving product quality (4.5/5.0) and new market opportunities (4.4/5.0) are the most influential drivers mentioned after cost reduction. Although export opportunity is another driver parallel with these drivers, it is not mentioned as quite so influential as the others because of the fact that Group A participants are mainly dependent on national markets and they do not have a share of foreign markets. In short, among internal drivers, topics related to profit making and product quality are more influential compared to others, which are related to brand management and improving companies' technical capabilities. Lastly, awareness of the company (2.6/5.0) had the lowest value among internal drivers.

Group B – in-house designer

In the overall evaluation for Group B, grading of internal drivers did not distribute in a wide range as for Group A (figure4.5). Still, three drivers could be defined as more influential compared to others. Values of internal drivers in Group B are illustrated in figure 4.6 below:

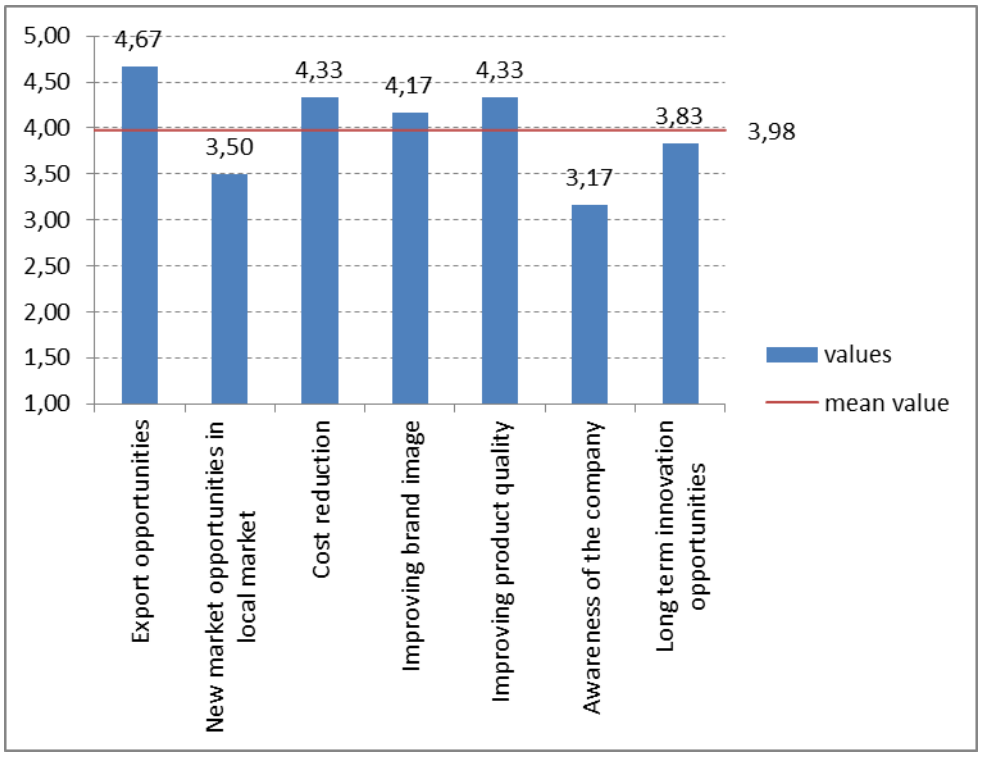

Figure 4.6: Internal drivers for SPD (Group B)

The driver with the highest value (export opportunities, 4.67/5.0) is still related with market opportunities. However, it shifted from local market opportunities to foreign markets. The other two highest rated drivers were the same as for Group A: 'cost reduction' (4.33/5.0)

and ‘improving product quality’ (4.33/5.0). The driver with the lowest value was still ‘awareness of the company’.

Group C – consultant designer

In the overall evaluation, freelance furniture designers mentioned drivers for SPD in parallel with their customers’ perspectives. They graded “export opportunities” and “improving product quality” with the highest values (4.8/5.0). Interestingly, improving brand image (4.6/5.0) had the third highest value among the drivers (see figure 4.7).

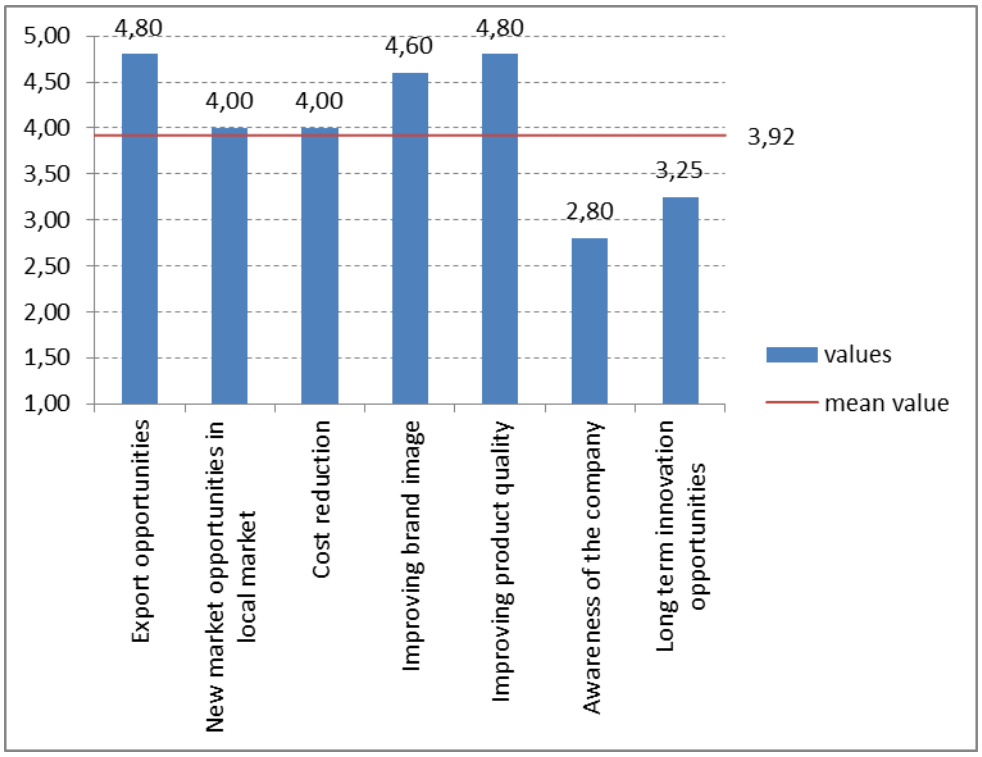

Figure 4.7: Internal drivers for SPD (Group C)

Cross-comparison of groups

In terms of internal drivers for SPD, all three groups revealed agreement on the influence of ‘improving product quality’ (Group A: 4.5/5.0, Group B: 4.33/5.0, Group C: 4.8/5.0). In all groups, product quality improvement was mentioned as one of three most influential drivers for SPD. After product quality improvement, ‘cost reduction’ had the second highest value and rated in first place in Group A (4.7/5.0) and second place in Group B (4.33/5.0) and fourth place in Group C (4.0/5.0).

With regard to new market opportunities, participants represented two different perspectives based on their market expectations. Export opportunities were rated as the most influential driver for Group B (4.67/5.0) and Group C (4.8/5.0), while it was rated as the second least influential in Group A (2.7/5.0). From these results it can be estimated that

design capabilities of furniture manufacturing SMEs are closely related with their market goals. Furniture manufacturing SMEs employing in-house product designers or collaborating with consultants consider export market opportunities more highly compared with SMEs in which product development is not dealt with as a specific issue. However, the local market is still important for furniture manufacturing SMEs, because it is mentioned in the third place in Group A (4.4/5.0), which constitutes the majority of the sector.

In terms of brand management, design capability is parallel with the influence of brand image. As furniture manufacturing SMEs increase their design capability (i.e. employ in-house designers, work with freelance designers), they rate the influence of brand image higher. Moreover, Group C has the highest value (4.6/5.0) in brand image improvement.

Different from above, sustainability awareness of the company has the lowest value amongst all groups (Group A: 2.6/5, Group B: 3.17/5, Group C: 2.8/5.0). It is obvious that among all internal drivers, sustainability awareness is the least influential. In fact, it can be stated as a barrier instead of a driver for SPD. Therefore this item should not be counted as a driver and SPD should instead be pursued on the basis of other internal drivers.

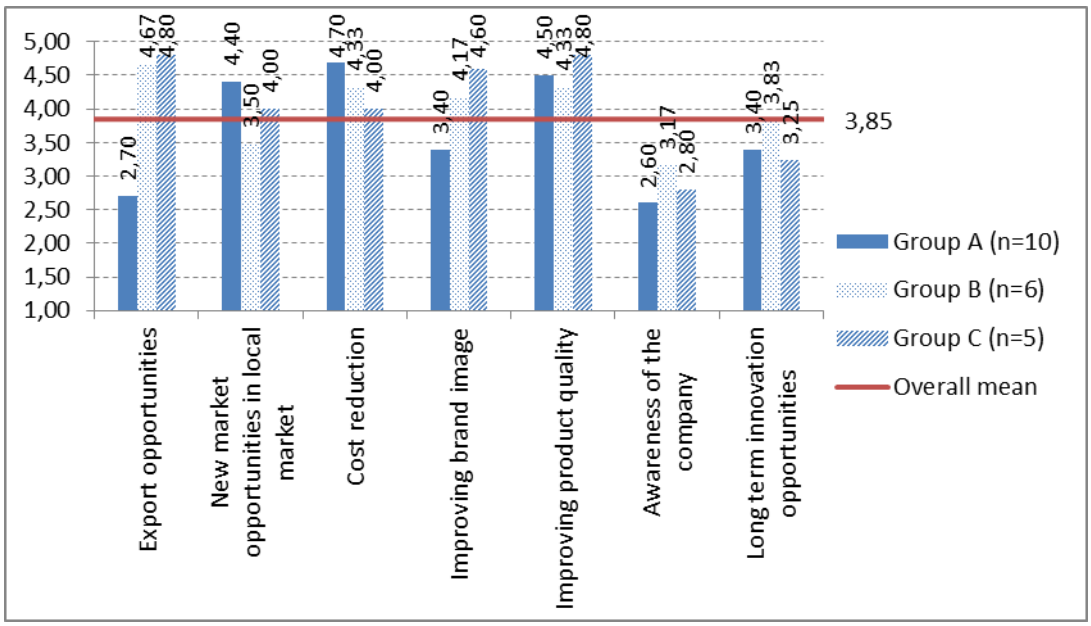

Figure 4.8: Cross-comparison of internal drivers for SPD

4.5.2 External drivers for SPD

Group A – no designer

The mean values of external drivers for SPD and overall mean value of these drivers in Group A are illustrated in Figure 4.9. Among the external drivers, ‘market competition’ (4.7/5.0), and ‘customer demand’ (4.6/5.0) are rated the highest. From these results, it can

be estimated that strengthening their position with respect to market competition, by satisfying their customers, is the most influential driver for drawing the attention of furniture manufacturing SMEs fitting the profile of Group A. Also, 'public opinion' and 'legislations' (3.7/5.0) are mentioned as influential external drivers.

The least influential external drivers were found to be NGO pressure (1.6/5.0) and supplier demand (2.1/5.0). It is interesting to note that participants in the group mentioned public opinion as one of most influential drivers, but NGO pressure as the least influential. Although NGO's are closely related with public opinion, results show that there is only a weak connection for furniture manufacturing SMEs in Ankara. In other words, the low values of these drivers, which are expected to influence companies to consider SPD in their facilities, can in fact act as a barrier as with the case for 'awareness of the company' for the internal drivers.

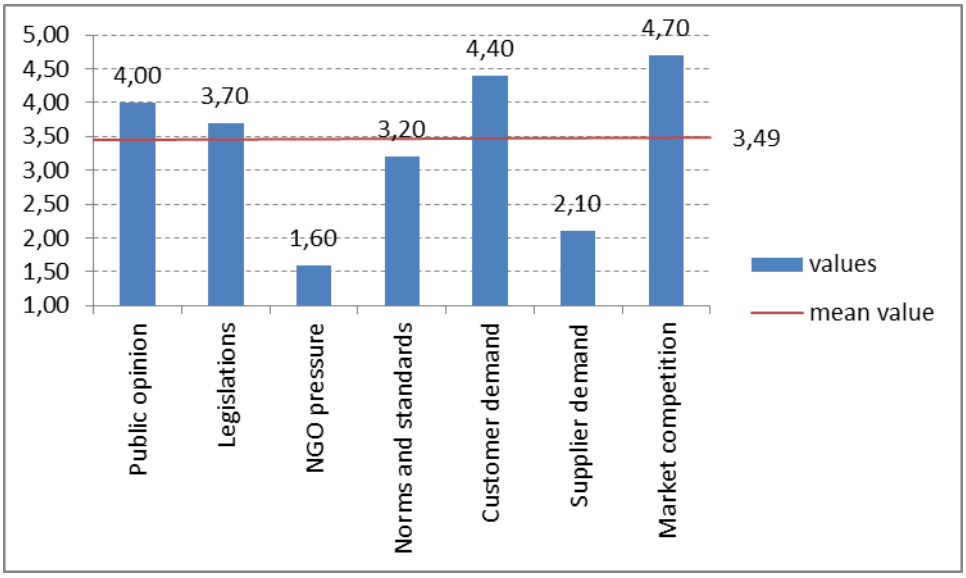

Figure 4.9: External drivers for SPD (Group A)

Group B – in-house designer

The mean values of external drivers for SPD and overall mean value of these drivers in Group B are illustrated in Figure 4.10. 'Market competition' (4.83/5.0) was again the most influential external driver. In fact, the order of external drivers is almost same as Group A, the only difference being change between second and third highest rated drivers. From these results, it can be predicted that the product design capabilities of furniture manufacturing SMEs does not play an important role on the effect of external drivers for SPD.

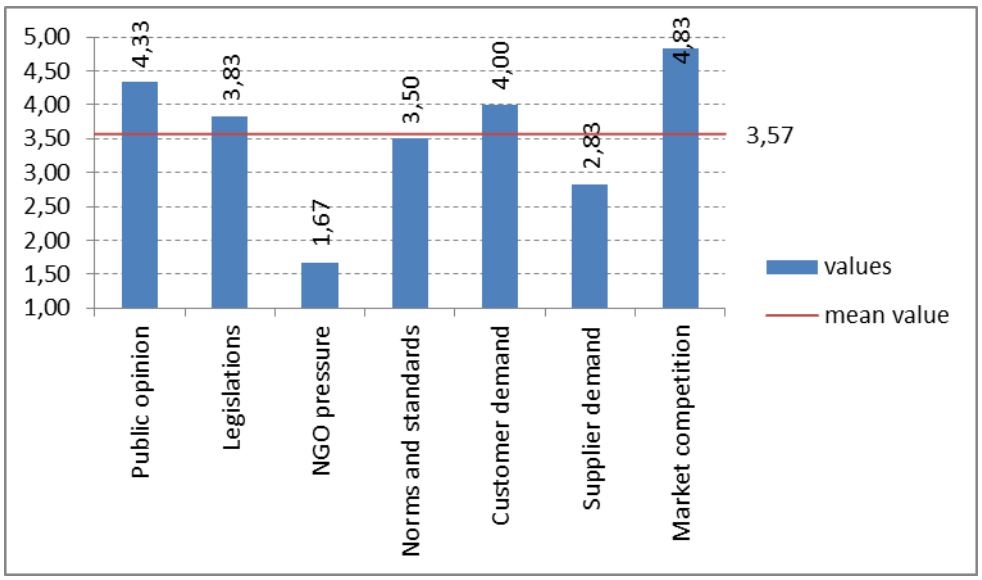

Figure 4.10: External drivers for SPD (Group B)

Group C – consultant designer

In Figure 4.11, mean values and the overall mean value of external drivers for SPD in Group C are illustrated. 'Market competition' (4.6/5.0) and 'customer demand' (4.2/5.0) are rated among the three highest rated external drivers, just the same as Group A and B. Different from those groups, 'norms and standards' (4.2/5.0) is rated as one of the top three drivers. Additionally, 'public opinion' (3.0/5.0) is not one of the highest rated drivers in this group. In fact, it is the third least influential external driver, with a value lower than the overall mean for the group.

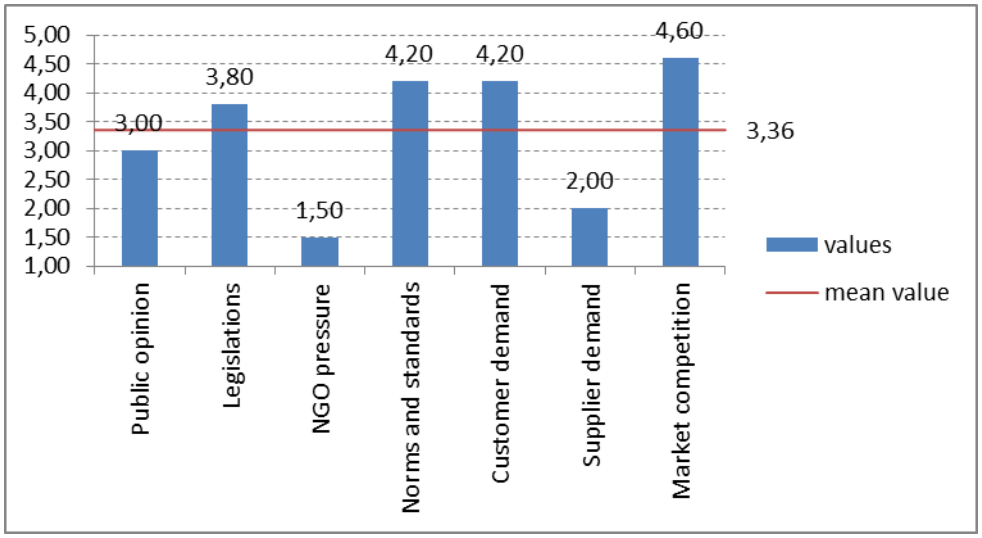

Figure 4.11: External drivers for SPD (Group C)

Cross-comparison of groups

The mean values of external drivers for each group and the overall mean value across all groups are illustrated in Figure 4.12.

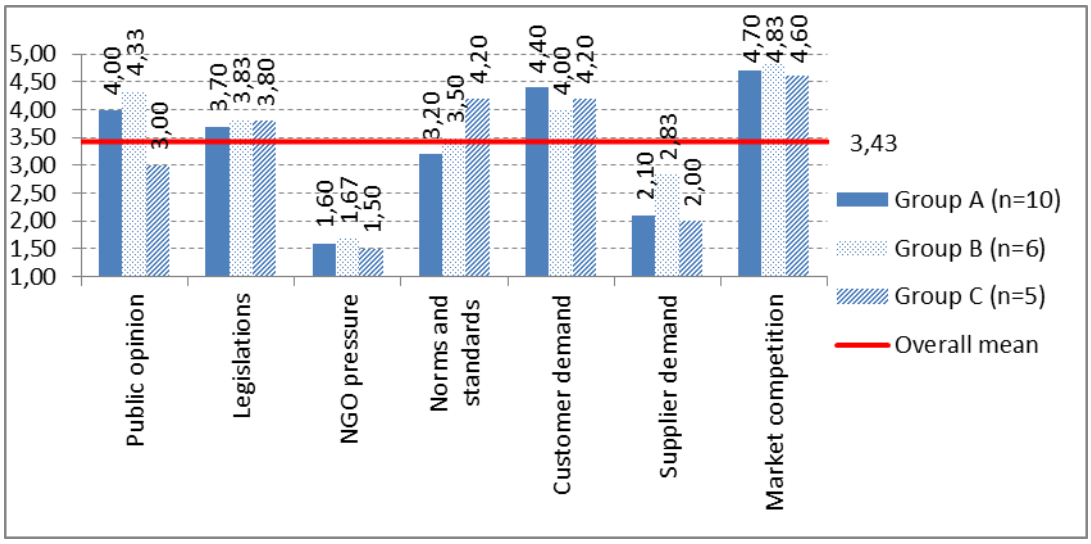

Figure 4.12: Cross-comparison of internal drivers for SPD

According to the results, 'market competition' has the highest values in all groups. Although it is the most influential external driver, furniture designers should be critical about this issue. The influence of this driver can also make it obligatory in product development. In other words, designers must fulfil this requirement; otherwise, conflicting with this driver can act as a 'no-go barrier'.

Opposite to market competition, NGO pressure is rated as the least influential external driver. As mentioned in Section 3.1.4.1, there is a conflicting statement between public opinion and NGO pressure in Groups A and B. In literature, NGOs are mentioned as societal stakeholders (Hillary, 2003; Crul & Diehl, 2009) in SPD. Therefore, NGOs are mentioned as closely related to public opinion. However, public opinion is rated as one of the most influential drivers in the study. From this result, it is fair to say NGOs are not evaluated as a societal stakeholder in SPD by furniture manufacturing SMEs. That is, the influence of NGOs is not enough to be taken into consideration by these enterprises.

Supplier demand is another external driver which should be analysed. In Group A and C, values for 'supplier demand' are close to each other because of different reasons. On the one hand, participants in Group A mentioned that they do not have long-term suppliers as partners. Therefore their relationships are not greater than purchasing necessary equipment or materials. On the other hand, participants in Group C mentioned that they do not have connection with their customers' suppliers. Therefore they do not evaluate supplier demand as an influential external driver. In spite of the fact that participants in

Group B rated this driver higher than other two groups, it is not mentioned as more influential than other external drivers, except NGO pressure.

In terms of 'norms and standards', Group A and B have close mean values, which is also close to the overall mean. However, Group C participants rated this driver as one of the most influential three external drivers. Freelance furniture designers, who are collaborating with large-scale furniture manufacturers, mention norms and standards to be influential in their design process. In other words, as design capabilities increase, the influence of norms and standards increases.

In addition to the drivers mentioned above, all groups shared close ratings in legislations and customer demand. They rated these drivers above the overall mean value and defined them as one of the most influential drivers for their business.

4.6 Barriers to implementing SPD

Group A – no designer

In Figure 4.13, values of barriers to implementing SPD for Group A are illustrated.

