LISBOA SCHOOL OF ECONOMICS & MANAGEMENT

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MASTER
MANAGEMENT AND INDUSTRIAL STRATEGY

MASTER'S FINAL WORK
DISSERTATION

DESIGN IN BUSINESS: AN ON-LINE SURVEY TO PORTUGUESE INNOVATION-DRIVEN FIRMS ABOUT DESIGN MATURITY

RUI MIGUEL MOREIRA DA SILVA

OCTOBER - 2014

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SUPERVISION:

PH.D. MANUEL DUARTE M. MONTEIRO LARANJA
PH.D. RITA ASSOREIRA ALMENDRA

OCTOBER - 2014

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Lisbon, October 2014.

Rui Silva

EPIGRAPH

"The dogmas of the quiet past are inadequate to the stormy present. The occasion is piled high with difficulty, and we must rise with the occasion. As our case is new, so we must think anew and act anew. We must disenthrall ourselves, and then we shall save our country."

President Abraham Lincoln, in the Annual Message to Congress, December 1st, 1862

"Design is to design a design to produce a design."

John Heskett, in *Design: A Very Short Introduction*, 2005, p.3

"Design in its broadest sense is the most important mental operation for the future. Judgment thinking is not enough in a changing world because judgment is based on the past. We need to design the way forward."

Edward De Bono

ABSTRACT

In recent years, the Design field and professional designers have been acknowledged as a driver and enabler of innovation, and thus important to key business activities and to firms' performance and competitiveness. The complex nature of Design still raises obstacles to the comprehension of its activity and results. Research revealed that different firms can have different understanding of Design's value potential and that their perception and usage (*design maturity)* might play a decisive role in the way design activity is practiced in a firm.

This research intended to investigate and provide insights regarding Portuguese business firms' perception and usage of Design. For that purpose, the current Design Maturity level of Portuguese innovation-driven firms was described, using the Danish Design Ladder (DDL) framework. A survey strategy was applied, by a self-administered on-line questionnaire based on the De.:SID survey, to a group of 226 innovation-driven SMEs - *COTEC Portugal's Rede PME Inovação*[1]. A response rate of 33% was achieved and interesting insights were found about the importance Design can have in a business context.

The main conclusion is that respondents' *design maturity* corresponds to the DDL's third stage: *Design as Process.* Moreover, data suggests a difference between firm's perception and the actual importance and usage of the Design role in their business, which reveals a certain lack of knowledge and experience in working with Design.

Keywords: Design, Design Maturity, Design Ladder, SMEs, Survey

[1] Innovative SME Network (free translation)

RESUMO

Nos últimos anos, o campo do Design e os profissionais desta área têm sido reconhecidos como impulsionadores e facilitadores de inovação, possuindo consequentemente um papel relevante nas atividades-chave das empresas, na sua performance e competitividade. A complexa natureza do Design continua a criar obstáculos à sua compreensão e aos seus resultados. Investigações revelam que diferentes empresas têm diferentes noções do potencial valor do Design e que a sua perceção e utilização (*design maturity*) pode desempenhar um papel decisivo na forma como as atividades de Design são praticadas na empresa.

Esta pesquisa pretende investigar e contribuir para a melhoria da compreensão, relativamente à perceção e utilização do Design nas empresas Portuguesas. Para tal, o atual nível de *design maturity* das empresas Portuguesas orientadas para a Inovação, foi descrito utilizando a abordagem do *Danish Design Ladder* (DDL).

A estratégia de inquérito foi aplicada através de um questionário online autoadministrado, baseado no inquérito do De.:SID a um grupo de 226 PME orientadas para a inovação – Rede PME Inovação COTEC da COTEC Portugal. Foi alcançada uma taxa de resposta de 33% e algumas conclusões interessantes foram extraídas sobre a importância que o Design pode ter num contexto empresarial.

A principal conclusão é que a *design maturity* dos respondentes corresponde ao terceiro estágio do DDL: *Design como Processo*. Adicionalmente os dados sugerem que existe uma diferença entre a perceção das empresas e a real importância e utilização do papel do Design no seu negócio, revelando alguma falta de conhecimento e experiência na sua aplicação.