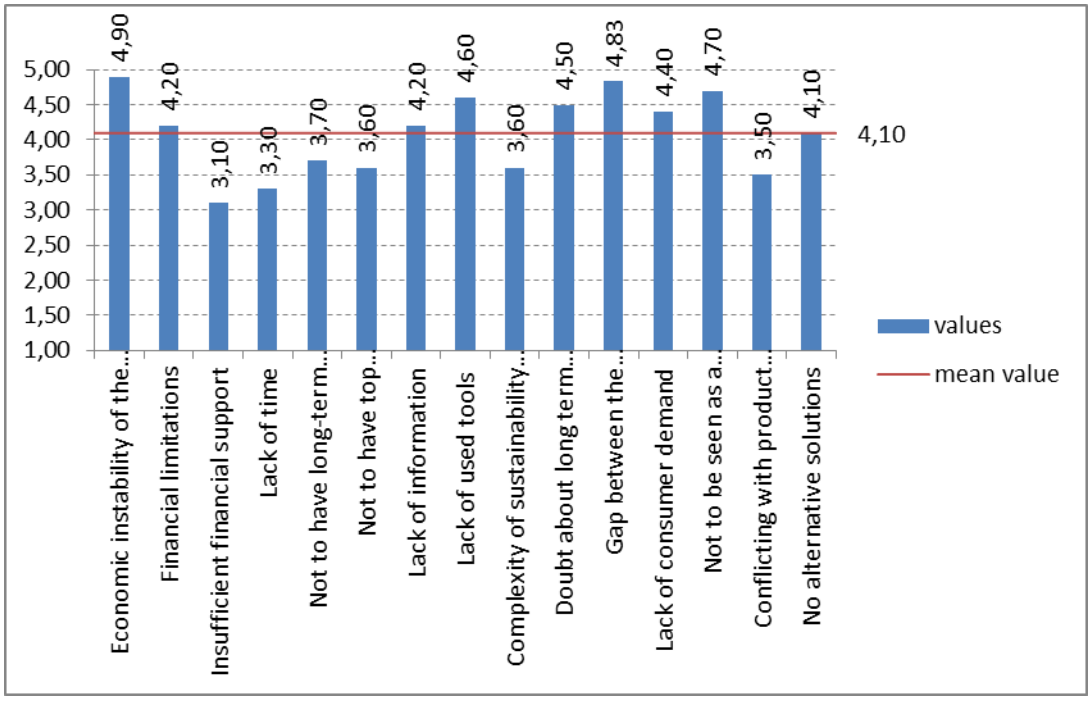

Figure 4.13: Barriers to implementing SPD (Group A)

According to results, the economic instability of the country (4.9/5.0) is mentioned as the most influential barrier. At first, economic instability should be parallel with long-term strategy (3.7/5.0); however in the study the mean values of these two barriers are not close.

In fact, long-term strategy is rated below the overall mean of all barriers. During the interviews, participants were asked the reason behind this difference in their answers. Participants mentioned two reasons. The first was the fact that micro and small scale furniture manufacturing enterprises do not have personnel for setting goals for future strategies. The second reason was the fact that long-term strategies are not helpful to deal with financial crises therefore the firms are more concerned with current problems of the market instead of future ones.

The second most influential barrier in group A was ‘gap between the developer and practitioner of SPD tools’ (4.83/5.0). Participants mentioned that ‘they were aware of environmental problems like everyone’, but they do not have any connection with universities or they are not informed by any institute about their environmental impact and sustainability credentials. Because of the influence of this gap, it is not possible to analyse another barrier, which is ‘complexity of sustainability tools’ (3.6/5.0). Participants who are not informed about SPD and SPD tools cannot evaluate the complexity of these tools due to the absence of their experience. Moreover the mean value of ‘lack of used tools’ (4.6/5.0) also supports the validity of this judgement.

The third most influential barrier was mentioned as ‘not to be seen as a commercial benefit’ (4.7/5.0). Participants summed up the essence of this barrier as there is no reason to conduct SPD unless it promises a win-win situation for them. This argument is supported by ‘doubt about long-term benefits’ (4.5/5.0)

‘Insufficient financial support’ was mentioned as the least influential barrier. It is interesting that, enterprises with ‘financial limitations’ (4.2/5.0) do not mention support as a key element to deal with that problem. They do not mention support as a solution because they do not believe they would obtain suitable support while larger enterprises are more available and convenient for support from institutes such as banks and development agencies.

Another barrier which is mentioned as not influential as other barriers is ‘lack of time’. Especially micro and small scale furniture manufacturing enterprises emphasize that they do not have a very dense schedule, and they can spare time for training so long as it is planned with their daily work plans.

Group B – in-house designer

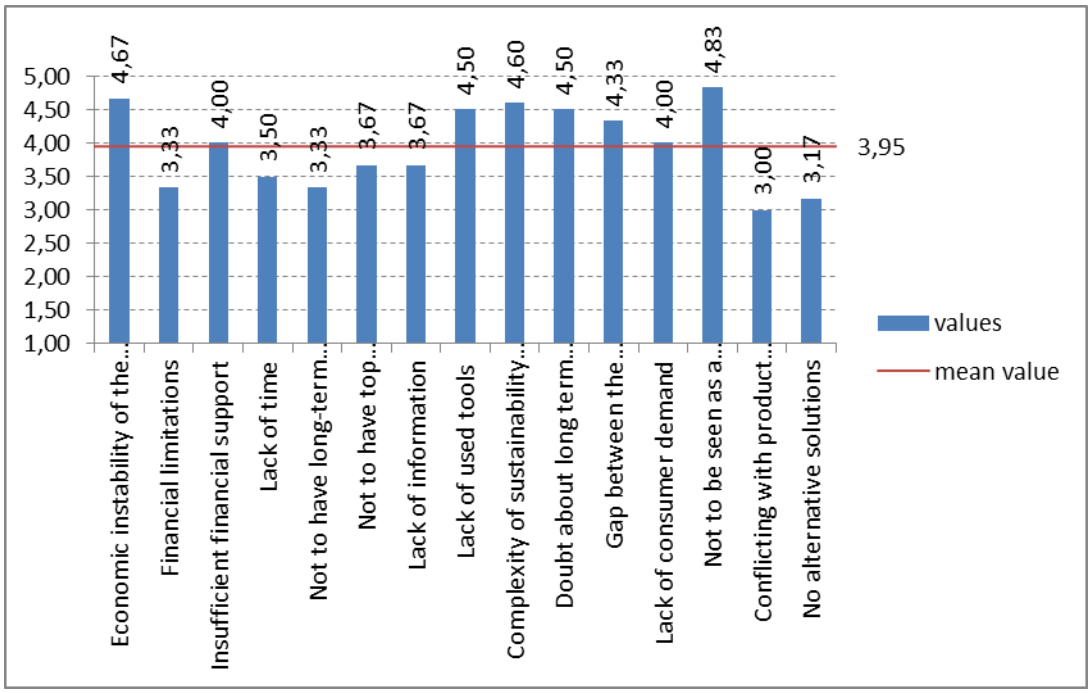

Figure 4.14: Barriers to implementing SPD (Group B)

In Group B (see figure 4.14), 'not to be seen as a commercial benefit' (4.83/5.0) is the most influential barrier preventing participants from applying SPD in their facilities. Their reason is the same as participants in Group A, mentioned in the previous section. The second highest rated barrier is the 'economic instability of the country' (4.67/5.0). Although they mention they have long-term strategies (3.33/5.0) in order to increase their export share, the current economic crisis causes serious problems to achieve their strategy goals.

In terms of SPD knowledge and awareness of SPD tools, barriers become relatively more influential. 'Lack of information' (3.67/5.0) is mentioned as not as especially influential barrier for them. They emphasized that they are well aware of sustainability problems; however they do not know how to deal with sustainability in their sector (lack of used tools, 4.5/5.0). In addition to these, in house designers in the companies mentioned that software programmes and certificates, which they scanned in the Internet, are not easy to understand because of complex numerical systems and foreign language (complexity of SPD tools, 4.5/5.0).

In terms of financial barriers against SPD, participants were more flexible and mentioned that they would spare funds for new perspectives if they promise win-win situations for their companies. Therefore they rated financial limitations (3.33/5.0) below the overall mean value indicating it not to be a strong influence. Still, participants emphasized that they need financial support to manage the risk of trying SPD, which is very unfamiliar to them.

‘Conflicting with product features’ (3.0/5.0) is rated as the lowest influential barrier against implementation of SPD. Participants stated that furniture design and manufacturing in low quantities have both advantages and disadvantages during the design process. However, participants rely on their product design capabilities with tacit knowledge of their personnel. Therefore, they mention that they can find solutions for SPD without conflicting product features. Another barrier parallel to this is ‘no alternative solution’ (3.17/5.0). Companies again mentioned the same reasons and told that most of the time, they find internal solutions for problems they encounter during product development.

Group C – consultant designer

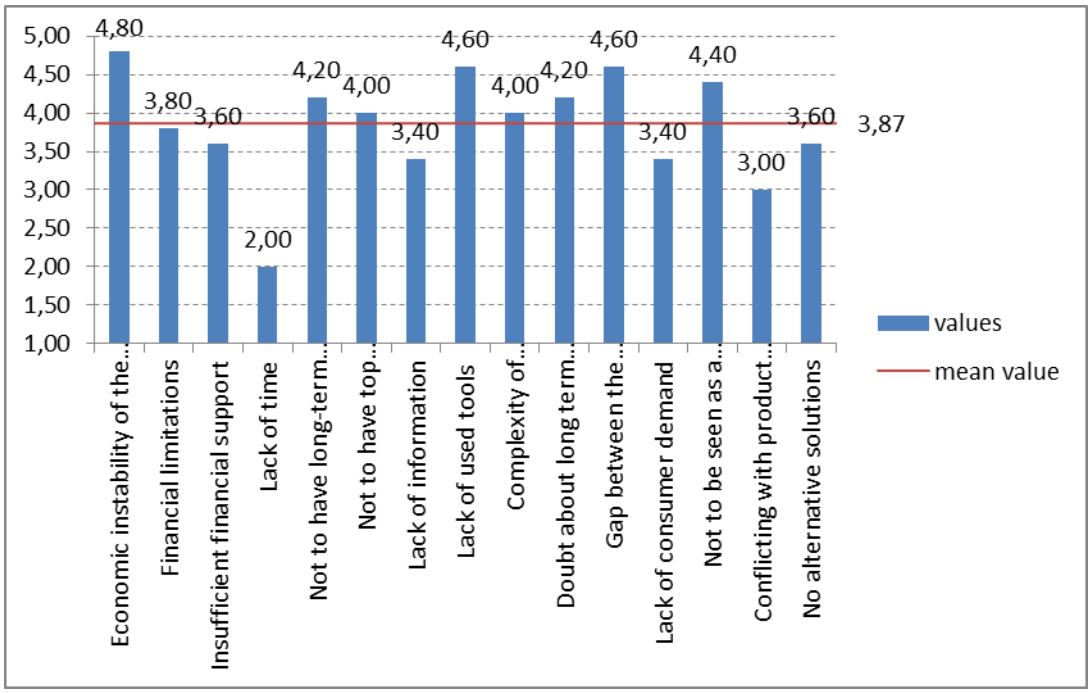

Figure 4.15: Barriers to implementing SPD (Group C)

According to the results illustrated in figure 4.15, ‘economic instability of the country’ (4.8/5.0) is repeated as the most influential barrier against SPD. However, freelance designers whose client profile is constituted more often by medium to large scale companies rated this barrier lower than others whose customers are mostly furniture manufacturing SMEs. In other words, participants rated this barrier parallel with their customers’ profile.

The second highest value is shared between two barriers, which are ‘lack of used tools’ and ‘gap between the developers and practitioners of SPD tools’ (4.6/5.0). In terms of sustainability awareness, which is raised by ‘lack of information’ (3.4/5.0), participants rated it lower than the prior two barriers. From these three results, it can be estimated that participants are aware of sustainability; however SPD tools are not accessible to these furniture designers.

The fourth highest value among barriers belongs to ‘not to be seen as commercial benefit’ (4.4/5.0). During interviews, participants told that SPD must promise commercial benefit in order to be convincing to their clients. Otherwise it is not possible to collaborate with their customers, who value this aspect above most of the others.

Among the barriers, ‘lack of time’ (2.0/5.0) is mentioned as the lowest influential barrier against implementation of SPD. Although participants mentioned their workload is heavy, they also pointed out the fact that, as furniture designers, they ought to be the individual dealing with SPD in their sector instead of other employees.

The second barrier with the lowest value was ‘conflicting with product features’ (3.0/5.0). In spite of the fact that this is an influential barrier for manufacturers, participants agreed that, as outsourced consultants, it is their job to find product solutions.

Cross-comparison of groups

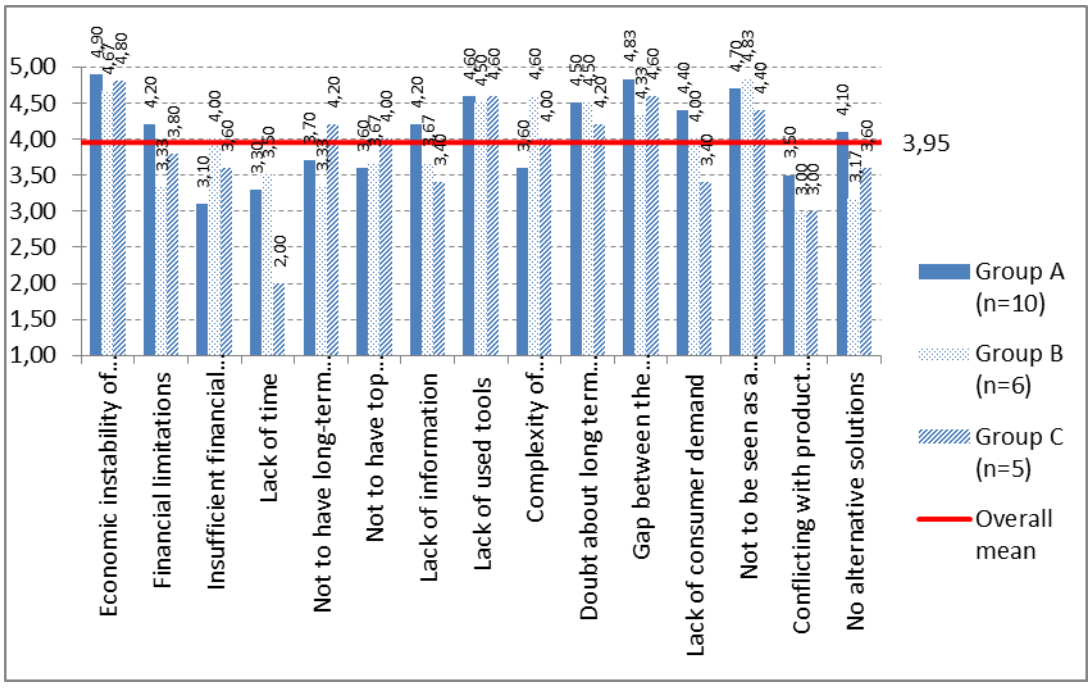

Figure 4.16: Cross-comparison of barriers to implementing SPD

The overall mean values across Figure 4.13, 4.14, 4.15 show that participants from different profiles have close ratings for the overall influence of barriers to implementing SPD (Group A: 4.1/5, Group B: 3.95, group C: 3.87/5.0). In other words, participants across groups agreed on the limitations of managing SPD in furniture manufacturing SMEs. Still, they encounter different obstacles related to product development which should be studied in order to customize SPD tools for different profiles in the furniture manufacturing industry.

The four most influential barriers to implementing SPD can be grouped in two groups related to economic obstacles and SPD tools. The most influential two barriers of these are related to economic obstacles. ‘Economic instability of the country’ is mentioned as one of the two most influential barriers in all three groups and in the overall evaluation; it is the highest rated barrier in the study. ‘Not to be seen as a commercial benefit’ is the second highest rated barrier in the study, which is supported by ‘market competition’ in the external drivers section. These two results show that SPD must promise economic benefits for furniture manufacturing SMEs in order to have a chance to be realized.

Barriers related to SPD tools are rated the third and fourth most influential. Participants emphasized that SPD tools are not available and they are not easy to use during their product development process. Therefore it is important to revise current SPD tools according to the requirements of users in furniture manufacturing SMEs.

In terms of barriers with lowest influence, ‘lack of time’ (Group A: 3.3/5, Group B: 3.5/5, Group C: 2/5.0) is in first place. The micro and small scale enterprises in Group A mentioned they can spare time, especially in the second and third quarter of the year, because in this time period their schedule is mostly constituted by sales which allows them to deal with training and workshops. Participants in Group C rated this barrier lower than Group B because they consider themselves responsible for SPD and they should spare time for it. Also they mention that, compared to their in-house colleagues, they are more concentrated in product design while others ought to spare time for their firms’ internal issues (e.g. price analysis, settling tenders, supply management, etc.).

The second least influential barrier for SPD is mentioned as ‘conflicting with product features’ (Group A: 3.5/5, Group B: 3/5, Group C: 3/5.0). Among the barriers, this is the one most related to the product development process. However participants in Group A and Group B mentioned that furniture manufacturing industry can deal with promoting product solutions better than other industries because of the fact that SMEs in this industry are frequently using labour-intensive manufacturing techniques in low quantities. Compared with large-scale enterprises, this allows them to be more flexible during their product development process.

4.7 SPD strategies

In this section, SPD strategies will be analysed in six groups as divided in the interview. Firstly, these groups will be compared based on their overall mean values (see Figure 4.17).

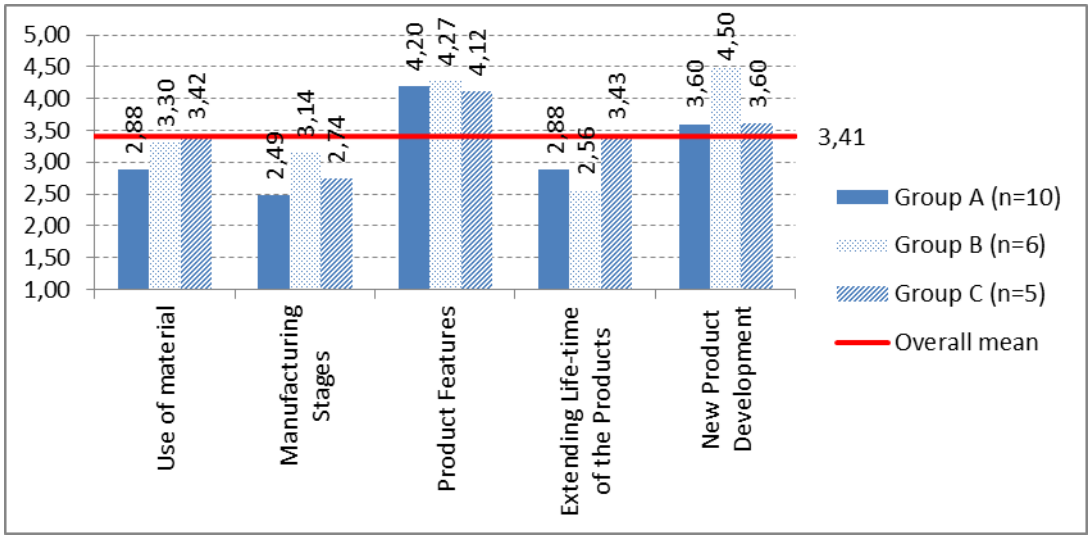

Figure 4.17: Comparison of SPD strategy topics

According to the results, SPD strategies related to product features (4.2/5.0) are the most frequently used for furniture design. Moreover the ratings of all three groups are close to each, showing agreement to attend to these strategies during product design. The second most frequently used SPD strategies were found to relate to ‘new product development’ (3.9/5.0). However the ratings of groups show differences, which will be analysed in detail in the cross comparison section of this strategy group. The mean value of SPD strategies related to material use (3.2/5.0) is rated close to the overall mean value of all SPD strategies so it was not remarkable.

The other two SPD strategy groups, related to ‘extending product life-time’ (2.96/5.0) and ‘manufacturing stages’ (2.8/5.0) are rated below the overall mean value of SPD strategies. Regarding product life-time extension, participants of Group C refer to these strategies more frequently in their design projects than principles of Group A or B.

4.7.1 Strategies related to material use

Group A – no designer

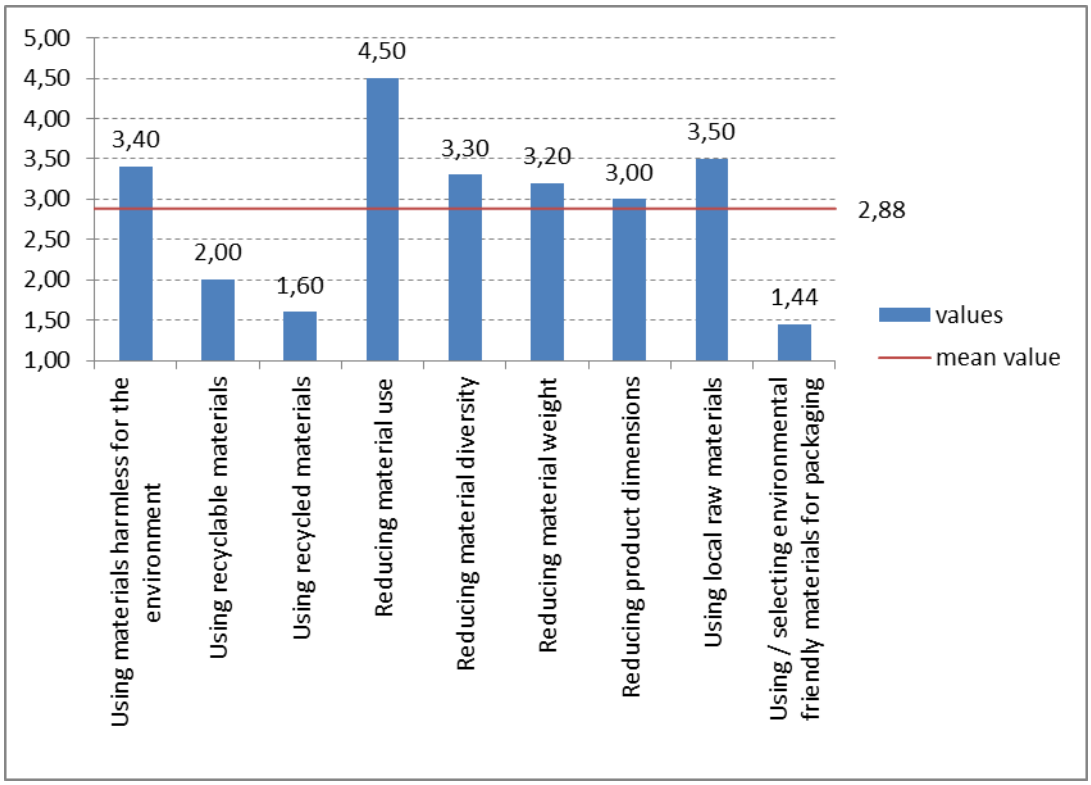

Figure 4.18: Frequency of SPD strategies related to material use (Group A)

The frequency of use of SPD strategies related to material use in Group A (Figure 4.18) can be divided into three groups. Firstly, 'reducing material use' (4.5/5.0) is the most frequently used SPD strategy. The main reason behind this is the fact that material reduction results in both economic savings and reduction of environmental impact. Therefore this strategy can be applied with the incentive of seeing financial benefits. However, the other two related strategies 'reducing material diversity' (3.3/5.0) and 'reducing material weight' (3.2/5.0) are not frequently carried out compared to 'reducing material use'. During the interviews, participants mentioned that material diversity is a requirement for achieving a 'high quality' product family and they cannot reduce their products' material variance. In terms of material weight, they are not concerned with material weight so long as they are not responsible for logistics or do not manufacture the product in high quantities.