Palavras-chave: Design, Design Maturity, Design Ladder, PME, Survey

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LIST OF ACRONYMS AND ABBREVIATIONS

APD – Associação Portuguesa de Designers[2]

CPD – Centro Português de Design[3]

DDL - Danish Design Ladder

De.:SID - Design as a Company's Strategic resource: Study of the Impacts of Design

DGEEC - Direcção-Geral de Estatísticas da Educação e Ciência[4]

FCT - Fundação para a Ciência e Tecnologia[5]

FTSE - Financial Times Stock Exchange

GPEARI - Gabinete de Planeamento, Estratégia, Avaliação e Relações Internacionais[6]

KMO - Kaiser-Meyer-Olkin

PCA - Principal Components Analysis

R&D – Research and Development

RQs - Research Questions

SMEs - Small and Medium Enterprises

SPSS - Statistical Package for the Social Sciences

SQs - Survey Questions

[2] Association of Portuguese Designers (free translation)
[3] Portuguese Design Centre (free translation)
[4] Directorate General of Education and Science Statistics (free translation)
[5] Portuguese national funding agency for science, research and technology (free translation)
[6] Office for Planning, Strategy, Evaluation and International Relations (free translation)

1. INTRODUCTION

1.1. Research and Problem Contextualization

To achieve sustainable growth and prosperity, business firms must adapt to globalization, increasing competition and diverse consumer demand. In this context, innovation is seen as the key driver of competitiveness, economic growth and part of the solution to environmental and social challenges (European Commission, 2009). However, the complexity of the innovation process requires holistic approaches to innovation, particularly from SMEs often with fewer resources available (European Commission, 2009).

In recent years, the development of concepts such as strategic design (Zurlo, 1999; Meroni, 2008), design-driven innovation (Verganti, 2009), design thinking (Kelley, 2001; Brown, 2009; Martin, 2009) and design management (Gorb, 1986; Mozota, 2003), accentuated business firms' attention upon Design field as a driver and enabler of innovation activities (European Commission, 2009) in a business context. In fact, the Design field and professional designers, previously considered as a powerful but neglected strategic tool (Kotler and Rath, 1984), are now acknowledged as important to all key business activities (Bruce & Bessant, 2002; Cooper & Press, 1995; Walsh *et al.*, 1992) and thus to firms' performance and competitiveness (European Commission, 2009; 2012).

However, the complex nature of Design makes difficult the comprehension of its activity and its results (Cross, 2006; Mozota, 2003). Recent empirical research revealed that different firms can have different understanding of Design's value potential (Kretzschmar, 2003; Nieminen *et al.*, 2005; De.:SID, 2007). Business managers might consider Design as (a) not important at all to its business; (b) important only in providing aesthetic product features requested by the market; (c) important both as an output and as a method or process that can add value in the

product/service development process, and; (d) as strategically important to the firm's identity, corporate/business strategy and value chain, acting as a permanent catalyst for innovation and sustainability (Kretzschmar, 2003). It is possible thus to infer that the contribute of Design and professional designers to the business field is all but linear and well defined, with different realities existing at the same time at the same place (Heskett, 2005).

It is business managers' Design awareness that will determine its scope of activity in a business firm's value chain (Walsh *et al.*, 1992). In other words, a firm's *design maturity* (Walker, 1990) might play a decisive role in the way design activity is practiced and the contribution strategic designers, design managers and other design professionals can offer to a firm.

1.2. Problem Statement

The Portuguese business industry has in recent years faced economic difficulties caused by severe austerity measures, mostly due to a national debt crisis. In this context, Design's potential is recognized by the European Commission (2009; 2012), who aims to enable Design to become an integral part of Europe's innovation policy, mainly due to its contribute to innovation, quality and to business firm's non-cost competitiveness (Augusto Mateus & Associados, 2013). This research intends to make a diagnosis of Portuguese business firms' perception and usage of Design, which from now on will be referred as *Design Maturity*.