In terms of 'using local raw materials' (3.5/5.0), participants mentioned that they are sensitive about supplying their materials from local firms. However they emphasize this topic as an ethical matter related with local development and the national economy, which is also related with social aspects of sustainable development.

‘Using/selecting environmental friendly materials for packaging’ (1.44/5.0) was evaluated as almost ‘never’ in the study. Participants mentioned that packaging is not related to their product quality or design and they do not have an impact over customers’ choice. Also according to participants, there is not much choice for packaging material in the furniture industry. In addition to all these two of participants mentioned that they do not use packaging materials and this strategy was therefore not applicable to them.

The three SPD strategies related to material selection had differences in their gradings. Among these ‘using material harmless for the environment’ (3.4/5.0) had the highest frequency, which corresponds to more than ‘sometimes’. However, participants only mentioned use of wood and claimed that it is harmless for the environment. Although wood is a natural organic material, unconscious use of this material would also result in environmental problems. They did not refer to the materials which they use for surface treatment (painting, lacquering etc.) or plastics (vinyl, PU foam, etc.). The other two related strategies, which are ‘using recyclable materials’ (2.0/5.0) and ‘using recycled materials’ (1.6/5.0), are rated below the overall mean of all material use strategies. In three of the interviews, participants mistook the term “recyclable” for “reusable” and they mentioned reuse of wood panels for reducing waste as a strategy in their firms. Also, they did not mention wood and chip as a recyclable material. In terms of recycled materials, participants stated that using recycled materials can result in low product quality, which conflicts with their main commercial strength against large-scale furniture manufacturers.

Group B – in-house designer

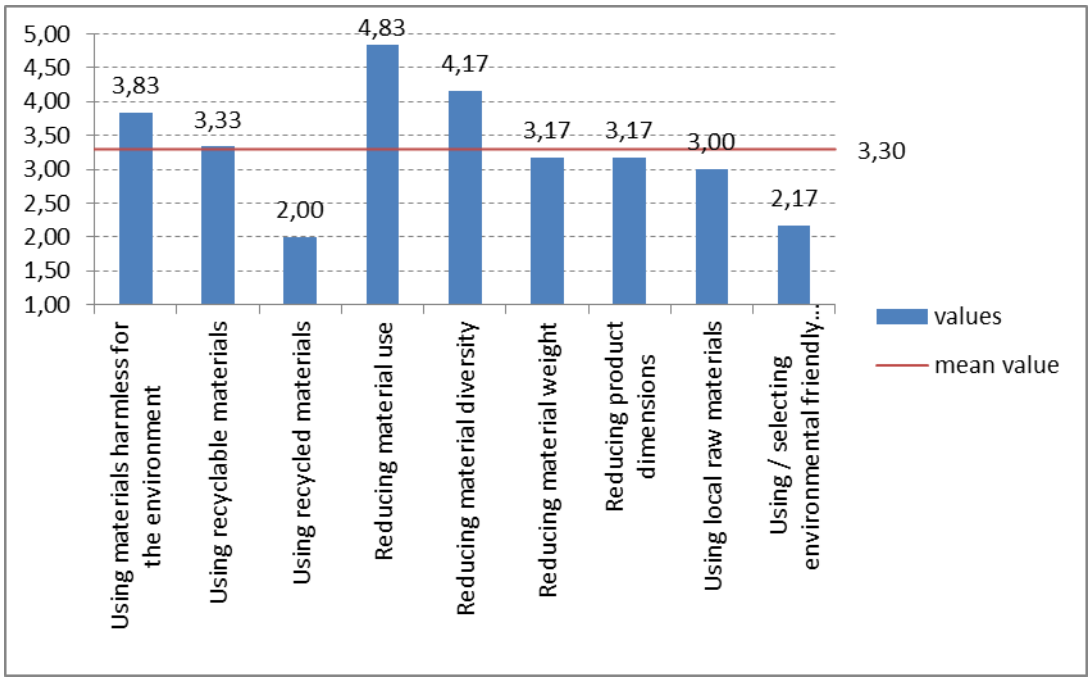

Figure 4.19: Frequency of SPD strategies related to material use (Group B)

In the use of SPD strategies related to material use in Group B (figure 4.19) two strategies were mentioned as above 'usually' (reducing material use: 4.83/5.0 and reducing material diversity: 4.17/5.0) and the other two strategies were mentioned as 'rare'. According to the participants, 'reducing material use' is based on the same reason mentioned for Group A. In terms of 'reducing material variety', participants emphasized that manufacturing with less material variance allows companies to lower their supply costs. Along with an economic benefit, reduction of material variance also can help to reduce the ecological footprint of a product.

SPD strategies rated as 'rare' in Group B were 'using/selecting environmental friendly materials for packaging' (2.17/5.0) and 'using recycled materials' (2.0/5.0). On the one hand, in terms of packaging material selection, participants mentioned the same reason as Group A in that it is not easy to be flexible with packaging. On the other hand, in terms of recycled materials, participants mentioned that they rarely use recycled materials in their products. However, recycled wood derivatives (chipboard, MDF, HDF, blockboard etc.) are widely used in the furniture industry.

Group C – consultant designer

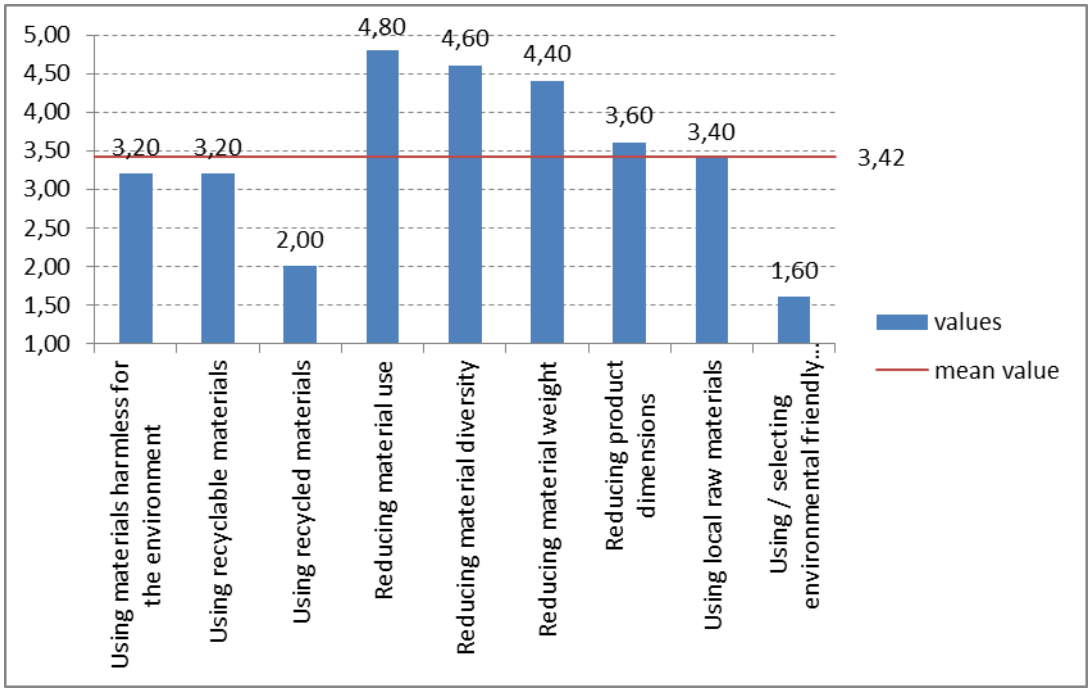

Figure 4.20: Frequency of SPD strategies related to material use (Group C)

In Group C, material use strategies of SPD are again divided into three groups: those that are frequently used, rarely used and used sometimes (see figure 4.20). On the one hand, rarely used strategies are the same as for Group A and B. On the other hand, one additional material related SPD strategy was mentioned as 'usually' used: 'reducing material weight'. Freelance furniture designers emphasize that lightweight materials help

them to deal with problems encountered in the later stages of a product life-time. For example, lightweight products are easier to transport and install after sales. Moreover, the weight of a product is closely related to usage scenarios like ease of cleaning, rearranging and customizing multifunctional designs.

Cross-comparison of groups

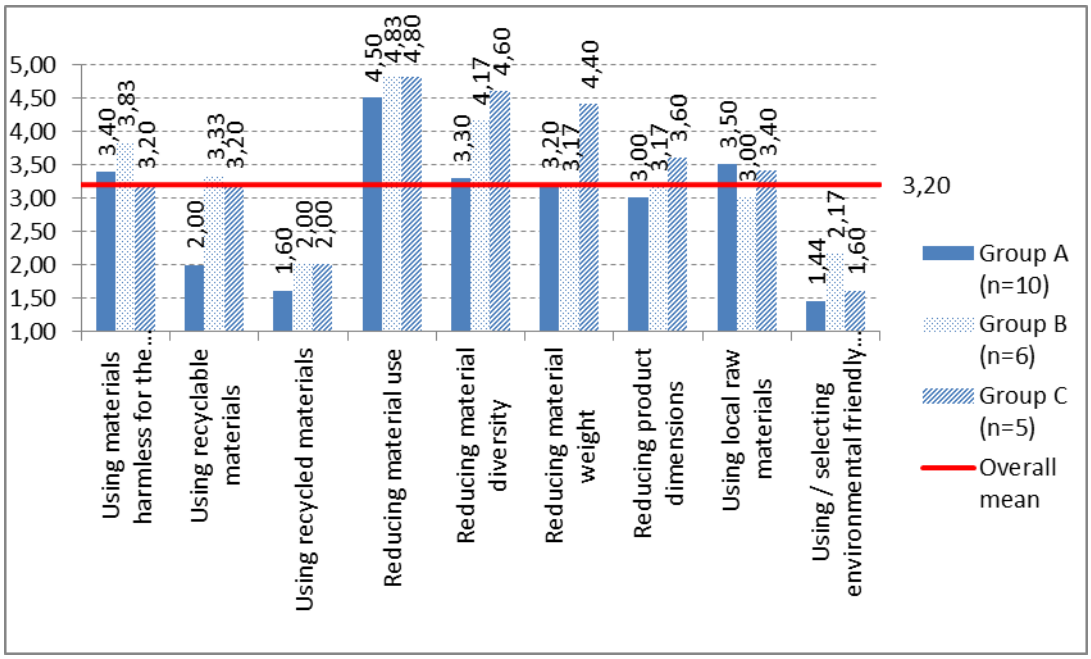

Figure 4.21: Cross-comparison of SPD strategies related to material use

Among the strategies illustrated in Figure 4.21, the strategy most related with financial return is the most common strategy used by all groups. 'Reducing material use' (4.71/5.0) is preferred more often because it promises savings for manufacturers, which is a priority for them.

The second common SPD strategy in this section is 'reducing material diversity' (4.02/5.0). In this strategy, Group A showed a difference from Group C (see Appendix H). Participants mentioned that they ought to use different kinds of materials in order to achieve their high-end quality products. Therefore they were not positive about reducing their material variety. However, Groups C were applying this strategy more often because using fewer material types can ease several issues related to manufacturing, such as manufacturing processes, stocking, supplying as well as reducing material costs due to bulk purchasing of materials.

'Reducing material weight' was the third most common strategy among the participants. Concerning this issue, Group C used this strategy more frequently than the other groups and they mention the benefits of this strategy in the latter stages of product life more often than others.

The fourth most common strategy was ‘using materials harmless for the environment’ (3.48/5.0). Although they mention they consider the environmental impact of their materials, their ratings about using recycled/recyclable materials shows conflict in results. After all, it is not easy for a company to admit to having no strategy in place for the use of environmentally friendly materials. Therefore, the following two strategies allow us to confirm the viability of the first strategy in the field study. ‘Using recyclable materials’ (2.84/5.0) shows us that furniture manufacturing SMEs employing in-house design responsible personnel and out sourced design consultants are more frequently concerned with recyclability of their materials compared to furniture manufacturing SMEs that do not employ design responsible personnel. In terms of ‘using recycled materials’ (1.87/5.0), all groups rate this strategy below “rare”. Unfortunately this strategy is under-used: it can promise fundamental benefits in both economic and environmental aspects. As mentioned earlier, recycled materials (especially wood derivatives) are already being used in furniture manufacturing and it can be improved upon by using recycled plastics for structural components and supports in these products. Moreover with certifications and labelling it can help medium scale furniture manufacturers to improve their export share: this point was mentioned for medium scale enterprises only, because in the study micro and small scale firms did not mention export markets as a motivation for their company.

Lastly, ‘using/selecting environmental friendly materials for packaging’ (1.74/5.0) was the most rare SPD strategy rated in this topic. Apparently participants have not considered this strategy in their projects up until now. In contrast, Group C participants mentioned this strategy as being out of their work description or project subjects. Other strategies, which are ‘reducing product dimensions’ (3.26/5.0) and ‘using local raw materials’ (3.3/5.0), were rated close to the overall mean value in all groups. The only difference found out between groups is the fact that furniture manufacturing SMEs employing in-house design responsible personnel are positive about sourcing materials from foreign countries, thanks to their financial possibilities. They mentioned they would import components or materials, as long as they promise better or more affordable product solutions.

4.7.2 Strategies related to manufacturing stage

Group A – no designer

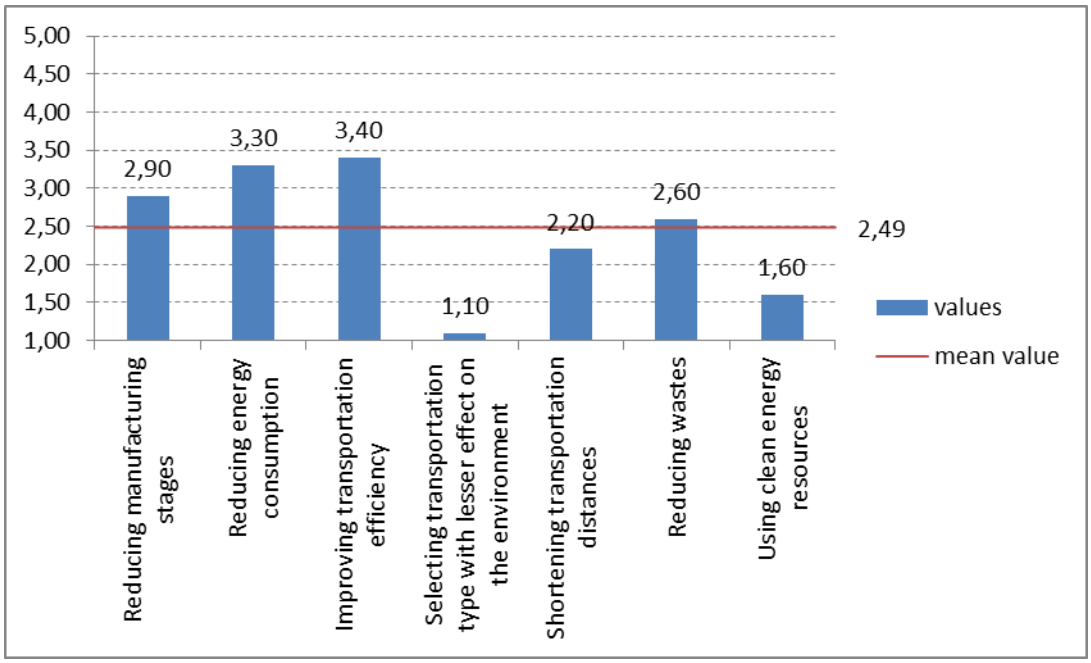

Figure 4.22: SPD strategies related to manufacturing stage (Group A)

As illustrated in Figure 4.22, participants rated none of the strategies as 'usually' or 'always'. They carry out these strategies ranging from 'never' to 'sometimes'. Among the strategies, 'improving transportation efficiency' (3.4/5.0) is the most frequently applied. With this strategy, participants can transport their products in smaller volumes, which reduces transportation costs and the ecological footprint of logistics. Still, participants from micro scale firms, especially manufacturing home furnishings, do not refer to this strategy as a must for their product design. Transporting in very low quantities enables them to manufacture large size furniture in one piece, which is also mentioned in designing modular products and reducing product dimensions in other strategy groups.

The second most frequently used strategy is "reducing energy consumption" (3.3/5.0). Participants mentioned that energy expenditure is a serious financial burden for them and if it is possible to find a solution to that problem through product design, they would gladly accept to adopt this strategy in their product development process.

The third most frequently mentioned strategy in this topic is "reducing manufacturing stages" (2.9/5.0). They referred to this strategy as being used 'sometimes'. However, they again mentioned they needed to do everything to achieve their quality standards. If their craftsmen or labour should carry out several processes, such as repetitive surface treatment processes, it must be done.

The most remarkable rating among the strategies was for to ‘selecting transportation type with lesser effect on the environment’ (1.1/5.0). The very low mean value of this strategy means that participants never considered this strategy. It is understandable because this strategy is carried out by large-scale multinational companies with an international logistics network.

Another rarely used strategy is ‘using clean energy resources’ (1.6/5.0). Three of the participants mentioned that they use their wood-based manufacturing waste for heating in the winter. Other participants also mentioned that this is common among furniture manufacturing SMEs and workshops with low-tech equipment. Moreover, using clean energy resources requires a considerable amount of investment with smart building facilities. Therefore this strategy is more suited to large-scale enterprises, just like the abovementioned strategy.

Group B – in-house designer

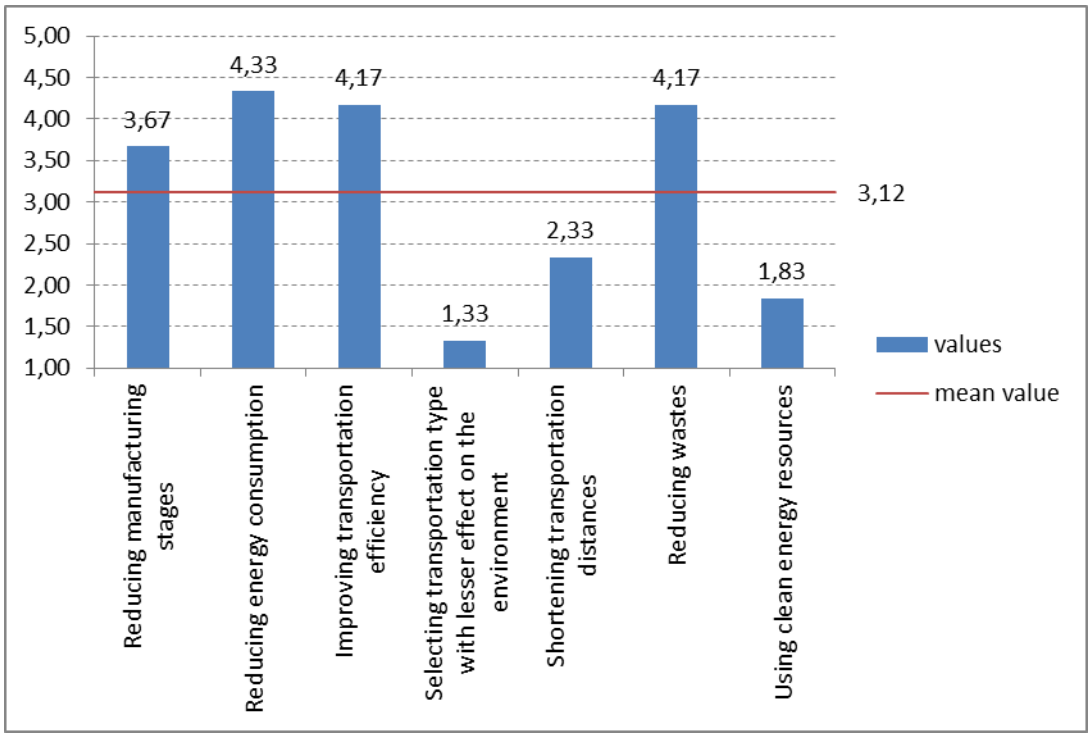

Figure 4.23: SPD strategies related to manufacturing stage (Group B)

As shown in Figure 4.23, the most frequently and rarely used SPD strategies show similarities with Group A. However, in terms of degree of frequency, the most frequently used strategies are used more often compared to Group A. ‘Reducing energy consumption’ (4.33/5.0) is again one of the most effective strategies mentioned in the section. Although they refer to it as a frequent strategy, they also mention that it is mostly related with their firms’ manufacturing department. In other words, reducing energy consumption during the

manufacturing stage is important but it is more relevant to another department and not in their direct control.

The two strategies following the most frequent were ‘improving transportation efficiency’ and ‘reducing wastes’ (4.17/5.0). On the one hand, ‘Improving transportation efficiency’ is again frequently used because of the same reasons mentioned in the previous section. However, it has more frequency compared to Group A because of a difference in the manufacturing scale. Companies in Group B are constituted by medium scale companies and the influence of logistics is more visible compared to participants from Group A. Therefore participants are more sensitive about logistics strategies in order to improve financial savings. On the other hand; ‘reducing wastes’ is the other most frequently used strategy and participants mentioned that manufacturing in high quantities with standardized models enables them to estimate the output of their production processes. Because of this fact, participants mentioned that material saving during the manufacturing stage can result ina dramatic amount of saving for their enterprises.

In terms of ‘reducing manufacturing stages’ (3.67/5.0), participants mentioned that automation in their facilities can deal with certain manufacturing processes. Therefore they must develop their products according to their manufacturing capabilities and reduction in these stages can enable them to manipulate their manufacturing facilities more effectively.

SPD strategies related with transportation are rated as ‘rare’ (or below) in Group B. ‘Selecting transportation type with lesser effect on the environment’ (1.33/5.0) is the most rarely seen strategy in this group. Participants mentioned that this strategy can be useful for reducing environmental impact. However, they also emphasized that logistics is not one of topics which they are involved in. The same reason is valid for another strategy, ‘shortening transportation distances’ (2.33/5.0). Still, they claim they can have more influence on this strategy because they have influence on selection of their suppliers. ‘Using clean energy resources’ (1.83/5.0) was referred to the second most rare strategy and participants mentioned that it is above their reach in their companies. This strategy could be conducted only with the help of manufacturing departments and top management commitment for sustainability.

Group C – consultant designer

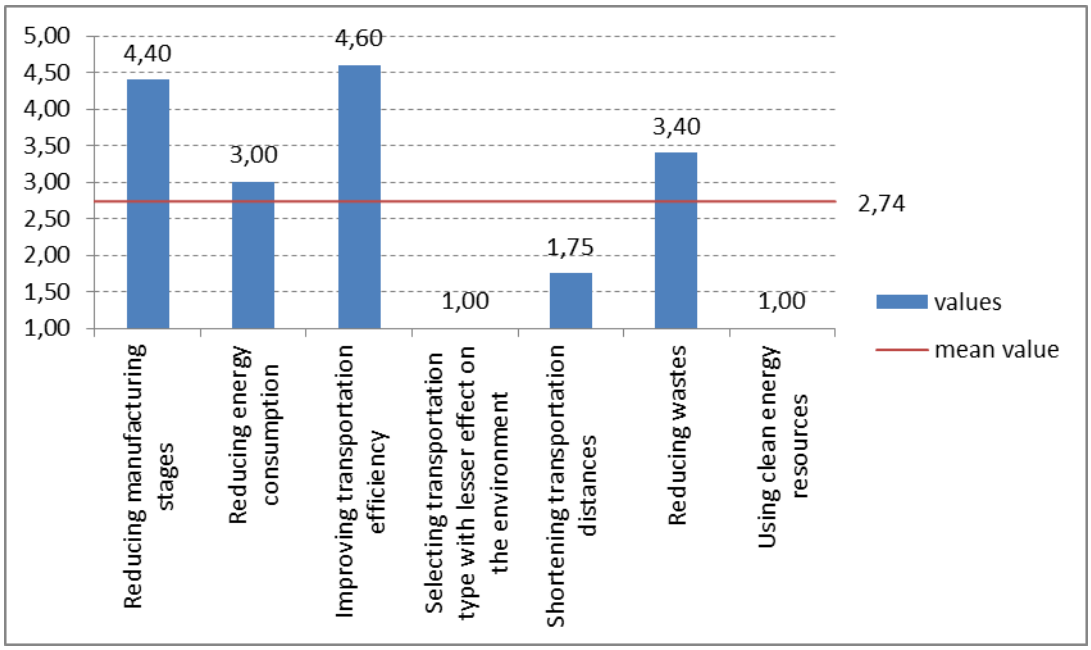

Figure 4.24: SPD strategies related to manufacturing stage (Group C)

According to Figure 4.24, while two strategies are referred to as ‘usually’, two strategies are mentioned as ‘never’. ‘Improving transportation efficiency’ (4.6/5.0) is mentioned as the most frequently used strategy once again. The second most frequently used strategy in this group is ‘reducing manufacturing stages’ (4.4/5.0). Participants mentioned this strategy as a key strategy to develop products that are easy to manufacture with lower costs. Developing minimal products with fewer manufacturing processes promises a win-win situation for both their clients and consumers. ‘Reducing wastes’ (3.4/5.0) is another strategy which is ‘sometimes’ used during the product design process. Freelance furniture designers are using this strategy in their projects because of the same reasons mentioned previously, to reduce manufacturing costs.

Three strategies which participants referred to ‘rarely’ or ‘never’ are related with transportation and clean energy use. In fact, participants mentioned logistics strategies as “irrelevant” with their collaboration with their clients. They indicated that transportation is not an issue dealt with in their projects. They are dealing with assembly and stocking of their designs but they do not interfere with supplying or logistics decisions, which are carried out by their clients’ manufacturing or logistics departments. ‘Using clean energy resources’ is also entitled as “irrelevant”. Participants mentioned that this strategy should be offered by other consultancy firms specialized in manufacturing and environmental certification processes (total quality management, environmental impact statements, material certificates etc.)

Cross-comparison of groups

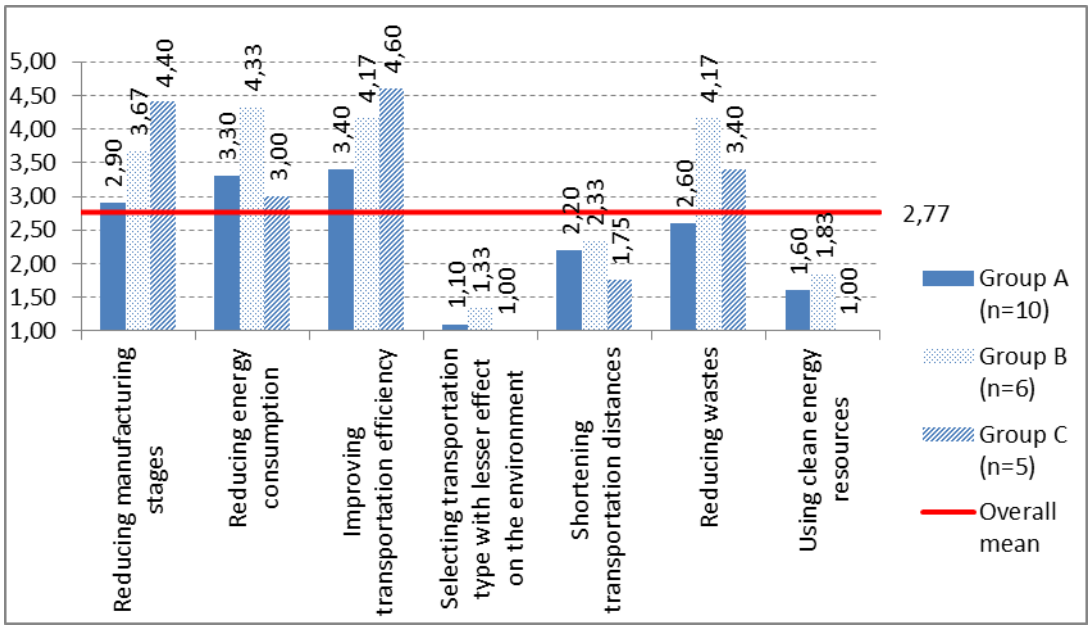

Figure 4.25: Cross-comparison of SPD strategies related to manufacturing stage

Values in figure 4.25 show that all groups agree on the most rarely used strategies. Apparently furniture manufacturing SMEs do not utilize any SPD strategies related with management of transportation type and network during their product development process. 'Using clean energy resources' (1.48/5.0) is also almost "never" used in product development processes. Participants frequently mentioned that it is not related with product design responsible personnel in these enterprises and it is not applicable to furniture manufacturing SMEs.

For other strategies with mean values around or above the overall mean value, Group A does not use these strategies as frequently as participants in Group B and Group C. Among these strategies, 'improving transportation efficiency' (4.06/5.0) is the most frequently used strategy. As a matter of fact, this strategy is more frequently used in enterprises with higher manufacturing scales. 'Reducing manufacturing stages' (3.66/5.0) is the second most commonly used strategy in this section. Freelance furniture designers (Group C) use this strategy more frequently than other participants. 'Reducing energy consumption' (3.54/5.0) is the third most frequently used strategy and participants of Group B (4.33/5.0) consider this issue more than the other two groups. Although Group C also indicated this strategy as important and useful for their clients, they stated that it is not one of their major concerns among their product development criteria. 'Reducing wastes' (3.39/5.0) is rated lower than expected before field study. Among groups, Group A (2.6/5.0) rarely use this strategy. Surprisingly, four of the participants in Group A stated that they do not generate "much amount of waste". They do not consider wood left over from manufacturing as "waste" and three of them use it for heating purposes. Group C (3.4/5.0)

also states this strategy is more related with manufacturing responsible personnel of their clients because it is related with manufacturing capability.

4.7.3 Strategies related to product features

Group A – no designer

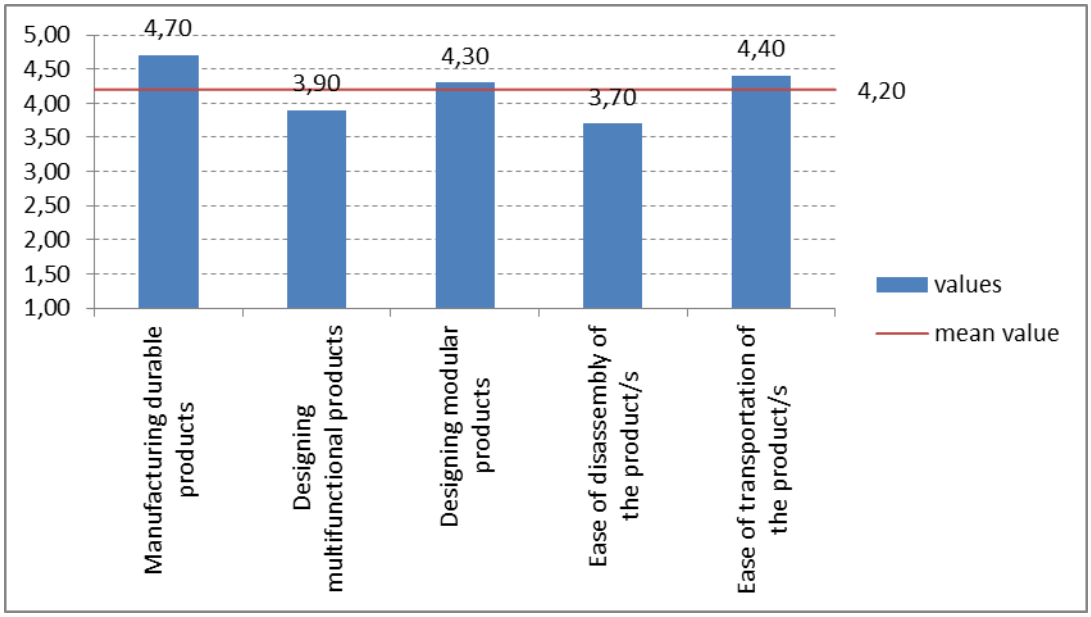

Figure 4.26: SPD strategies related to product features (Group A)

According to values in Figure 4.26, all SPD strategies in this section are utilized frequently, compared to other SPD strategies in the field study. In other words, participants of Group A use these strategies ranging from 'usually' to almost 'always'. Among these strategies, 'manufacturing durable products' (4.7/5.0) is the most frequently used strategy. In the light of this result, it is expected that this strategy should allow serious benefits, however participants mentioned a serious possible disadvantage of this strategy along with its advantages. According to participants, products 'made to last' have a disadvantage in that, furniture which does not require repairing or maintenance reduces customer relations to a minimum level after sale. Therefore customers do not remember these firms until they need new furniture, which could happen after these enterprises have already gone out of business.

Two strategies following 'manufacturing durable products' have close values, 'ease of transportation of products' (4.4/5.0) and 'designing modular products' (4.3/5.0). It is estimated for these two strategies to follow the previously mentioned strategy because they are closely related. Modularity helps designers to build product systems allowing ease of maintenance and manufacturing. In addition to these, modular products are transported easier thanks to their disassembled components. However 'ease of disassembly of

products' (3.7/5.0) is rated lower than these two strategies. Participants stated the reason behind this difference as the fact that different from office furniture, home furniture does not have to be easily disassembled unless it needs maintenance involving part replacement.

Group B – in-house designer

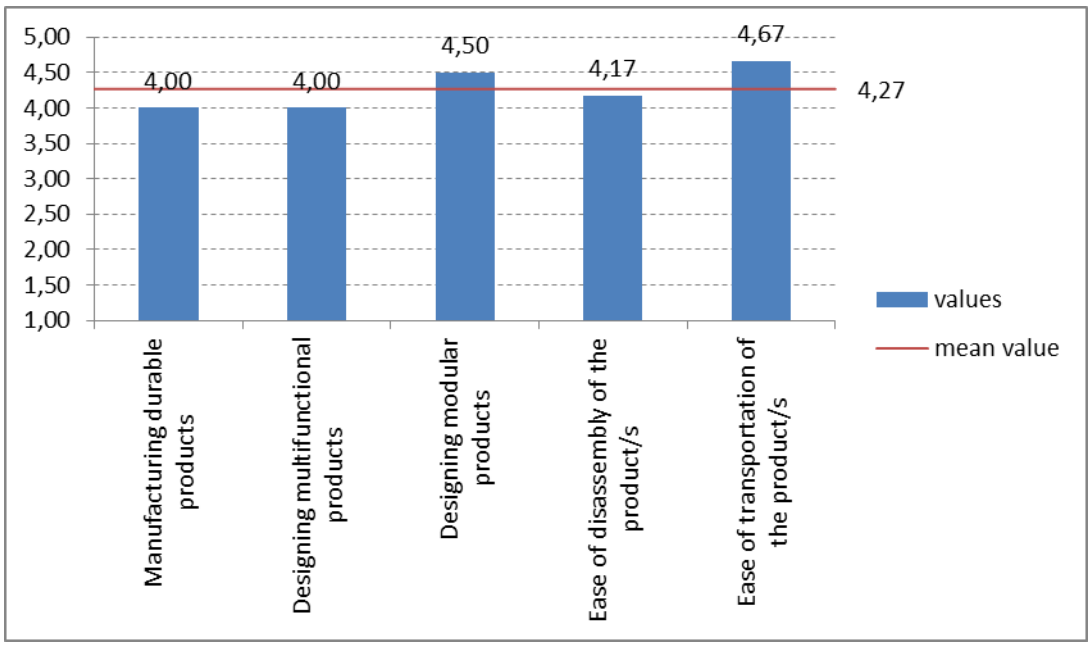

Figure 4.27: SPD strategies related to product features (Group B)

According to results in Figure 4.27, all participants in Group B mentioned SPD strategies related to product features as 'one of the most frequent ones'. Among these strategies those tied to logistics, 'ease of transportation of products' (4.67/5.0) and 'designing modular products' (4.5/5.0), were mentioned as more frequent compared to others. Participants stated that logistics are handled professionally and damage caused by transportation is the responsibility of third parties. Therefore, transportation should be considered during product development.

In terms of 'manufacturing durable products' (4.0/5.0), participants of Group B had a different approach than participants in Group A (4.7/5.0) (See Appendix H). Participants mentioned that every product has a life-time and durability should be evaluated accordingly. Apart from that, durability is optimized according to the products' warranty period of a product.

Group C – consultant designer

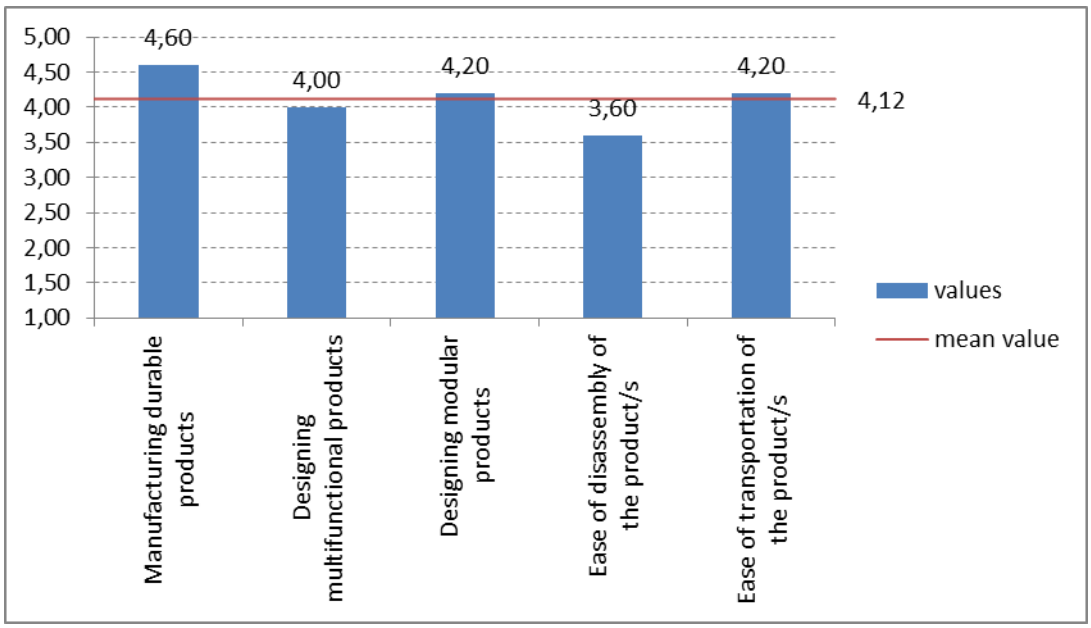

Figure 4.28: SPD strategies related to product features (Group C)

According to values in Figure 4.28, 'manufacturing durable products' (4.6/5.0) is the most frequently used SPD strategy in Group C. Participants referred to this strategy as a key element for future projects. A benefit of this strategy for participants in Group C are the fact that long-lasting products designed by freelance furniture designers serve as a reference for their enterprises.

'Designing modular products' and 'ease of transportation of products' (4.2/5.0) are rated with the second highest value. Participants proposed the same reasons as Group B. They also mentioned a specific issue about 'designing multifunctional products' (4.0/5.0). They emphasized that multifunctionality should be dealt with carefully in furniture design. Although they usually use this strategy in office furniture, they underline that products should answer users' expectations before dealing with additional features. To illustrate, seating must be adequately comfortable before offering other functions.

Finally, 'ease of disassembly of the products' (3.6/5.0) is rated with the lowest value, which still corresponds to above 'sometimes'. Participants mentioned that assembly is more frequently considered in their projects than disassembly due to the fact that disassembly is not carried out, while assembly is mandatory. Moreover they emphasized that permanent joinery and assembly is used in order to deal with structural wear and stress during use.

Cross-comparison of groups

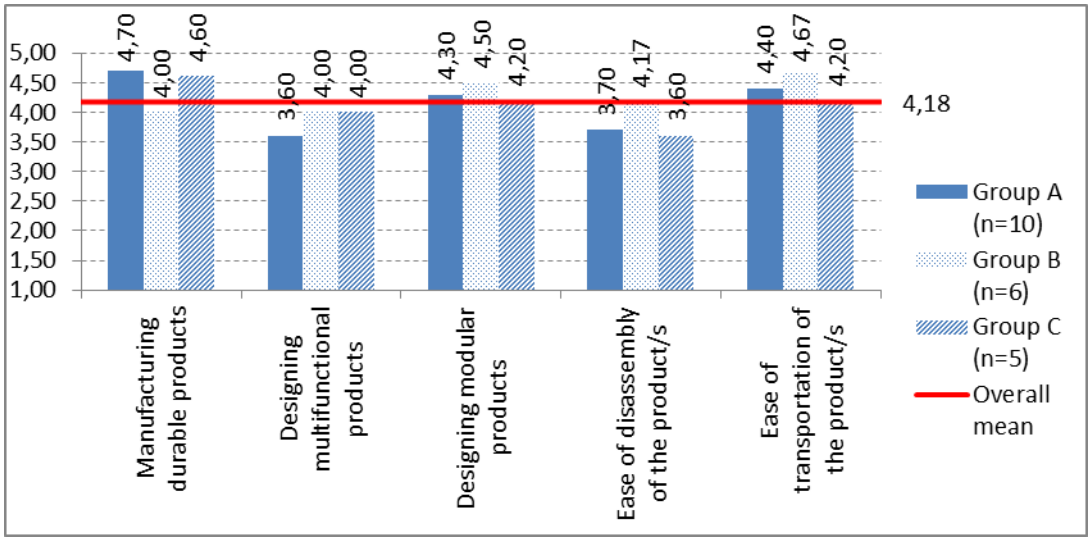

Figure 4.29: Cross-comparison of SPD strategies related to product features

According to results in figure 4.29, all strategies and groups have close ratings. Although they can arise from different reasons, their frequency of use is parallel with each other. Overall, the results in figure 4.17 show that participants in all groups are considering SPD strategies related to product features more frequently than for other subgroups.