To meet this challenge, this study attempts to provide insights to the following main question:

- *What is the current level of Portuguese innovation-driven firms' Design Maturity?*

1.3. Research relevance and objectives

The general objective and main motivation of this research is to analyze and describe the *Design Maturity* of *Portuguese* business firms, in particular innovation-driven firms. Its benefits are to hopefully contribute for a better comprehension of Design's role and importance

in today's organizations. By "Portuguese business firms" it is meant firms operating in the Portuguese territory, regardless of its headquarters' nationality. It is not expected to achieve a general and definitive conclusion but to rise, if possible, interesting ideas and insights about the role and importance of Design in a business context. In the future, this research's findings may be useful (a) for promoting the integration of business management and design teaching; (b) for promoting the potential of professional designers; and (c) to inquire if Portuguese innovation-driven firms are aligned with the European Commission's innovation agenda for 2020.

1.4. Thesis structure

This research is divided in five sections: (1) the contextualization of the topic, the problem statement and research's objectives and relevance; (2) a literature review regarding the aspects that make Design strategically relevant to business firms and the research questions derived from it; (3) the methodology used to address them; and (4) the disclosure of the applied methodology's results. Finally, (5) the last section discloses this research's main conclusions, its limitations and recommendations for future investigations.

2. LITERATURE REVIEW

2.1. The complex definition and nature of Design

Although Design's *epistemology* and *praxiology* (Cross, 2006) are not in the scope of this research, it is essential to address Design's complex definition, nature and goals to facilitate a more complete and accurate perspective of Design's value, in a business context. Design is constantly present in people's lives since almost everything is *designed*: work tools, clothes, systems, cities, experiences, etc. (Cross, 2006; Heskett, 2005). However, its definition is in itself problematic due to its different meanings, its multidisciplinary nature and its usage in different contexts (Bruce & Bessant, 2002; Heskett, 2005; Walsh *et al*., 1992).

Etymologically, "Design" is derived from the Latin *de + signare* which means to mark out, to sign (Terzidis, 2007), to designate or to give significance by assigning to a use, a user, or an owner (Krippendorff, 2006). In the English language, depending of the context, the word can refer to (a) a *verb* or (b) a *noun* (Flusser, 1999; Mozota, 2003), what is a frequent source of confusion (Mozota, 2003). Design as a *verb* can mean "to feign or simulate, to draft, to sketch, to shape or to proceed strategically", indicating an intentional activity or process. As a *noun* it refers to a "plan, goal, form or fundamental structure", the outcome of that process (Flusser & Cullars, 1995). This research focuses in the former interpretation, the *verb* dimension.

Design's object of study, methods and techniques are not immutable, but always evolving and adapting to the world's increasing complexity (Krippendorff, 2006), to the economic and cultural context and to its practitioners and users (Cooper & Press, 1995).

Krippendorff argues that Design is *making sense of things* (1989; 2006) which implies that Design intervention is not restricted to products' properties (form, structure, function and utility). Design can address to other *artifacts* such as goods, services and identities; interfaces (e.g. between users and machines); systems and networks, projects and even discourses. Each design discipline can address one or more of these *artifacts*.

Design's object of study is thus the artificial world (Cross, 2006; Krippendorff, 2006; Simon, 1969), since its main goal is to create something new (an *artifact*) that "would not come naturally" (Krippendorff, 2006, p.25), by generating and communicating specific design proposals (Cross, 2006). For instance, *designing* a lever to overcome gravity (Flusser, 1999) or changing user's behaviour towards an object's manoeuvre. In this sense, "Design is primarily concerned with problem solving" (Bruce & Bessant, 2002, p.19).

However, "designing is not normal problem-solving" (Cross, 2006, p.77). Its approach is applicable to both (a) well-defined or *tame* problems (Simon, 1969), i.e. mathematical and

other structured problems; and to (b) ill-defined or *wicked problems* (Rittel & Webber, 1973; Conklin, 2006), i.e. unstructured or complex problems: environmental degradation, terrorism and poverty (Rittel & Webber, 1973) and also corporate strategy issues (Camillus, 2008).