4.7.4 Strategies related to extending life-time of products

Group A – no designer

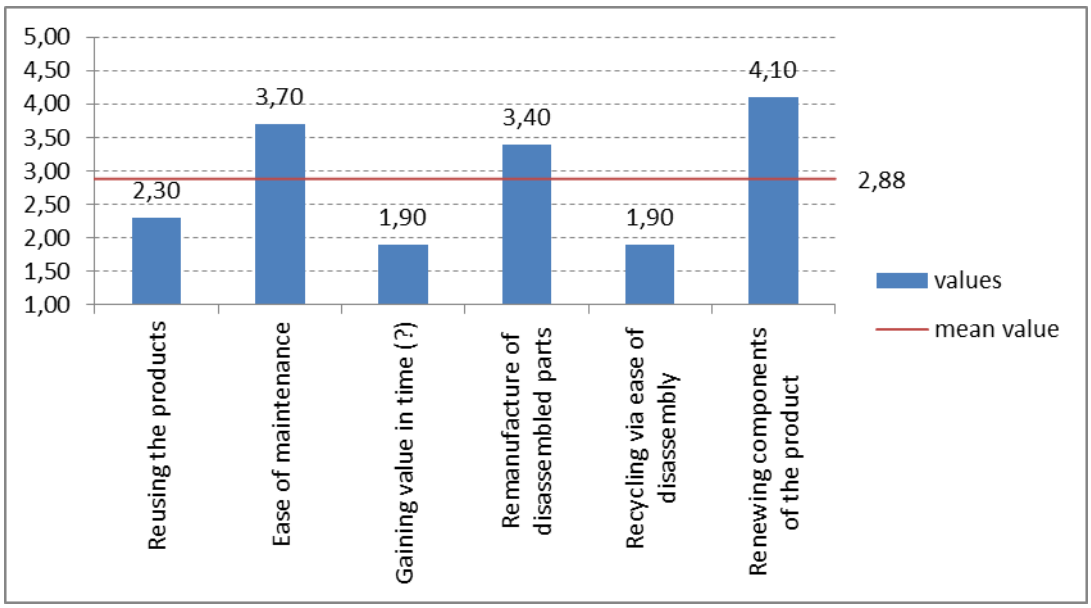

Figure 4.30: SPD strategies related to extending life-time of products (Group A)

According to figure 4.30, SPD strategies in this subgroup do not get a chance to be utilized as much as strategies mentioned in other sections. The results show that three strategies are used more frequently, while the remaining strategies are rarely used.

'Renewing components of the product' (4.1/5.0) is the most frequently used strategy related with product life-time extension. Participants emphasized that product components used in furniture have different life-times and replacing worn-out components helps furniture to be used for a longer period of time. Moreover, they mentioned that this strategy is used more frequently during economic crises. Customers with limited financial resources prefer to renovate/recondition their furniture's upholstery, cushioning and accessories and maintain the original skeleton. This strategy allows customers to both save money and renew their furniture simultaneously.

'Ease of maintenance' (3.7/5.0) is referred to as the second most frequently used strategy in this subgroup. The third most frequently used strategy, 'remanufacture of disassembled parts' (3.4/5.0) is carried out 'sometimes' according to the results. Participants touched briefly on a close relationship between two strategies. Disassembling is used as a strategy for enhancing easier maintenance along with improved transportation efficiency. However, disassembling is not referred to as a strategy which is frequently used in product development.

In terms of rarely used strategies, 'gaining value in time' and 'recycling via ease of disassembly' (1.9/5.0) share the least value. Although collectibles and classic design is frequently mentioned during the interviews, participants emphasized that these issues do not provide any financial benefit for them. In spite of the fact that, traditional furniture and manufacturing techniques are more common in this group compared to Group B, participants do not use their advantage in this issue effectively. Only end-of-life strategy is mentioned in this section (recycling via ease of disassembly), and it has one obstacle for this group. In spite of the fact that 'designing modular products' (4.3/5.0) and 'ease of disassembly of the products' (3.7/5.0) are rated with higher values, participants mentioned that recyclability of manufacturing materials is not considered frequently during their product development process. Therefore a design for disassembly strategy within their products is not related to recycling needs or purposes.

Group B – in-house designer

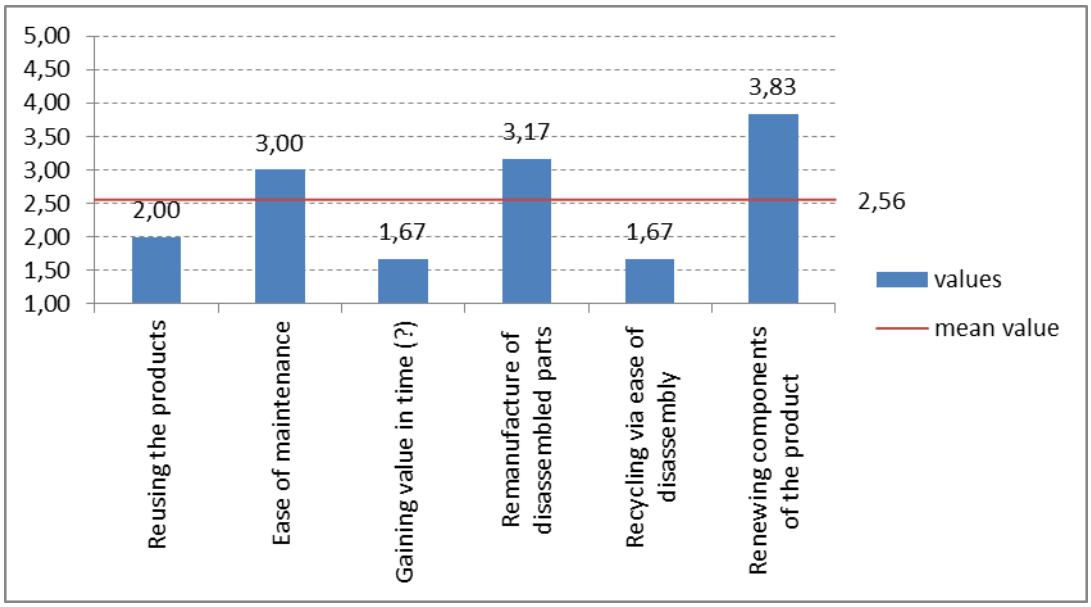

Figure 4.31: SPD strategies related to extending life-time of products (Group B)

According to figure 4.31, the order of SPD strategies in Group B is parallel with Group A. 'Renewing components of the product' (3.83/5.0) is rated as the most frequently used SPD strategy in this category, followed by 'remanufacture of disassembled parts' (3.17/5.0) and 'ease of maintenance' (3.0/5.0). Although the three most frequent strategies are the same with Group A, participants pointed out a different perspective regarding maintenance issues. They emphasized that maintenance involves two different approaches. Smaller scale companies with limited financial and manufacturing capabilities are dealing with repair more frequently. In other words, batch manufacturing enterprises prefer repairing product components while they mostly prefer replacing damaged/worn out parts with new ones.

Three remaining SPD strategies, 'reusing the products' (2.0/5.0), 'gaining value in time' and 'recycling via ease of disassembly' (1.67/5.0) are rated with close values to Group A. However, unlike Group A, participants pointed out that they do not renovate their customers' old furniture. They emphasized that renovation is more suited to furniture manufacturing enterprises with batch production facilities.

Group C – consultant designer

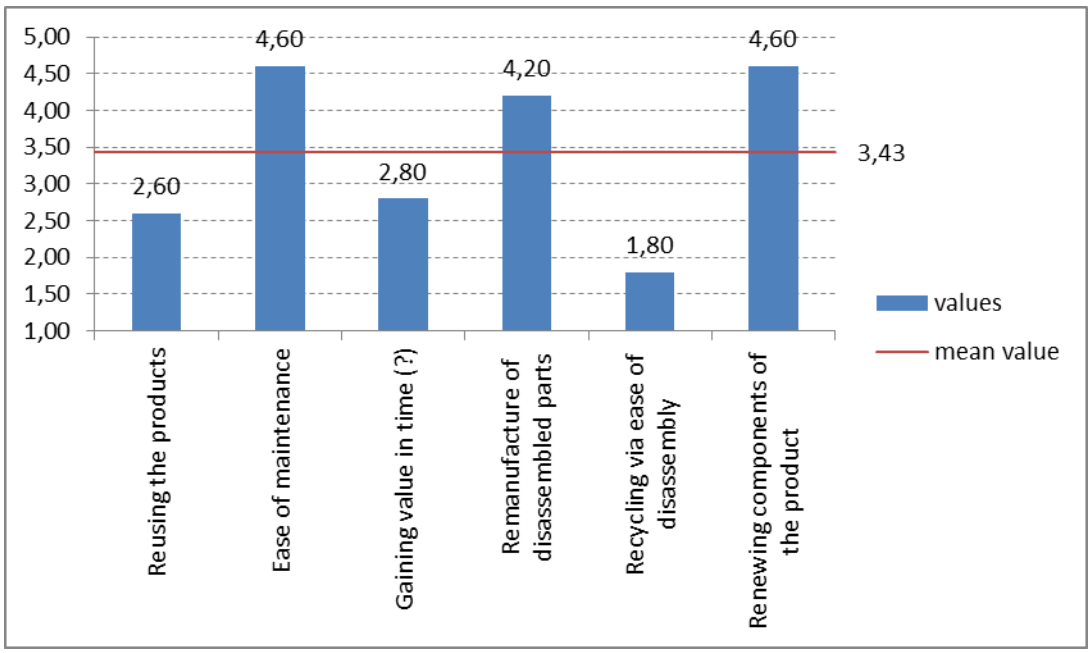

Figure 4.32: SPD strategies related to extending life-time of products (Group C)

According to Figure 4.32, the three most frequently used SPD strategies in this category repeat in the same order as in Group B. However the values of these strategies, 'renewing components of the products' (4.6/5.0), 'ease of maintenance' (4.6/5.0) and 'remanufacture of disassembled parts' (4.2/5.0), are higher compared to the other two groups. It can be estimated that, freelance furniture designers use these SPD strategies more frequently compared to the two other groups. Participants mentioned that they experienced these strategies during their education and their previous projects for which they collaborated with large-scale furniture manufacturing enterprises. Besides, they emphasize that these strategies are useful for convincing their clients about their contribution to their clients' former products.

The other three SPD strategies in this category are still being used but less frequently than the others. While freelance furniture designers share similar approaches with the other two groups in terms of 'recycling via ease of disassembly' (1.8/5.0) and 'reusing the products' (2.6/5.0), their have a different attitude about 'gaining value over time'. Participants in this group emphasized that this strategy would promise great benefits both for their clients and their firms. However, the product visions of their clients and market conditions do not allow them to study on "timeless" designs or potential 'design classics'. Still, this reason cannot be evaluated as a 'no-go barrier' for freelance furniture designers.

Cross-comparison of groups

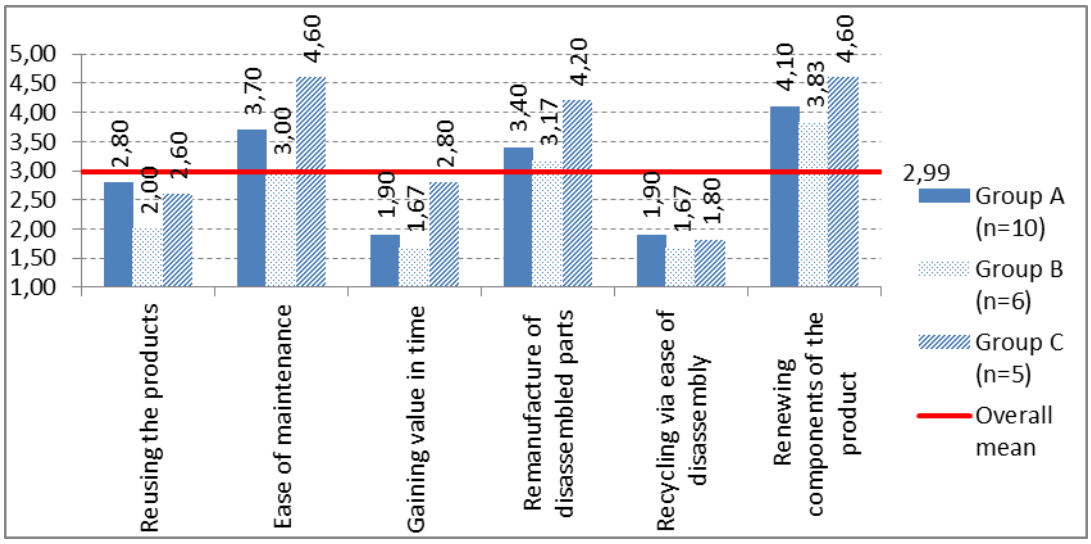

Figure 4.33: Cross-comparison of SPD strategies related to extending life-time of products

According to results illustrated in Figure 4.33, the participants from the three groups agreed on the frequently used SPD strategies, namely 'renewing components of the product' (4.18/5.0), 'ease of maintenance' (3.77/5.0), 'remanufacture of disassembled parts' (3.59/5.0). Among these SPD strategies Group C evaluated the highest values, meaning they conduct these strategies more frequently than other participants. The highest numerical difference in these results was found out for the 'ease of maintenance' strategy. Although Group C has a higher score than other groups, it cannot be estimated that the other two groups do not consider these strategies in their product development process, because values of the other two groups still vary from 'sometimes' to 'usually' in frequency. In other words, these SPD strategies are set in higher stages of priority list of freelance designers.

In terms of 'rarely' used SPD strategies, all groups share the same perspective on 'recycling via ease of disassembly' (1.79/5.0), which is the rarest strategy. For the other two rare strategies, 'reusing the products' (2.47/5.0) and 'gaining value in time' (2.12/5.0), participants of Group C gave higher values than Group B as in previous SPD strategies mentioned above.

4.7.5 Strategies related to new product development

Cross-comparison of groups

According to results illustrated in figure 4.34, the participants from the three groups agreed on the frequency of SPD strategy, namely 'adapting to new technologies' (4.1/5.0). All participants were willing to adapt new technologies. However participants of Group A were

not very optimistic about this strategy because of their financial limitations and they emphasized that they are following the new technologies as much as they can. In other words they reflected their precatory words in this section. Another interesting point in the study is about the other strategy, which is 'developing know-how at the company' (3.7/5.0). Participants of Group C mentioned that developing know-how is not usually applicable during their collaborations. In fact, this strategy is more related to in-house designers because their responsibility for the improvement of confidential know-how is higher compared to themselves.

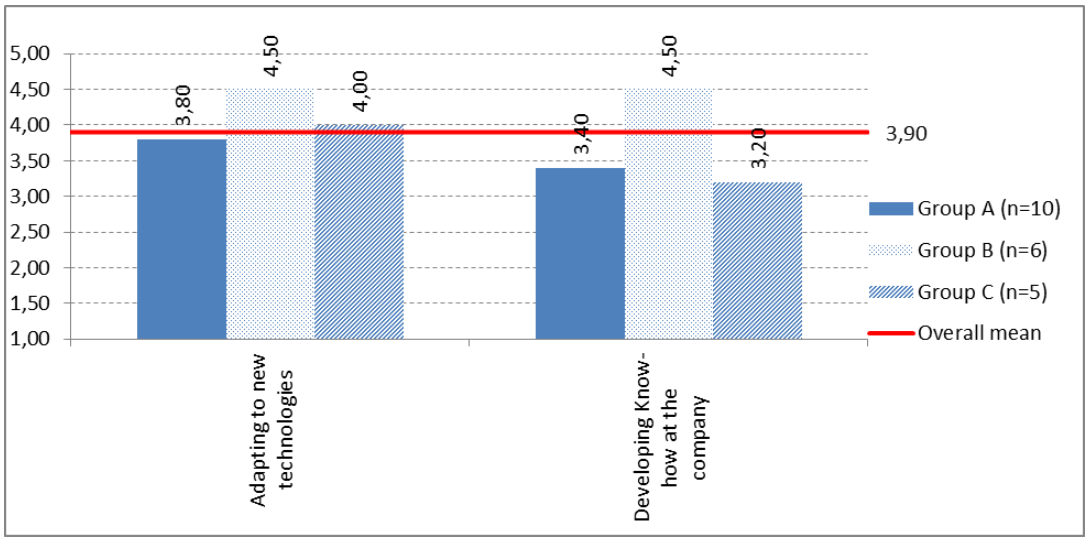

Figure 4.34: Cross-comparison of SPD strategies related to new product development

CHAPTER 5

CONCLUSIONS

In this chapter, findings of the field study are analysed so as to provide answers to the research questions mentioned at the commencement of the study. In the later sections, the chapter provides a discussion of implications for further research and limitations of the study.

5.1 Research questions revisited

In this section, the three main research questions are discussed and analysed in the light of the field study findings.

Q1: Do SME furniture manufacturers in the Ankara region implement SPD; and if not, what barriers prevent them from doing so? How can SPD be shifted into a main-stream concern for these companies?

Unfortunately, none of the participants mentioned a specific SPD approach during their product development. Although some of the SPD strategies mentioned in the eighth section of the interview (see Appendices A and B), are frequently used by the participants, still it cannot be assessed that the participants implement SPD. The main reason for this is the fact that the overall concept of sustainability is not mentioned as a priority by the participants.

Table 5.1: Most influential barriers to implementing SPD in furniture manufacturing SMEs in the Ankara region

Barriers	Likert-scale value (/ 5.00)
• Economic instability of the country	4,79
• Not to be seen as a commercial benefit	4,64
• Gap between the developers and practitioners of SPD	4,59
• Lack of used tools	4,57
OVERALL MEAN (OF ALL BARRIERS)	**3,95**
STANDARD DEVIATION	**0,55**

The most influential barriers to implementing SPD are illustrated in Table 4.1. They were selected based on having values above one standard deviation from the mean value. Barriers related to economic disadvantages and SPD tools were found to be the most

influential from the field study. Regarding SPD tools, participants encountered obstacles about getting information or obtaining consultancy about SPD, and learning how to implement SPD approaches in their product development projects. As mentioned in the field study findings, economic obstacles can act as a 'no-go barrier', which means these barriers can prevent furniture manufacturing SMEs in the Ankara region from implementing SPD despite possible future benefits.

In fact, the reason that economic instability of the country is mentioned as the most influential barrier, as well as the most commonly mentioned reason in the study, is that changing conditions of the industry disables them to make long-term strategies for their future goals. The unpredictable economic crisis possibilities in the sector lead these companies to keep their economic savings rather than investing their limited resources into new product development projects. Therefore, these companies become more passive in difficult financial climates compared to other periods.

The ineffective barriers are helpful for revealing the strong features of furniture manufacturing SMEs in the Ankara region. There are two barriers with values falling below one standard deviation from the overall mean value (see Appendix C). These drivers are 'conflicting with product features' (3.17/5.0) and 'lack of time' (2.93/5.0). In terms of time management for SPD projects, participants mentioned that they can arrange time for these training activities during seasons when the sector does not have intense work schedules (especially summer seasons). Furthermore, furniture manufacturing SMEs possess confidence that they can deal with SPD concerns whilst not undermining product features. In other words, the participants communicated a tendency to be able to deal with problems about product features while developing furniture in a new approach (SPD).

In order to change SPD into a mainstream concern for furniture manufacturing SMEs in Ankara region, SPD should promise serious win-win situations for them. According to the field study, companies are not open to try SPD as a strategy in their firms as long as it is perceived as a serious risk that does not deliver essential benefits. In fact, these firms cannot invest their limited resources in an unfamiliar concept. Therefore, economic opportunities of SPD should be introduced as a solution for these companies, which can help them to deal with their main obstacles, prior to environmental or social aspects of SPD.

In order to convince furniture manufacturing SMEs to give SPD a chance, they should be informed with successful examples of SPD which carried out by their peer groups or competitor companies. For instance, Herman Miller, which was mentioned in the second chapter (p. 16), is not an appropriate example because it does not fit into the profile of furniture manufacturing SMEs; however Maria Yee (p. 20) or Diego Masera's study with Mexican furniture workshops can be used as an example for motivating the participants.

Maria Yee is a good example for furniture manufacturing SMEs targeting export markets; because companies employing design-responsible staff or collaborating with freelance furniture designers are interested in strategies which can help them to differentiate from their competitors. Using tacit knowledge and local resources specific to a company's region (even developing new materials based on know-how about these materials) can be useful for these companies. Also, the SPD case study carried out with Mexican furniture manufacturers can be useful for small furniture workshops in Ankara because these companies are also using their craftspeople's capabilities and they share the same obstacles regarding SPD. They both have limited financial resources and manufacturing costs are also influential.

Q2: Which design strategies used by Ankara region furniture manufacturing SMEs have closest resemblance to SPD strategies?

SPD strategies are grouped in five categories, dealing with different aspects of product development and stages of the product life-cycle (see Appendices A and B). Among these subgroups, strategies related to product features are rated as the most frequently applied concepts during product development projects (see Appendix C).

Table 5.2: Most frequently applied SPD strategies in furniture manufacturing SMEs in the Ankara region

SPD strategies	Likert-scale value (/ 5.00)
• Reducing material use • Manufacturing durable products • Ease of transportation of the product/s • Designing modular products	4,71 4,43 4,42 4,33
OVERALL MEAN (OF ALL SPD STRATEGIES)	**3,27**
STANDARD DEVIATION	**1,00**

According to Table 4.2, three of most frequent strategies (i.e. manufacturing durable products, ease of transportation of products and designing modular products) relate to product features. Within these strategies, 'manufacturing durable products' is mentioned as the most frequently used strategy. All participants mentioned that they usually use this strategy, however only participants in Group B (firms with design responsible personnel) mentioned that the concept of durability should be evaluated within the borders of a product's estimated life-time and manufacturers' responsibilities. The two other strategies mentioned deal with the logistics phase of furniture production and distribution. In spite of the fact that participants mentioned that changing transportation type or shortening distances by reconfiguring networks are almost never used, it is clear that they focus on improving transportation efficiency by developing the transportation efficiency of their products.

The only SPD strategy not falling under the 'product features' subgroup was 'reducing material use'. This strategy was rated with the highest value within all SPD strategies and was referred to as being implemented in almost all product development processes. This result was expected before the study, because this strategy not only considers sustainability but also promises remarkable economic savings for manufacturers. Reducing material costs is valuable for the furniture manufacturing industry because raw material shortage is mentioned as a threat for this industry (MOBSAD, 2009).

Table 5.3: Rarely used SPD strategies in furniture manufacturing SMEs in the Ankara region

SPD strategies	Likert-scale value (/ 5.00)
• Gaining value in time	2,12
• Shortening transportation distances	2,09
• Using recycled materials	1,87
• Recycling via ease of disassembly	1,79
• Using / selecting environmental friendly materials for packaging	1,74
• Using clean energy resources	1,48
• Selecting transportation type with lesser effect on the environment	1,14
OVERALL MEAN (OF ALL BARRIERS)	**3,27**
STANDARD DEVIATION	**1,00**

According to Table 4.3, seven SPD strategies are not amongst the design strategies used by furniture manufacturing SMEs in the Ankara region. These seven strategies were referred to as ranging from "never" to "rarely" used, according to the Likert-scale. Because of the fact that these strategies are not well known for these enterprises, designers who are implementing SPD in these enterprises should be cautious about their adoption. While three of these strategies are not preferred because of incapability, others still can be implemented by all enterprises regardless of their scales. The three strategies with the lowest values (selecting transportation type with lesser effect on the environment, using clean energy sources and selecting environmental friendly materials for packaging) are criticized by not being suitable for firms at an SME scale, because of their financial investment requirements. However, it is possible to implement the remaining strategies. Two of these strategies (using recycled materials and shortening transportation distances) can be implemented if supply chains are reconfigured accordingly. In terms of 'recycling via ease of disassembly', a 'design for disassembly' approach should be supported by additional gains. Although recycling is a positive outcome for the future, still this approach can be used for reducing maintenance and renovation costs, which would be more attractive to SMEs than a direct result in environmental benefits. In spite of the fact that the most rarely used SPD strategy (gaining value in time) has examples in foreign markets, it was found not applicable to the participants of this study because they emphasized that

they do not get benefit from classic furniture or exchange of these artefacts. Therefore designers should adopt other value-creation scenarios to economic returns.

Q3: Which internal and external opportunities of SPD are influential on Ankara region SMEs operating in the furniture manufacturing sector?

Concerning internal and external opportunities, the grading for two particular drivers was higher than one standard deviation (see Appendix D). The internal driver 'improving product quality' (4.54/5.0) was evaluated as one of the most influential drivers in all groups. Although it is not above the standard deviation range in the first two groups (Group A and Group B), the overall mean value is still the highest among all internal drivers. The other most influential opportunity was an external driver, defined as 'market competition' (4.71/5.0). All participant groups rated this driver as the most influential driver. Moreover, participants referred to this driver as a 'must' more than an opportunity. Therefore a SPD approach must suit to requirements of market competition in order to have a chance of being implemented by furniture manufacturing SMEs in the Ankara region. Otherwise it would not prefer to be used by these enterprises.

Another set of internal drivers which is important to mention is 'new market opportunities'. These opportunities were divided into two drivers in the study: 'export opportunities' (4.06/5.0) and 'new market opportunities in the local market' (3.97/5.0). These drivers were graded as influential. However, the different characteristics of participant groups reduce the overall mean value of each driver. For example, on the one hand, furniture manufacturing SMEs, in which no design-responsible personnel is employed, are not interested in foreign markets because they do not have access to these economies. In other words, they see their future in the national economy rather than foreign markets. On the other hand, furniture manufacturing SMEs with higher design capabilities (i.e. employing in-house design-responsible staff, or outsourcing design consultancy), along with freelance furniture designers, are more interested in foreign markets than internal markets. They emphasize increasing the share of exports as an opportunity for the sector.

In addition to the most influential drivers, it can be useful to review the drivers that are not rated as influential. Lack of influence of drivers is useful for improving sustainability projects which will be developed in the near future. In this sense, the least effective strategy in the study, which should be discussed at first, was uncovered as 'NGO pressure' (1.59/5.0). Participants mentioned that they do not get involved with any NGO with regard to sustainability issues. In fact, they claim that they do not sense any NGO pressure on any issues. From this perspective, it is fair to say that NGOs do not play a role in furniture manufacturing SMEs' product development activities in the Ankara region. This result was foreseen as an outcome, because of the fact that during the field study set-up the contact resources of furniture manufacturing SMEs was found inadequate. In other words, even if NGOs are interested in lobbying or supporting furniture manufacturing SMEs; there is no

constitution responsible for the industry. The second ineffective driver in the study was found to be 'supplier demand' (2.31/5.0). As with 'NGO pressure', furniture manufacturing SMEs do not come across demand from their suppliers with regard to sustainability assessments of their products. In fact, their relationship is referred to as only involving trade and payments. Moreover, freelance furniture designers underline the fact that supplier selection and relations are out of their job description, whereas in-house designers have more influence on this issue. The third and last ineffective driver is the 'sustainability awareness of the company' (2.86/5.0). 'Sustainability awareness' is a complicated issue because it is not always possible to see the direct outcomes of this driver as an approach to SPD. Participants mostly figured that in spite of the fact that they are aware of sustainability problems, they do not know their role in this phenomenon or the ways in which they can participate or contribute.

Q4: How do the opportunities and barriers to SPD differ between (i) furniture companies employing no specific design-responsible staff, (ii) furniture companies employing design-responsible staff, and (iii) freelance designers providing design services to furniture companies?

Although all three groups share common approaches in terms of opportunities and barriers to SPD, their differences can also be helpful for future studies, which would be conducted with enterprises fitting the criteria mentioned above.

In spite of the fact that all participants were positive about the new market opportunities that can be developed with more sustainable products, companies employing no specific design-responsible staff have a different approach regarding their target markets. Compared with the other two groups, these enterprises prioritize local markets rather than exporting their products to foreign markets (see Appendix J). In fact, companies interested in increasing their export share consider product design as a key element for achieving their purpose. Therefore furniture companies employing design responsible and freelance furniture designers also consider improving brand identity as more important compared to the companies employing no specific design-responsible staff. Therefore, designers who are collaborating with companies previously employing no design-responsible staff, or who find themselves working as an in-house designer, can be expected to focus on market trends and requirements of local market before foreign ones.

In addition to these, norms and standards were considered as more important by freelance furniture designers compared to furniture companies employing no specific design responsible staff. The most probable reason behind this difference is the fact that freelance furniture designers are mostly dealing with manufacturing in high volume production rather than custom or low quantity manufactured products. In this sense, standards claiming sustainability goals in this sector can prompt furniture companies manufacturing in high volumes of quantity to consider features of their products in terms of sustainability.

5.2 Avenues for further research

Although the results of the study reveal that barriers to implementation of SPD are more influential than drivers, sustainable furniture design has a great variety of issues that can be studied in order to increase success rates. Moreover, the findings of the research show that how different design capabilities of furniture manufacturing SMEs can be tied to different product development approaches. Thus, further work in the area can be narrowed-down in terms of subsectors and features of SPD tools used within these sectors. For instance, Eco labelling is widely used in the furniture sector but has no application for SMEs. In addition, environmental management systems are mentioned to be too complex and expensive for SMEs. Another potential subject for research is the gap between researchers and practitioners of SPD. Researchers can execute SPD training sessions with furniture SMEs, funded by NGOs or government institutions. With the help of such training, the level of awareness of enterprises regarding sustainability and product design can be raised and analysed, so that the impact of awareness and background knowledge on SPD can be assessed.

Another approach about SPD and SMEs is research through design (i.e. using design practice as a vehicle for a research study). In most case studies, the impact of professional product designers on SPD is not mentioned. Collaboration between educational institutions, professional furniture designers or furniture manufacturing SMEs, particularly through social responsibility projects, can help to reveal and articulate the differences that product designers can make to the industry with regard to improving sustainability credentials. Moreover, such studies can result in SPD methods specific for the furniture industry. However, a researcher employing a ‘research through design’ approach should be patient for getting finalized results, because analysis of product development, manufacturing processes, marketing, and end-of-life impacts of a designed product will take far more time than survey studies, which examine existing products and make projections about future outcomes.

5.3 Limitations of the study

In this last section, the different types of difficulties encountered during the study are mentioned, in order to help future researchers interested in studying relations between SMEs and SPD. It is also essential that limitations of the study and mentioned so as to be rectified or otherwise dealt with during any follow-up work for this present study.

The main obstacle countered in the field study was the lack of valid information databases about micro-sized enterprises. Most online databases of furniture NGOs are either not up to

date or include very little information about their members. Also, the most well-known sectorial communities consist of large-sized companies rather than SMEs.

Communication with the participants was another issue that should be addressed in the preparation phase of follow-up work or future studies. For this present study, the interview guideline sheet was prepared in both English and Turkish because it was necessary to conduct the study in participants' native language (Turkish) but report the findings in the instructional language of METU (English). Translation of sustainability terms was not easy to deal with because some of the terms' meanings in the Turkish language will undoubtedly have caused some degree of ambiguity. Moreover, sustainability terms in general are not clear for SMEs and they are not part of the daily language used within the furniture industry.

Lastly, because of inadequate data about companies in the sector, it was necessary to adopt availability sampling as the means for securing participants. Therefore the participants in the study represent no orderly or predefined selection from amongst subsectors. There are many subsectors in the furniture industry, dealing with different materials, manufacturing processes and markets. The industry is sufficiently broad that it will require larger-scale follow-up studies to draw general conclusions, rather than to make inferences from the findings reported from this more modest study. With this in mind, it may not be possible to find out specific features of companies or their operations unless collaborating with them in actual product design projects.

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APPENDIX A

PRE-FORMATTED INTERVIEW SHEET FOR GROUP A and B

(English Version)

1. Information about the firm/participant:

Position in the firm:	
Managerial structure of the company:	
Number of employee:	
Turnover (TL):	

2. Connections of the firm:

The organizations of which the firm has a membership:	
	Chamber of commerce
	Chamber of industry
	TIM (Turkish exporters assembly)
	KOSGEB (Small and medium industry development organization)
	OMSIAD(Office Furniture Industrialists and Businessmen Association)
	UAB (Turkish Timber Association)
	MOSDER (Association of Turkish Furniture Manufacturers)
	MOBSAD (Association of Turkish Furniture Industry Businessmen)
	MOBDER (Welfare Association of Exporters and Importers - Furniture Producers)
	Chamber of Furniture Makers and Carpenters
	Other ……

How do you explain the relationship of your company with the previously identified organizations?	
Legalizing export	
Institutionalisation (Eg:ISO...)	
Training	
New market opportunities	
Constructing local business network	
Other: ……	
Other: ……	

With what partner or subcontractor does your firm cooperate:	
Transportation:	
Raw material supplier:	
Manufacturing materials supplier: (paint, dye, laminates, etc.)	
Manufacturing technologies:	
Other:	
Other:	

3. Proficiency of the firm

Does your firm have any certificate about environmental management? If yes please specify? (ISO 14001, OSSAS, etc.)	
Yes	No

Did you get any training about these quality managements and sustainable product design? If yes please specify?	
Yes	No

Does local profession (tacit knowledge) play a role in your industrial design?	
Yes	No

4. Industrial design activities in the firm:

Have you undertaken any workshops or studies about product development in your company?	
Yes	No

Who takes the decisions through the product development process?

Do you have any experience of industrial design in your company?	
Yes	No

Which department or position in your company carries out industrial design studies?

Do you have any experience of industrial design in your company?		
In house	Part-time	Consultancy

In which phases does the designer participate in the product development?	
	Defining the gap in the market
	Concept generation
	Product development and design
	Developing prototypes
	Manufacturing
	Offering in the market
	...
	...

Do designers working for your company have influence on the:	
	Material selection
	Supplier selection
	Manufacturing process

Are the advantages of flexible production techniques and integrated scales raised during design for manufacture discussions?	
Yes	No

Did the designer get detailed information about the production capabilities of the firm?	
Yes	No

5. Consumer/client feedback

How do you get user feedback about your products?

Do you have any local networking effort about user feedback?	
Yes	No

6. Drivers of Sustainable Product Design

Factors to implement Sustainable Product Design can come from two different directions: from within the business itself (internal drivers) or from outside the company (external drivers).

Please rate your answers for the influence of the drivers below. 5 is for most, 1 is for least	**5**	**4**	**3**	**2**	**1**
Internal Drivers for Sustainable Product Design					
Export opportunities					
New market opportunities in local market					
Cost reduction					
Improving brand image					
Improving product quality					
Awareness of the company					
Long term innovation opportunities					
External Drivers for Sustainable Product Design					
Public opinion					
Legislations					
NGO pressure					
Norms and standards					
Customer demand					
Supplier demand					
Market competition					
...					
...					

7. Barriers against sustainable product design

There are some barriers that limit firms' abilities to commit to sustainable design approaches.

Please rate your answers for the influence of the barri below. (5 is for most, 1 is for least)	**5**	**4**	**3**	**2**	**1**
Economic stability of the country					
Financial limitations					
Insufficient financial support					
Lack of time					
Not to have long-term strategy in the organization					
Not to have top management commitment for the environment					
Lack of information					
Lack of used tools					
Complexity of sustainability tools					
Gap between the developers and practitioners of SPD					
Lack of consumer demand					
Not to be seen as a commercial benefit					
Conflicting with product features					
No alternative solutions					
...					
...					

8. Sustainable Product Design Strategies:

Various strategies of sustainable product design approach can be adapted to the stages of product development projects.

How often does your company use strategies mentio below? (5:usually, 1: never)	**5**	**4**	**3**	**2**	**1**
Use of material					
Using materials harmless for the environment					
Using recyclable materials					
Using recycled materials					
Reducing material use					
Reducing material diversity					
Reducing material weight					
Reducing product dimensions					
Using local raw materials					
Using / selecting environmental friendly materials for packaging					
Manufacturing Stage					
Reducing manufacturing stages					
Reducing energy consumption					
Improving transportation efficiency					
Selecting transportation type with lesser effect on the environme					
Shortening transportation distances					
Reducing wastes					
Using clean energy resources					
Product Features					
Manufacturing durable products					
Designing multifunctional products					
Designing modular products					
Ease of disassembly of the product/s					
Ease of transportation of the product/s					
Extending Life-time of the Products					
Reusing the products					
Ease of maintenance					
Gaining value in time (?)					
Remanufacture of disassembled parts					
Recycling via ease of disassembly					
Renewing components of the product					
Product Development					
Adapting to new technologies					
Developing Know-how at the company					
Other					
Other					
Other					

APPENDIX B

PRE-FORMATTED INTERVIEW SHEET FOR GROUP A and B

(Turkish Version)

1. Firma bilgileri:

Firmadaki görevi:	
Firmanın yönetim yapısının durumu:	
Çalışan sayısı:	
Yıllık Ciro/ İhracat rakamları:	

2. Firma bağlantıları:

Firmanın üyesi olduğu örgütler:	
	Ticaret odası
	Sanayi odası
	Türkiye İhracatçılar Meclisi
	KOSGEB
	OMSİAD (Ofis Mobilyaları Sanayi ve İş Adamları Derneği)
	TAİF (Türkiye Ağaç İsleri Esnaf ve Sanatkârları Federasyonu)
	MOSDER (Mobilya Sanayicileri Derneği)
	MOBSAD (Mobilya Sanayi İş Adamları Derneği)
	MOBDER (Mobilya Sanayicileri İthalat ve İhracatçıları Sosyal Yardımlaşma Derneği)
	Mobilyacı ve Marangozlar Odası
	Diğer…

Firmanızın üyesi olduğu örgütlerle (eğer varsa) ilişkisini nasıl tanımlarsınız:	
İhracat izni	
Kurumsallaşma	
Eğitim	
Yeni pazar olanakları	
Yerel iş ağı oluşturmak	
Diğer: …	
Diğer: …	

Firmanın ilişkide olduğu diğer firmalar:	
Nakliye:	
Hammadde tedariki:	
Üretim malzemeleri tedariki: (Boya, lake, kaplamalar)	
Üretim teknolojisi:	
Diğer:	
Diğer:	

3. Firma donanımı:

Firmanızın çevre yönetimi sistemleri ile ilgili sahip olduğu toplam kalite sertifikası var mı? (ISO 14000 vb.) Varsa açıklar mısınız?	
Evet	Hayır

Firmanızda çevre kalite yönetimi ve sürdürülebilir ürün tasarımı konusunda herhangi bir eğitim verildi mi? Varsa açıklar mısınız?	
Evet	Hayır

Firmanızın ürünlerinin tasarımında yerel uzmanlığınızın rolü var mıdır?	
Evet	Hayır

4. Firmanın endüstriyel tasarım ilişkileri:

Firmanız bünyesinde ürün geliştirme çalışmaları yürütüyor musunuz?	
Evet	Hayır

Ürün geliştirme aşamasında proje kararlarını kimler alıyor?

Firma olarak endüstriyel tasarım konusunda çalışma tecrübesi edindiniz mi? (E/H)	
Evet	Hayır

Firmanızda endüstriyel tasarım çalışmaları hangi pozisyon ya da departman tarafından yürütülmektedir?

Firmanızın tasarımcılarla çalışma şekli nasıldır?		
Tam zamanlı	Yarı zamanlı	Danışmanlık

Tasarımcı ürün geliştirme sürecine hangi aşamada katılmıştır?	
	İhtiyaç belirleme
	Konsept geliştirme
	Ürün geliştirme ve tasarım
	Prototip geliştirme
	Üretim
	Pazara sunma
	...
	...

Tasarımcıların proje esnasında aşağıdaki konularda herhangi bir etkisi bulunmakta mıdır?	
	Malzeme seçimi
	Tedarikçi seçimi
	Üretim yöntemi

Proje sürecinde esnek üretim teknikleri ve getirileri konusunu gündeme getirildi mi?	
Evet	Hayır

Tasarımcılar proje esnasında firmanın üretim kabiliyetleri konusunda detaylı bilgi aldılar mı?	
Evet	Hayır

5. Kullanıcı görüşleri

Firmanızın ürünleri ile ilgili kullanıcı görüşlerini nasıl alıyorsunuz?

Bu konuda yerel bir girişiminiz var mı?	
Evet	Hayır

6. Sürdürülebilir ürün tasarımı etmenleri

Sürdürülebilir ürün tasarımına ilişkin etmenler iki farklı sebepten kaynaklanabilir: firma içi faaliyetlerden (iç etmenler), firma dışı faktörlerden (dış etmenler).

Firmanız ile ilgili olarak aşağıda belirtilen etmenlerin etkisini değerlendiriniz. (5: en çok, 1: en az)	**5**	**4**	**3**	**2**	**1**
İç Etmenler					
İhracat olanağı					
Yerel pazarda yeni pazar olanakları					
Maliyetlerin düşürülmesi					
Marka imajının geliştirilmesi					
Ürün kalitesinin arttırılması					
Firma farkındalığı					
Uzun vadede bilgi üretimi					
Dış Etmenler					
Kamuoyu					
Yasal düzenlemeler					
Sivil örgütlerin talepleri					
Norm ve standartlar					
Müşteri talepleri					
Tedarikçi talepleri					
Pazarda rekabet avantajı					
...					
...					

7. Sürdürülebilir ürün tasarımına engeller

Firmanız ile ilgili olarak aşağıda belirtilen engellerin etkisini değerlendiriniz. (5: en çok, 1: en az)	**5**	**4**	**3**	**2**	**1**
Ülkedeki ekonomik istikrar durumu					
Finansal yetersizlikler					
Finansal desteklerin yetersizliği					
Zaman yetersizliği					
Firma bünyesinde uzun vadeli planlama yapılamaması					
Firma yönetiminin çevre konusunda herhangi bir yükümlülüğ olmaması					
Konu ile ilgili bilgi yetersizliği					
Teknik malzemelerin yetersizliği					
Teknik malzemelerin karmaşık oluşu					
Uzun vadede getirilerinden kuşku duyulması					
Teknik dokümanları geliştirenlerle uygulayanların bera çalışamaması					
Yeterli müşteri talebinin olmayışı					
Ticari getirisi olmaması					
Ürün özelliklerine ters düşmesi					
Alternatif çözümlerin bulunamayışı					
...					
...					

8. Sürdürülebilir ürün tasarımı stratejileri

Sürdürülebilir ürün tasarımı yaklaşımı ile ilgili çeşitli stratejileri, ürün geliştirme projelerinin aşmalarında kullanılabilmektedir.

Ürün tasarımında firmanızın aşağıdaki stratejilerden ne sıklıkla faydalanırlar: (5:her zaman, 1: hiçbir zaman)	**5**	**4**	**3**	**2**	**1**
Malzeme kullanımı					
Zararsız malzeme seçimi					
Geri dönüştürülebilir malzeme seçimi					
Geri dönüştürülmüş malzeme seçimi					
Malzeme kullanımını azaltma					
Malzeme çeşitliliğini azaltma					
Malzeme ağırlığı azaltma					
Ürün ebatlarını düşürme					
Yerel malzeme kullanımı					
Ambalaj için çevre dostu malzeme kullanımı					
Üretim aşaması					
Üretim basamaklarını azaltma					
Enerji kullanımını düşürme					
Nakliye verimliliğini arttırma					
Çevreye daha duyarlı nakliye yöntemleri kullanma					
Nakliye mesafelerini düşürme					
Üretilen atıkları azaltma					
Temiz enerji kaynaklarını kullanmak					
Ürün özellikleri					
Daha dayanıklı ürünler üretme					
Çok işlevli ürünler üretme					
Modüler ürünler üretme					
Demonte edilmesi kolay ürünler üretme					
Nakliyesi kolay ürünler üretilmesi					
Ürün ömrünün uzatılması					
Ürünlerin tekrar kullanılabilmesi					
Ürün bakımının kolaylığı					
Zamanla ürünün değer kazanması					
Demonte parçaların tekrardan üretilebilmesi					
Kolay demonte ile geri dönüşümün sağlanması					
Ürün birleşenlerinin yenilenebilmesi					
Ürün geliştirme aşaması					
Yeni teknolojilere uyum sağlamak					
Firma bünyesinde teknik bilgi üretilmesi					
…					
…					

APPENDIX C

PRE-FORMATTED INTERVIEW SHEET FOR GROUP C

(English version)

1. Information about the participant:

Would you tell top three sectors of your clients?		

Please rate your answers for the frequency of your consumers' scales below. (5 is for always, 1 is for never)	**5**	**4**	**3**	**2**	**1**
Micro scale (less than 10 employee)					
Small scale (between 10 and 50 employee)					
Medium scale (between 50 and 250 employee)					
Large scale (More than 250 employee)					

Did you get any training about sustainable product design? If yes please specify?	
Yes	No

Does local profession (tacit knowledge) play a role in your designs?	
Yes	No

2. Industrial design activities in the firm

In which phases do you participate in the product development?	
	Defining the gap in the market
	Concept generation
	Product development and design
	Developing prototypes
	Manufacturing
	Offering in the market
	...
	...