According to Cross (2006) and Thomas & Carrol (1979), designers tend to treat problems as being ill-defined even when the problems are well-defined, following a solution-focused strategy by iteratively reframing the problem, redefining constraints and goals (Cross, 2006) and generating a series of *what if* hypothesis, until a promising one emerges for further inquiry (Schön, 1983), instead of "merely accepting the problem as given" (Cross, 2006, p.77).

The above statements imply that the idea of Design as simply an output, as aesthetics or as art is a partial perspective. Design can also refer to a process of inquiry (Schön, 1983); a core business process (Bruce & Bessant, 2002; Mozota, 2003); a problem solving and creative activity that links consumer's needs with the potential of a firm. Hence, Design lies in the core of the innovation process (OCDE, 1982; Walsh *et al.*, 1992) and in the heart of the firm itself (Cooper & Press, 1995).

This research adopts the European Commission's definition of Design, sufficiently broad to consider all the different roles that design activity can engage in a business firm:

"Design for user-centred innovation is the activity of conceiving and developing a plan for a new or significantly improved product, service or system that ensures the best interface with user needs, aspirations and abilities, and that allows for aspects of economic, social and environmental sustainability to be taken into account." (European Commission, 2009, p.58).

2.2. The relation between Design, Innovation and Competitiveness

Regarding the role of Design in the innovation process, Walsh *et al.* (1992) argues that technological innovation is absolutely, but not exclusively, dependent of R&D.

In fact, while R&D focuses in producing new knowledge that is not necessarily applied to a practical ending and thus it may not lead to innovation, Design can be also important to every innovation, being it radical/disruptive or incremental (Mozota, 2003), and has or can have a more widespread presence in the innovation process, contributing into and outside R&D function (Walsh *et al.*, 1992).

A considerable overlap exists therefore between the two activities, since (a) much of the development work in R&D involves design, such as in providing information on new technological options, new user requirements, new materials and processes, that can guide R&D on new research directions (Cooper & Press, 1995); and (b) Design creates and tests experimental prototypes and other activities that translate the novel idea into a configuration of materials and components (Walsh *et al.*,1992).

According to Mozota (2003), Design acts as a thermostat for innovation, since it modulates, controls, and encourages creativity in a firm. Design is, however, far from being only focused in technological innovation, as the European Commission report (2009) clearly states. In the last 10 to 15 years, the report argues, there has been a shift towards Design as an essential activity for *user-centred* innovation in business, by studying users and/or by involving them through participatory design techniques, such as co-creation, focusing human needs, aspirations and abilities, striving for holistic and visionary solutions (European Commission, 2009), and towards a more strategic perspective of Design in business.

This shift resulted in the development of new design disciplines such as *Strategic Design* (Zurlo, 1999; Meroni, 2008), *Design-driven innovation* (Verganti, 2009), *Design Thinking* (Kelley, 2001; Brown, 2009; Martin, 2009) and *Design Management* (Gorb, 1986; Mozota, 2003). Each one of these disciplines has a specific philosophy and perspective of Design's role

and contribution in a business firm, being therefore impossible to address them in this document, due to space restrictions. However, they all agree that Design can be a holistic, multidisciplinary and cross-functional innovation activity, due to the designers' skills of acting as *gatekeepers* (Walsh & Roy, 1985) or *knowledge brokers* (Mozota, 2003), constantly maintaining the firm's focus on the customer (European Commission, 2009).

This allows Design to be present throughout industry in general, and in any firm in particular, becoming more *pervasive* than innovation itself, in the sense that it is present in other organizational departments, for example, marketing, manufacturing and corporate strategy (Walsh *et al.*,1992; Cooper & Press, 1995; Bruce & Bessant, 2002).

The notion of Design and the strategic role of a designer become thus much broader and depart significantly from the popular misconception of Design as simply *stylish* physical products. It has an important role in both technological and non-technological innovation and also in non-innovative activities, which means Design can be important both for research intensive industries, such as consumer electronics, and also to more traditional sectors not concerned with R&D or technological innovation, such as furniture or pottery (Walsh *et al.*, 1992).