Do you have influence on decisions related to issues mentioned below?	
	Material selection
	Supplier selection
	Manufacturing process

Are the advantages of flexible production techniques and integrated scales raised during manufacturing discussions?	
Yes	No

Do you get detailed information about the production capabilities of the firm?	
Yes	No

3. Drivers of Sustainable Product Design

Factors to implement Sustainable Product Design can come from two different directions: from within the business itself (internal drivers) or from outside the company (external drivers).

Please rate your answers for the influence of the drivers below. 5 is for most, 1 is for least	**5**	**4**	**3**	**2**	**1**
Internal Drivers for Sustainable Product Design					
Export opportunities					
New market opportunities in local market					
Cost reduction					
Improving brand image					
Improving product quality					
Awareness of the company					
Long term innovation opportunities					
External Drivers for Sustainable Product Design					
Public opinion					
Legislations					
NGO pressure					
Norms and standards					
Customer demand					
Supplier demand					
Market competition					
...					
...					

4. Barriers against sustainable product design

There are some barriers that limit firms' abilities to commit to sustainable design approaches.

Please rate your answers for the influence of the barri below. (5 is for most, 1 is for least)	**5**	**4**	**3**	**2**	**1**
Economic stability of the country					
Financial limitations					
Insufficient financial support					
Lack of time					
Not to have long-term strategy in the organization					
Not to have top management commitment for the environment					
Lack of information					
Lack of used tools					
Complexity of sustainability tools					
Gap between the developers and practitioners of SPD					
Lack of consumer demand					
Not to be seen as a commercial benefit					
Conflicting with product features					
No alternative solutions					
...					
...					

5. Sustainable Product Design Strategies:

Various strategies of sustainable product design approach can be adapted to the stages of product development projects.

How often does your company use strategies mentio below? (5:always, 1: never)	**5**	**4**	**3**	**2**	**1**
Use of material					
Using materials harmless for the environment					
Using recyclable materials					
Using recycled materials					
Reducing material use					
Reducing material diversity					
Reducing material weight					
Reducing product dimensions					
Using local raw materials					
Using / selecting environmental friendly materials for packaging					
Manufacturing Stage					
Reducing manufacturing stages					
Reducing energy consumption					
Improving transportation efficiency					
Selecting transportation type with lesser effect on the environme					
Shortening transportation distances					
Reducing wastes					
Using clean energy resources					
Product Features					
Manufacturing durable products					
Designing multifunctional products					
Designing modular products					
Ease of disassembly of the product/s					
Ease of transportation of the product/s					
Extending Life-time of the Products					
Reusing the products					
Ease of maintenance					
Gaining value in time (?)					
Remanufacture of disassembled parts					
Recycling via ease of disassembly					
Renewing components of the product					
Product Development					
Adapting to new technologies					
Developing Know-how at the company					
Other					
Other					
Other					

APPENDIX D

PRE-FORMATTED INTERVIEW SHEET FOR GROUP C

(Turkish version)

1. Katılımcı bilgileri:

Müşterleirinizin çoğunlukla oluşturduğu üç sektörü söylermisiniz?		

Lütfen müşterilerinizin çalışan sayısına bağlı ölçklerini sıklıklarına gore sıralayınız? (5: her zaman, 1: hiçbir zaman)	**5**	**4**	**3**	**2**	**1**
Mikro ölçek (10 çalışandan az)					
Küçük ölçek (10 ile 50 çalışan arası)					
Orta ölçek (50 ile 250 çalışan arası)					
Büyül ölçek (250 çalışandan fazla)					

Firmanızda çevre kalite yönetimi ve sürdürülebilir ürün tasarımı konusunda herhangi bir eğitim verildi mi? Varsa açıklar mısınız?	
Evet	Hayır

Firmanızın ürünlerinin tasarımında yerel uzmanlığınızın rolü var mıdır?	
Evet	Hayır

2. Firmalarla endüstriyel tasarım ilişkileri:

Ürün geliştirme sürecine hangi aşamalarda katılım gösteriyorsunuz?	
	İhtiyaç belirleme
	Konsept geliştirme
	Ürün geliştirme ve tasarım
	Prototip geliştirme
	Üretim
	Pazara sunma
	...
	...

Proje esnasında aşağıdaki konularda herhangi bir etkiniz bulunmakta mıdır?	
	Malzeme seçimi
	Tedarikçi seçimi
	Üretim yöntemi

Proje sürecinde esnek üretim teknikleri ve getirileri konusunu gündeme getirildi mi?	
Evet	Hayır

Proje esnasında firmanın üretim kabiliyetleri konusunda detaylı bilgi aldınız mı?	
Evet	Hayır

3. Sürdürülebilir ürün tasarımı etmenleri

Sürdürülebilir ürün tasarımına ilişkin etmenler iki farklı sebepten kaynaklanabilir: firma içi faaliyetlerden (iç etmenler), firma dışı faktörlerden (dış etmenler).

Firmanız ile ilgili olarak aşağıda belirtilen etmenleri değerlendiriniz. (5: en çok, 1: en az)	**5**	**4**	**3**	**2**	**1**
İç Etmenler					
İhracat olanağı					
Yerel pazarda yeni pazar olanakları					
Maliyetlerin düşürülmesi					
Marka imajının geliştirilmesi					
Ürün kalitesinin arttırılması					
Firma farkındalığı					
Uzun vadede bilgi üretimi					
Dış Etmenler					
Kamuoyu					
Yasal düzenlemeler					
Sivil örgütlerin talepleri					
Norm ve standartlar					
Müşteri talepleri					
Tedarikçi talepleri					
Pazarda rekabet avantajı					
...					
...					

4. Sürdürülebilir ürün tasarımına engeller

Firmanız ile ilgili olarak aşağıda belirtilen engelleri değerlendiriniz. (5: en çok, 1: en az)	**5**	**4**	**3**	**2**	**1**
Ülkedeki ekonomik istikrar durumu					
Finansal yetersizlikler					
Finansal desteklerin yetersizliği					
Zaman yetersizliği					
Firma bünyesinde uzun vadeli planlama yapılamaması					
Firma yönetiminin çevre konusunda herhangi bir yükümlülüğ olmaması					
Konu ile ilgili bilgi yetersizliği					
Teknik malzemelerin yetersizliği					
Teknik malzemelerin karmaşık oluşu					
Uzun vadede getirilerinden kuşku duyulması					
Teknik dokümanları geliştirenlerle uygulayanların bera çalışamaması					
Yeterli müşteri talebinin olmayışı					
Ticari getirisi olmaması					
Ürün özelliklerine ters düşmesi					
Alternatif çözümlerin bulunamayışı					
...					
...					

5. Sürdürülebilir ürün tasarımı stratejileri

Sürdürülebilir ürün tasarımı yaklaşımı ile ilgili çeşitli stratejileri, ürün geliştirme projelerinin aşmalarında kullanılabilmektedir.

Ürün tasarımında firmanızın aşağıdaki stratejilerden ne sıklıkla faydalanırlar: (5:her zaman, 1: hiçbir zaman)	**5**	**4**	**3**	**2**	**1**
Malzeme kullanımı					
Zararsız malzeme seçimi					
Geri dönüştürülebilir malzeme seçimi					
Geri dönüştürülmüş malzeme seçimi					
Malzeme kullanımını azaltma					
Malzeme çeşitliliğini azaltma					
Malzeme ağırlığı azaltma					
Ürün ebatlarını düşürme					
Yerel malzeme kullanımı					
Ambalaj için çevre dostu malzeme kullanımı					
Üretim aşaması					
Üretim basamaklarını azaltma					
Enerji kullanımını düşürme					
Nakliye verimliliğini arttırma					
Çevreye daha duyarlı nakliye yöntemleri kullanma					
Nakliye mesafelerini düşürme					
Üretilen atıkları azaltma					
Temiz enerji kaynaklarını kullanmak					
Ürün özellikleri					
Daha dayanıklı ürünler üretme					
Çok işlevli ürünler üretme					
Modüler ürünler üretme					
Demonte edilmesi kolay ürünler üretme					
Nakliyesi kolay ürünler üretilmesi					
Ürün ömrünün uzatılması					
Ürünlerin tekrar kullanılabilmesi					
Ürün bakımının kolaylığı					
Zamanla ürünün değer kazanması					
Demonte parçaların tekrardan üretilebilmesi					
Kolay demonte ile geri dönüşümün sağlanması					
Ürün birleşenlerinin yenilenebilmesi					
Ürün geliştirme aşaması					
Yeni teknolojilere uyum sağlamak					
Firma bünyesinde teknik bilgi üretilmesi					
…					
…					
…					

APPENDIX E

DRIVERS FOR SPD (IN ORDER OF NUMERICAL VALUE)

Drivers for SPD				
Internal Drivers	**Group A**	**Group B**	**Group C**	**Overall Mean Value**
Improving product quality	4,50	4,33	4,80	4,54
Cost reduction	4,70	4,33	4,00	4,34
Export opportunities	2,70	4,67	4,80	4,06
Improving brand image	3,40	4,17	4,60	4,06
New market opportunities in local market	4,40	3,50	4,00	3,97
Long term innovation opportunities	3,40	3,83	3,25	3,49
Awareness of the company	2,60	3,17	2,80	2,86
MEAN VALUE	**3,67**	**4,00**	**4,04**	**3,90**
STANDARD DEVIATION	**0,87**	**0,53**	**0,78**	**0,57**
External Drivers	**Group A**	**Group B**	**Group C**	**Overall Mean Value**
Market competition	4,70	4,83	4,60	4,71
Customer demand	4,40	4,00	4,20	4,20
Public opinion	4,00	4,33	3,00	3,78
Legislations	3,70	3,83	3,80	3,78
Norms and standards	3,20	3,50	4,20	3,63
Supplier demand	2,10	2,83	2,00	2,31
NGO pressure	1,60	1,67	1,50	1,59
MEAN VALUE	**3,39**	**3,57**	**3,33**	**3,43**
STANDARD DEVIATION	**1,16**	**1,05**	**1,20**	**1,09**

: Items rated above standard deviation

: Items rated below standard deviation

APPENDIX F

BARRIERS TO IMPLEMENT SPD (IN ORDER OF NUMERICAL VALUE)

Barriers	Group A	Group B	Group C	Overall Mean Value
Economic instability of the country	4,90	4,67	4,80	4,79
Not to be seen as a commercial benefit	4,70	4,83	4,40	4,64
Gap between the developers and practitioners of SPD	4,83	4,33	4,60	4,59
Lack of used tools	4,60	4,50	4,60	4,57
Doubt about long term benefits	4,50	4,50	4,20	4,40
Complexity of sustainability tools	3,60	4,60	4,00	4,07
Lack of consumer demand	4,40	4,00	3,40	3,93
Financial limitations	4,20	3,33	3,80	3,78
Lack of information	4,20	3,67	3,40	3,76
Not to have top management commitment for the environment	3,60	3,67	4,00	3,76
Not to have long-term strategy in the organization	3,70	3,33	4,20	3,74
No alternative solutions	4,10	3,17	3,60	3,62
Insufficient financial support	3,10	4,00	3,60	3,57
Conflicting with product features	3,50	3,00	3,00	3,17
Lack of time	3,30	3,50	2,00	2,93
MEAN VALUE	**4,08**	**3,94**	**3,84**	**3,95**
STANDARD DEVIATION	**0,58**	**0,60**	**0,72**	**0,55**

: Items rated above standard deviation

: Items rated below standard deviation

APPENDIX G

LIST OF SPD STRATEGIES (IN ORDER OF NUMERICAL VALUE)

SUSTAINABLE PRODUCT DESIGN STRATEGIES	Group A	Group B	Group C	Mean value
Reducing material use	4,50	4,83	4,80	4,71
Manufacturing durable products	4,70	4,00	4,60	4,43
Ease of transportation of the product/s	4,40	4,67	4,20	4,42
Designing modular products	4,30	4,50	4,20	4,33
Renewing components of the product	4,10	3,83	4,60	4,18
Adapting to new technologies	3,80	4,50	4,00	4,10
Improving transportation efficiency	3,40	4,17	4,60	4,06
Reducing material diversity	3,30	4,17	4,60	4,02
Designing multifunctional products	3,60	4,00	4,00	3,87
Ease of disassembly of the product/s	3,70	4,17	3,60	3,82
Ease of maintenance	3,70	3,00	4,60	3,77
Developing Know-how at the company	3,40	4,50	3,20	3,70
Reducing manufacturing stages	2,90	3,67	4,40	3,66
Reducing material weight	3,20	3,17	4,40	3,59
Remanufacture of disassembled parts	3,40	3,17	4,20	3,59
Reducing energy consumption	3,30	4,33	3,00	3,54
Using materials harmless for the environment	3,40	3,83	3,20	3,48
Reducing wastes	2,60	4,17	3,40	3,39
Using local raw materials	3,50	3,00	3,40	3,30
Reducing product dimensions	3,00	3,17	3,60	3,26
Using recyclable materials	2,00	3,33	3,20	2,84
Reusing the products	2,80	2,00	2,60	2,47
Gaining value in time	1,90	1,67	2,80	2,12
Shortening transportation distances	2,20	2,33	1,75	2,09
Using recycled materials	1,60	2,00	2,00	1,87
Recycling via ease of disassembly	1,90	1,67	1,80	1,79
Using / selecting environmental friendly materials for packaging	1,44	2,17	1,60	1,74
Using clean energy resources	1,60	1,83	1,00	1,48
Selecting transportation type with lesser effect on the environment	1,10	1,33	1,00	1,14
MEAN VALUE	**3,06**	**3,35**	**3,39**	**3,27**
STANDARD DEVIATION	**0,99**	**1,06**	**1,15**	**1,00**

: Items rated above standard deviation

: Items rated below standard deviation

APPENDIX H

ONE WAY ANOVA TEST RESULTS FOR MULTIPLE COMPARISONS OF PARTICIPANT GROUPS (STRATEGIES)

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Strategy 1	GROUP A	GROUP B	-,43333	,67412	,899	-2,3530	1,4863
		GROUP C	,20000	,63246	,986	-1,6365	2,0365
	GROUP B	GROUP A	,43333	,67412	,899	-1,4863	2,3530
		GROUP C	,63333	,73106	,793	-1,5035	2,7702
	GROUP C	GROUP A	-,20000	,63246	,986	-2,0365	1,6365
		GROUP B	-,63333	,73106	,793	-2,7702	1,5035
Strategy 2	GROUP A	GROUP B	-1,33333	,57735	,112	-2,9260	,2593
		GROUP C	-1,20000	,54365	,138	-2,7162	,3162
	GROUP B	GROUP A	1,33333	,57735	,112	-,2593	2,9260
		GROUP C	,13333	,56372	,994	-1,5144	1,7810
	GROUP C	GROUP A	1,20000	,54365	,138	-,3162	2,7162
		GROUP B	-,13333	,56372	,994	-1,7810	1,5144
Strategy 3	GROUP A	GROUP B	-,40000	,47610	,803	-1,7308	,9308
		GROUP C	-,40000	,43970	,765	-1,6402	,8402
	GROUP B	GROUP A	,40000	,47610	,803	-,9308	1,7308
		GROUP C	0,00000	,48305	1,000	-1,4122	1,4122
	GROUP C	GROUP A	,40000	,43970	,765	-,8402	1,6402
		GROUP B	0,00000	,48305	1,000	-1,4122	1,4122
Strategy 4	GROUP A	GROUP B	-,33333	,34960	,735	-1,2898	,6231
		GROUP C	-,30000	,36667	,813	-1,3037	,7037
	GROUP B	GROUP A	,33333	,34960	,735	-,6231	1,2898
		GROUP C	,03333	,26034	,999	-,7421	,8088
	GROUP C	GROUP A	,30000	,36667	,813	-,7037	1,3037
		GROUP B	-,03333	,26034	,999	-,8088	,7421
Strategy 5	GROUP A	GROUP B	-,86667	,42947	,183	-2,0465	,3132
		GROUP C	-1,30000*	,38730	,016	-2,3662	-,2338
	GROUP B	GROUP A	,86667	,42947	,183	-,3132	2,0465
		GROUP C	-,43333	,39299	,656	-1,5852	,7185
	GROUP C	GROUP A	1,30000*	,38730	,016	,2338	2,3662
		GROUP B	,43333	,39299	,656	-,7185	1,5852

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons							
Tamhane							
Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Strategy 6	GROUP A	GROUP B	,03333	,36667	1,000	-,9732	1,0398
		GROUP C	-1,20000*	,40825	,035	-2,3195	-,0805
	GROUP B	GROUP A	-,03333	,36667	1,000	-1,0398	,9732
		GROUP C	-1,23333*	,29627	,011	-2,1451	-,3216
	GROUP C	GROUP A	1,20000*	,40825	,035	,0805	2,3195
		GROUP B	1,23333*	,29627	,011	,3216	2,1451
Strategy 7	GROUP A	GROUP B	-,16667	,47726	,981	-1,5022	1,1689
		GROUP C	-,60000	,60000	,709	-2,2633	1,0633
	GROUP B	GROUP A	,16667	,47726	,981	-1,1689	1,5022
		GROUP C	-,43333	,43333	,738	-1,9116	1,0449
	GROUP C	GROUP A	,60000	,60000	,709	-1,0633	2,2633
		GROUP B	,43333	,43333	,738	-1,0449	1,9116
Strategy 8	GROUP A	GROUP B	,50000	,54263	,775	-1,2704	2,2704
		GROUP C	,10000	,29627	,983	-,7954	,9954
	GROUP B	GROUP A	-,50000	,54263	,775	-2,2704	1,2704
		GROUP C	-,40000	,57155	,880	-2,1764	1,3764
	GROUP C	GROUP A	-,10000	,29627	,983	-,9954	,7954
		GROUP B	,40000	,57155	,880	-1,3764	2,1764
Strategy 9	GROUP A	GROUP B	-,72222	,45677	,360	-1,9760	,5315
		GROUP C	-,15556	,52364	,988	-1,6732	1,3621
	GROUP B	GROUP A	,72222	,45677	,360	-,5315	1,9760
		GROUP C	,56667	,50442	,648	-,9532	2,0866
	GROUP C	GROUP A	,15556	,52364	,988	-1,3621	1,6732
		GROUP B	-,56667	,50442	,648	-2,0866	,9532
Strategy 10	GROUP A	GROUP B	-,76667	,48189	,356	-2,0932	,5599
		GROUP C	-1,50000*	,49777	,030	-2,8664	-,1336
	GROUP B	GROUP A	,76667	,48189	,356	-,5599	2,0932
		GROUP C	-,73333	,32318	,146	-1,6923	,2256
	GROUP C	GROUP A	1,50000*	,49777	,030	,1336	2,8664
		GROUP B	,73333	,32318	,146	-,2256	1,6923
Strategy 11	GROUP A	GROUP B	-1,03333	,59722	,289	-2,6701	,6035
		GROUP C	,30000	,52810	,926	-1,1480	1,7480
	GROUP B	GROUP A	1,03333	,59722	,289	-,6035	2,6701
		GROUP C	1,33333	,52705	,096	-,2169	2,8836
	GROUP C	GROUP A	-,30000	,52810	,926	-1,7480	1,1480
		GROUP B	-1,33333	,52705	,096	-2,8836	,2169

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons							
Tamhane							
Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Strategy 12	GROUP A	GROUP B	-,76667	,37859	,182	-1,8084	,2750
		GROUP C	-1,20000*	,41899	,040	-2,3477	-,0523
	GROUP B	GROUP A	,76667	,37859	,182	-,2750	1,8084
		GROUP C	-,43333	,29627	,459	-1,3451	,4784
	GROUP C	GROUP A	1,20000*	,41899	,040	,0523	2,3477
		GROUP B	,43333	,29627	,459	-,4784	1,3451
Strategy 13	GROUP A	GROUP B	-,23333	,23333	,724	-,9516	,4850
		GROUP C	,10000	,10000	,717	-,1923	,3923
	GROUP B	GROUP A	,23333	,23333	,724	-,4850	,9516
		GROUP C	,33333	,21082	,438	-,4084	1,0750
	GROUP C	GROUP A	-,10000	,10000	,717	-,3923	,1923
		GROUP B	-,33333	,21082	,438	-1,0750	,4084
Strategy 14	GROUP A	GROUP B	-,13333	,59255	,995	-1,7401	1,4735
		GROUP C	,45000	,55000	,814	-1,0761	1,9761
	GROUP B	GROUP A	,13333	,59255	,995	-1,4735	1,7401
		GROUP C	,58333	,41667	,486	-,6689	1,8356
	GROUP C	GROUP A	-,45000	,55000	,814	-1,9761	1,0761
		GROUP B	-,58333	,41667	,486	-1,8356	,6689
Strategy 15	GROUP A	GROUP B	-1,56667*	,48189	,028	-2,9630	-,1703
		GROUP C	-,80000	,72877	,685	-3,3058	1,7058
	GROUP B	GROUP A	1,56667*	,48189	,028	,1703	2,9630
		GROUP C	,76667	,78811	,744	-1,7280	3,2614
	GROUP C	GROUP A	,80000	,72877	,685	-1,7058	3,3058
		GROUP B	-,76667	,78811	,744	-3,2614	1,7280
Strategy 16	GROUP A	GROUP B	-,23333	,40689	,924	-1,3654	,8987
		GROUP C	,60000	,26667	,145	-,1794	1,3794
	GROUP B	GROUP A	,23333	,40689	,924	-,8987	1,3654
		GROUP C	,83333	,30732	,121	-,2479	1,9145
	GROUP C	GROUP A	-,60000	,26667	,145	-1,3794	,1794
		GROUP B	-,83333	,30732	,121	-1,9145	,2479
Strategy 17	GROUP A	GROUP B	,70000*	,21344	,028	,0761	1,3239
		GROUP C	,10000	,32489	,987	-,8319	1,0319
	GROUP B	GROUP A	-,70000*	,21344	,028	-1,3239	-,0761
		GROUP C	-,60000	,24495	,197	-1,5652	,3652
	GROUP C	GROUP A	-,10000	,32489	,987	-1,0319	,8319
		GROUP B	,60000	,24495	,197	-,3652	1,5652

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Strategy 18	GROUP A	GROUP B	-,40000	,47610	,803	-1,7308	,9308
		GROUP C	-,40000	,54160	,861	-2,0354	1,2354
	GROUP B	GROUP A	,40000	,47610	,803	-,9308	1,7308
		GROUP C	0,00000	,57735	1,000	-1,7243	1,7243
	GROUP C	GROUP A	,40000	,54160	,861	-1,2354	2,0354
		GROUP B	0,00000	,57735	1,000	-1,7243	1,7243
Strategy 19	GROUP A	GROUP B	-,20000	,40277	,950	-1,3798	,9798
		GROUP C	,10000	,43076	,994	-1,2591	1,4591
	GROUP B	GROUP A	,20000	,40277	,950	-,9798	1,3798
		GROUP C	,30000	,50662	,920	-1,1943	1,7943
	GROUP C	GROUP A	-,10000	,43076	,994	-1,4591	1,2591
		GROUP B	-,30000	,50662	,920	-1,7943	1,1943
Strategy 20	GROUP A	GROUP B	-,46667	,50111	,747	-1,8245	,8912
		GROUP C	,10000	,64550	,998	-1,7939	1,9939
	GROUP B	GROUP A	,46667	,50111	,747	-,8912	1,8245
		GROUP C	,56667	,59535	,755	-1,3106	2,4440
	GROUP C	GROUP A	-,10000	,64550	,998	-1,9939	1,7939
		GROUP B	-,56667	,59535	,755	-2,4440	1,3106
Strategy 21	GROUP A	GROUP B	-,26667	,33993	,830	-1,1880	,6546
		GROUP C	,20000	,45947	,966	-1,1738	1,5738
	GROUP B	GROUP A	,26667	,33993	,830	-,6546	1,1880
		GROUP C	,46667	,42947	,680	-,9072	1,8405
	GROUP C	GROUP A	-,20000	,45947	,966	-1,5738	1,1738
		GROUP B	-,46667	,42947	,680	-1,8405	,9072
Strategy 22	GROUP A	GROUP B	-,36667	,49554	,852	-1,7097	,9764
		GROUP C	,20000	,64118	,987	-1,6885	2,0885
	GROUP B	GROUP A	,36667	,49554	,852	-,9764	1,7097
		GROUP C	,56667	,59535	,755	-1,3106	2,4440
	GROUP C	GROUP A	-,20000	,64118	,987	-2,0885	1,6885
		GROUP B	-,56667	,59535	,755	-2,4440	1,3106
Strategy 23	GROUP A	GROUP B	1,03333	,59722	,309	-,6913	2,7580
		GROUP C	-,90000	,41500	,141	-2,0371	,2371
	GROUP B	GROUP A	-1,03333	,59722	,309	-2,7580	,6913
		GROUP C	-1,93333*	,55176	,028	-3,6376	-,2291
	GROUP C	GROUP A	,90000	,41500	,141	-,2371	2,0371
		GROUP B	1,93333*	,55176	,028	,2291	3,6376

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Strategy 24	GROUP A	GROUP B	-,60000	,60919	,723	-2,3512	1,1512
		GROUP C	-,90000	,74907	,615	-3,3126	1,5126
	GROUP B	GROUP A	,60000	,60919	,723	-1,1512	2,3512
		GROUP C	-,30000	,83066	,980	-2,8105	2,2105
	GROUP C	GROUP A	,90000	,74907	,615	-1,5126	3,3126
		GROUP B	,30000	,83066	,980	-2,2105	2,8105
Strategy 25	GROUP A	GROUP B	1,06667	,58119	,248	-,5343	2,6676
		GROUP C	-,80000	,44721	,267	-2,0337	,4337
	GROUP B	GROUP A	-1,06667	,58119	,248	-2,6676	,5343
		GROUP C	-1,86667*	,46667	,015	-3,3171	-,4162
	GROUP C	GROUP A	,80000	,44721	,267	-,4337	2,0337
		GROUP B	1,86667*	,46667	,015	,4162	3,3171
Strategy 26	GROUP A	GROUP B	-,26667	,66165	,973	-2,3138	1,7805
		GROUP C	,10000	,46547	,996	-1,2800	1,4800
	GROUP B	GROUP A	,26667	,66165	,973	-1,7805	2,3138
		GROUP C	,36667	,70789	,944	-1,7533	2,4867
	GROUP C	GROUP A	-,10000	,46547	,996	-1,4800	1,2800
		GROUP B	-,36667	,70789	,944	-2,4867	1,7533
Strategy 27	GROUP A	GROUP B	1,60000	,78457	,203	-,7105	3,9105
		GROUP C	-,50000	,47493	,674	-1,8014	,8014
	GROUP B	GROUP A	-1,60000	,78457	,203	-3,9105	,7105
		GROUP C	-2,10000	,71414	,072	-4,4014	,2014
	GROUP C	GROUP A	,50000	,47493	,674	-,8014	1,8014
		GROUP B	2,10000	,71414	,072	-,2014	4,4014
Strategy 28	GROUP A	GROUP B	-,70000	,51747	,484	-2,1069	,7069
		GROUP C	-,20000	,59255	,983	-1,9004	1,5004
	GROUP B	GROUP A	,70000	,51747	,484	-,7069	2,1069
		GROUP C	,50000	,56273	,785	-1,1971	2,1971
	GROUP C	GROUP A	,20000	,59255	,983	-1,5004	1,9004
		GROUP B	-,50000	,56273	,785	-2,1971	1,1971
Strategy 29	GROUP A	GROUP B	-1,10000	,58595	,225	-2,6877	,4877
		GROUP C	,20000	,60553	,984	-1,4635	1,8635
	GROUP B	GROUP A	1,10000	,58595	,225	-,4877	2,6877
		GROUP C	1,30000	,50662	,091	-,1943	2,7943
	GROUP C	GROUP A	-,20000	,60553	,984	-1,8635	1,4635
		GROUP B	-1,30000	,50662	,091	-2,7943	,1943

*. The mean difference is significant at the 0.05 level.

APPENDIX I

ONE WAY ANOVA TEST RESULTS FOR MULTIPLE COMPARISONS OF PARTICIPANT GROUPS (BARRIERS)

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Barrier 1	GROUP A	GROUP B	,23333	,23333	,724	-,4850	,9516
		GROUP C	,10000	,22361	,964	-,6286	,8286
	GROUP B	GROUP A	-,23333	,23333	,724	-,9516	,4850
		GROUP C	-,13333	,29059	,960	-,9833	,7167
	GROUP C	GROUP A	-,10000	,22361	,964	-,8286	,6286
		GROUP B	,13333	,29059	,960	-,7167	,9833
Barrier 2	GROUP A	GROUP B	,86667*	,29059	,033	,0662	1,6671
		GROUP C	,40000	,42426	,762	-,9602	1,7602
	GROUP B	GROUP A	-,86667*	,29059	,033	-1,6671	-,0662
		GROUP C	-,46667	,42947	,680	-1,8405	,9072
	GROUP C	GROUP A	-,40000	,42426	,762	-1,7602	,9602
		GROUP B	,46667	,42947	,680	-,9072	1,8405
Barrier 3	GROUP A	GROUP B	-,90000	,50442	,263	-2,2737	,4737
		GROUP C	-,50000	,66916	,853	-2,4282	1,4282
	GROUP B	GROUP A	,90000	,50442	,263	-,4737	2,2737
		GROUP C	,40000	,57155	,883	-1,4713	2,2713
	GROUP C	GROUP A	,50000	,66916	,853	-1,4282	2,4282
		GROUP B	-,40000	,57155	,883	-2,2713	1,4713
Barrier 4	GROUP A	GROUP B	-,20000	,62004	,986	-2,1171	1,7171
		GROUP C	1,30000*	,40961	,032	,1125	2,4875
	GROUP B	GROUP A	,20000	,62004	,986	-1,7171	2,1171
		GROUP C	1,50000	,64550	,142	-,4587	3,4587
	GROUP C	GROUP A	-1,30000*	,40961	,032	-2,4875	-,1125
		GROUP B	-1,50000	,64550	,142	-3,4587	,4587
Barrier 5	GROUP A	GROUP B	,36667	,53852	,888	-1,3179	2,0512
		GROUP C	-,50000	,29250	,304	-1,3146	,3146
	GROUP B	GROUP A	-,36667	,53852	,888	-2,0512	1,3179
		GROUP C	-,86667	,53333	,388	-2,5622	,8288
	GROUP C	GROUP A	,50000	,29250	,304	-,3146	1,3146
		GROUP B	,86667	,53333	,388	-,8288	2,5622
Barrier 6	GROUP A	GROUP B	-,06667	,65320	,999	-1,8851	1,7518
		GROUP C	-,40000	,61824	,897	-2,1469	1,3469
	GROUP B	GROUP A	,06667	,65320	,999	-1,7518	1,8851
		GROUP C	-,33333	,66667	,949	-2,2820	1,6153
	GROUP C	GROUP A	,40000	,61824	,897	-1,3469	2,1469
		GROUP B	,33333	,66667	,949	-1,6153	2,2820

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Barrier 7	GROUP A	GROUP B	,53333	,44222	,581	-,6963	1,7629
		GROUP C	,80000	,49441	,370	-,6718	2,2718
	GROUP B	GROUP A	-,53333	,44222	,581	-1,7629	,6963
		GROUP C	,26667	,52068	,946	-1,2843	1,8176
	GROUP C	GROUP A	-,80000	,49441	,370	-2,2718	,6718
		GROUP B	-,26667	,52068	,946	-1,8176	1,2843
Barrier 8	GROUP A	GROUP B	,10000	,31447	,985	-,7629	,9629
		GROUP C	0,00000	,32998	1,000	-,9407	,9407
	GROUP B	GROUP A	-,10000	,31447	,985	-,9629	,7629
		GROUP C	-,10000	,33166	,988	-1,0782	,8782
	GROUP C	GROUP A	0,00000	,32998	1,000	-,9407	,9407
		GROUP B	,10000	,33166	,988	-,8782	1,0782
Barrier 9	GROUP A	GROUP B	-1,00000	,56569	,341	-2,8804	,8804
		GROUP C	-,40000	,77028	,948	-3,1450	2,3450
	GROUP B	GROUP A	1,00000	,56569	,341	-,8804	2,8804
		GROUP C	,60000	,62716	,800	-2,6827	3,8827
	GROUP C	GROUP A	,40000	,77028	,948	-2,3450	3,1450
		GROUP B	-,60000	,62716	,800	-3,8827	2,6827
Barrier 10	GROUP A	GROUP B	0,00000	,34960	1,000	-,9486	,9486
		GROUP C	,30000	,33500	,770	-,6184	1,2184
	GROUP B	GROUP A	0,00000	,34960	1,000	-,9486	,9486
		GROUP C	,30000	,30000	,717	-,5769	1,1769
	GROUP C	GROUP A	-,30000	,33500	,770	-1,2184	,6184
		GROUP B	-,30000	,30000	,717	-1,1769	,5769
Barrier 11	GROUP A	GROUP B	,50000	,37268	,525	-,6449	1,6449
		GROUP C	,23333	,29627	,839	-,6784	1,1451
	GROUP B	GROUP A	-,50000	,37268	,525	-1,6449	,6449
		GROUP C	-,26667	,41366	,900	-1,4852	,9519
	GROUP C	GROUP A	-,23333	,29627	,839	-1,1451	,6784
		GROUP B	,26667	,41366	,900	-,9519	1,4852
Barrier 12	GROUP A	GROUP B	,40000	,49889	,831	-1,1247	1,9247
		GROUP C	1,00000	,55578	,332	-,8717	2,8717
	GROUP B	GROUP A	-,40000	,49889	,831	-1,9247	1,1247
		GROUP C	,60000	,67823	,785	-1,4083	2,6083
	GROUP C	GROUP A	-1,00000	,55578	,332	-2,8717	,8717
		GROUP B	-,60000	,67823	,785	-2,6083	1,4083

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Barrier 13	GROUP A	GROUP B	-,13333	,22608	,918	-,7583	,4917
		GROUP C	,30000	,28868	,702	-,5910	1,1910
	GROUP B	GROUP A	,13333	,22608	,918	-,4917	,7583
		GROUP C	,43333	,29627	,459	-,4784	1,3451
	GROUP C	GROUP A	-,30000	,28868	,702	-1,1910	,5910
		GROUP B	-,43333	,29627	,459	-1,3451	,4784
Barrier 14	GROUP A	GROUP B	,50000	,52175	,732	-,9238	1,9238
		GROUP C	,50000	,55277	,764	-1,0133	2,0133
	GROUP B	GROUP A	-,50000	,52175	,732	-1,9238	,9238
		GROUP C	0,00000	,40825	1,000	-1,2193	1,2193
	GROUP C	GROUP A	-,50000	,55277	,764	-2,0133	1,0133
		GROUP B	0,00000	,40825	1,000	-1,2193	1,2193
Barrier 15	GROUP A	GROUP B	,93333	,41366	,125	-,2124	2,0791
		GROUP C	,50000	,58023	,805	-1,3531	2,3531
	GROUP B	GROUP A	-,93333	,41366	,125	-2,0791	,2124
		GROUP C	-,43333	,59535	,868	-2,3106	1,4440
	GROUP C	GROUP A	-,50000	,58023	,805	-2,3531	1,3531
		GROUP B	,43333	,59535	,868	-1,4440	2,3106

*. The mean difference is significant at the 0.05 level.

APPENDIX J

ONE WAY ANOVA TEST RESULTS FOR MULTIPLE COMPARISONS OF PARTICIPANT GROUPS (OPPORTUNITIES)

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Internal Driver 1	GROUP A	GROUP B	-1,96667*	,51747	,007	-3,3988	-,5346
		GROUP C	-2,10000*	,51316	,005	-3,5280	-,6720
	GROUP B	GROUP A	1,96667*	,51747	,007	,5346	3,3988
		GROUP C	-,13333	,29059	,960	-,9833	,7167
	GROUP C	GROUP A	2,10000*	,51316	,005	,6720	3,5280
		GROUP B	,13333	,29059	,960	-,7167	,9833
Internal Driver 2	GROUP A	GROUP B	,90000	,34801	,064	-,0445	1,8445
		GROUP C	,40000	,52068	,849	-1,2249	2,0249
	GROUP B	GROUP A	-,90000	,34801	,064	-1,8445	,0445
		GROUP C	-,50000	,50000	,733	-2,1416	1,1416
	GROUP C	GROUP A	-,40000	,52068	,849	-2,0249	1,2249
		GROUP B	,50000	,50000	,733	-1,1416	2,1416
Internal Driver 3	GROUP A	GROUP B	,36667	,39581	,760	-,7877	1,5210
		GROUP C	,70000	,38152	,283	-,4553	1,8553
	GROUP B	GROUP A	-,36667	,39581	,760	-1,5210	,7877
		GROUP C	,33333	,45947	,865	-1,0107	1,6773
	GROUP C	GROUP A	-,70000	,38152	,283	-1,8553	,4553
		GROUP B	-,33333	,45947	,865	-1,6773	1,0107
Internal Driver 4	GROUP A	GROUP B	-,76667	,58595	,512	-2,3657	,8323
		GROUP C	-1,20000	,49216	,088	-2,5504	,1504
	GROUP B	GROUP A	,76667	,58595	,512	-,8323	2,3657
		GROUP C	-,43333	,47022	,766	-1,8450	,9784
	GROUP C	GROUP A	1,20000	,49216	,088	-,1504	2,5504
		GROUP B	,43333	,47022	,766	-,9784	1,8450
Internal Driver 5	GROUP A	GROUP B	,16667	,37268	,963	-,9700	1,3033
		GROUP C	-,30000	,26034	,623	-1,0530	,4530
	GROUP B	GROUP A	-,16667	,37268	,963	-1,3033	,9700
		GROUP C	-,46667	,38873	,602	-1,6362	,7028
	GROUP C	GROUP A	,30000	,26034	,623	-,4530	1,0530
		GROUP B	,46667	,38873	,602	-,7028	1,6362
Internal Driver 6	GROUP A	GROUP B	-,56667	,67412	,801	-2,4151	1,2818
		GROUP C	-,20000	,60553	,984	-1,8635	1,4635
	GROUP B	GROUP A	,56667	,67412	,801	-1,2818	2,4151
		GROUP C	,36667	,60645	,915	-1,4123	2,1456
	GROUP C	GROUP A	,20000	,60553	,984	-1,4635	1,8635
		GROUP B	-,36667	,60645	,915	-2,1456	1,4123

*. The mean difference is significant at the 0.05 level

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Internal Driver 7	GROUP A	GROUP B	-,43333	,50442	,789	-1,8000	,9334
		GROUP C	,15000	,47170	,985	-1,1578	1,4578
	GROUP B	GROUP A	,43333	,50442	,789	-,9334	1,8000
		GROUP C	,58333	,39616	,447	-,6077	1,7743
	GROUP C	GROUP A	-,15000	,47170	,985	-1,4578	1,1578
		GROUP B	-,58333	,39616	,447	-1,7743	,6077
External Driver 1	GROUP A	GROUP B	-,33333	,53748	,906	-1,7901	1,1234
		GROUP C	1,00000	,52705	,223	-,4452	2,4452
	GROUP B	GROUP A	,33333	,53748	,906	-1,1234	1,7901
		GROUP C	1,33333	,45947	,052	-,0107	2,6773
	GROUP C	GROUP A	-1,00000	,52705	,223	-2,4452	,4452
		GROUP B	-1,33333	,45947	,052	-2,6773	,0107
External Driver 2	GROUP A	GROUP B	-,13333	,63770	,996	-1,9030	1,6364
		GROUP C	-,10000	,56470	,997	-1,6639	1,4639
	GROUP B	GROUP A	,13333	,63770	,996	-1,6364	1,9030
		GROUP C	,03333	,60645	1,000	-1,7456	1,8123
	GROUP C	GROUP A	,10000	,56470	,997	-1,4639	1,6639
		GROUP B	-,03333	,60645	1,000	-1,8123	1,7456
External Driver 3	GROUP A	GROUP B	-,06667	,40000	,998	-1,1543	1,0209
		GROUP C	,10000	,44597	,995	-1,1658	1,3658
	GROUP B	GROUP A	,06667	,40000	,998	-1,0209	1,1543
		GROUP C	,16667	,35746	,960	-1,0019	1,3352
	GROUP C	GROUP A	-,10000	,44597	,995	-1,3658	1,1658
		GROUP B	-,16667	,35746	,960	-1,3352	1,0019
External Driver 4	GROUP A	GROUP B	-,30000	,33500	,769	-1,2117	,6117
		GROUP C	-1,00000*	,31972	,025	-1,8793	-,1207
	GROUP B	GROUP A	,30000	,33500	,769	-,6117	1,2117
		GROUP C	-,70000	,30000	,128	-1,5769	,1769
	GROUP C	GROUP A	1,00000*	,31972	,025	,1207	1,8793
		GROUP B	,70000	,30000	,128	-,1769	1,5769
External Driver 5	GROUP A	GROUP B	,40000	,42687	,755	-,8575	1,6575
		GROUP C	,20000	,43461	,961	-1,1594	1,5594
	GROUP B	GROUP A	-,40000	,42687	,755	-1,6575	,8575
		GROUP C	-,20000	,52281	,976	-1,7343	1,3343
	GROUP C	GROUP A	-,20000	,43461	,961	-1,5594	1,1594
		GROUP B	,20000	,52281	,976	-1,3343	1,7343

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons

Tamhane

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
External Driver 6	GROUP A	GROUP B	**-,73333**	**,62716**	**,604**	**-2,4821**	**1,0154**
		GROUP C	**,10000**	**,51532**	**,997**	**-1,3150**	**1,5150**
	GROUP B	GROUP A	**,73333**	**,62716**	**,604**	**-1,0154**	**2,4821**
		GROUP C	**,83333**	**,57252**	**,453**	**-,8693**	**2,5359**
	GROUP C	GROUP A	**-,10000**	**,51532**	**,997**	**-1,5150**	**1,3150**
		GROUP B	**-,83333**	**,57252**	**,453**	**-2,5359**	**,8693**
External Driver 7	GROUP A	GROUP B	**-,13333**	**,27080**	**,949**	**-,8672**	**,6005**
		GROUP C	**,10000**	**,32489**	**,987**	**-,8319**	**1,0319**
	GROUP B	GROUP A	**,13333**	**,27080**	**,949**	**-,6005**	**,8672**
		GROUP C	**,23333**	**,29627**	**,839**	**-,6784**	**1,1451**
	GROUP C	GROUP A	**-,10000**	**,32489**	**,987**	**-1,0319**	**,8319**
		GROUP B	**-,23333**	**,29627**	**,839**	**-1,1451**	**,6784**

*. The mean difference is significant at the 0.05 level.

APPENDIX K

PARTICIPANTS LIST

	Participant Code	Number of Employee	Department of the Respondent
GROUP A	Company A	50-250	Marketing Executive
	Company B	50-250	Production Manager
	Company C	10-50	Owner Manager
	Company D	10-50	Owner Manager
	Company E	10-50	Production Manager
	Company F	0-10	Owner Manager
	Company G	0-10	Owner Manager
	Company H	0-10	Owner Manager
	Company I	0-10	Production Manager
	Company J	0-10	Owner Manager
GROUP B	Company K	50-250	Production Manager
	Company L	50-250	Marketing Manager
	Company M	50-250	In-house designer
	Company N	50-250	In-house designer
	Company O	10-50	In-house designer
	Company P	10-50	Production Manager

	Participant Code	Year of experience	EDUCATION
GROUP C	Designer A	5-10	Industrial Design
	Designer B	Over 20	Industrial Design
	Designer C	0-5	Interior Design
	Designer D	10-20	Interior Design
	Designer E	10-20	Self-Educated

The participants' information is in confidentiality. Any reader wishing to find out more information may contact the researcher.