This is significant also for SMEs because, although design activity is less capital intensive and has shorter pay-back periods than technological research, it still has the potential to drive and enable innovation and thus firm's competitiveness (European Commission, 2009).

A number or studies have been developed on the economic importance and value of Design, with some of them focusing in the micro-economic effects of Design, i.e. on firm's performance, others on its macro-economic effects. This literature review section focuses on the findings of micro-economic research that conclude Design usage has a positive impact on firm's performance, measured in terms of company's image, profitability, share price,

employment or exports (European Commission, 2009). Some of these studies are based on self-assessment surveys of firm's perception and usage of Design and others on statistical analysis.

Dosi *et al.* (1988) showed a correlation between top performing firms and design investment, which leads to growth and success. Studying firms investing in Design, Roy & Potter (1993) concluded: (a) 60% ran a profitable project; (b) 90% of projects that entered into production were profitable; (c) 40% had increased sales and (d) 13% increased exports. Design is a profitable investment since the return on investment is less than three years, with an average period of fifteen months (Potter *et. al*., 1991).

Bruce & Bessant (2002) argue that Design investment allows benefits such as: (a) the increase of profits by increasing sales or by decreasing manufacturing costs; (b) increase market share; (c) gain a competitive advantage; (d) revamp mature and failing products; and (e) provide a strategy for growth facilitating the launching of a new products or services.

The Design Council (2004) studied the impact of Design on stock market performance of U.K. publicly listed business firms. Following the performance of 166 firms, with different Design usage categories, over a period of ten years, the key finding of the study was that a group of 63 firms, identified as being effective users of Design, outperformed the FTSE 100 index over the entire period by 200%.

The *Design Innovation Group* (Walsh *et al.*, 1992) performed an extensive research on technological and product innovation on the U.K. industries, considering a range of performance measures (financial, commercial and of the design, e.g. winning design awards or prizes). Their conclusions include three main ideas. First, firms investing resources and professional expertise in product and industrial design, in both traditional and new industries, were commercially more successful than firms that paid less attention to these aspects of

Design. Design is, they argue, "the vital link between a market need, an invention or innovative idea and its translation into a product suitable of manufacture and use" (Walsh *et al.*,1992, p.3). Second, that product design and technological innovation, however well resourced, are not sufficient to ensure, at least in the longer term, the success of a product firm or economy. This is because paying attention to Design enables firms of all sizes, and across many sectors, the opportunity to differentiate from their competitors, and gain competitive advantages.

The third main conclusion is that to be competitive, the critical issue is not to be *design-conscious*, but to match the level of their competitors' commitment and investment in Design, and specially, to manage Design properly and integrate it with other key business activities. To achieve this, "senior management of the company should fully understand the role of design and product development in their business and hence make sure that there is clear responsibility for these activities" (Walsh *et al.*,1992, p.9). This conclusion is supported by Cooper and Press (1995), as they argue that "a strategic approach to design at board level elevates design to an innovative process with a long-term horizon." (Cooper & Press, 1995, p.3)

However, the potential of Design to improve business firm's competitiveness and innovation performance depends on the firms' perception and usage of Design. In this context, the *Danish Design Ladder* is often used to illustrate the level of design usage in business firms.

2.3. Design Maturity: The Danish Design Ladder framework

The *Danish Design Ladder* (DDL) was developed by the *Danish Design Council* as a framework used in a national research survey, to assess the economic benefits of Design in Denmark (Kretzschmar, 2003). The survey examined the design investment of one thousand firms, measuring and categorizing the different levels of design activity within the Danish firms. In other words, the survey measured the awareness of the importance and integration of

Design in firms. The higher a firm was ranked on the DDL, the greater strategic importance they attributed to Design. Hence Danish firms were categorized into four stages of design maturity, depending on their approach to design investment: (a) *No Design*, (b) *Design as Styling*, (c) *Design as Process* and (d) *Design as Innovation*, as illustrated in figure 1 below.

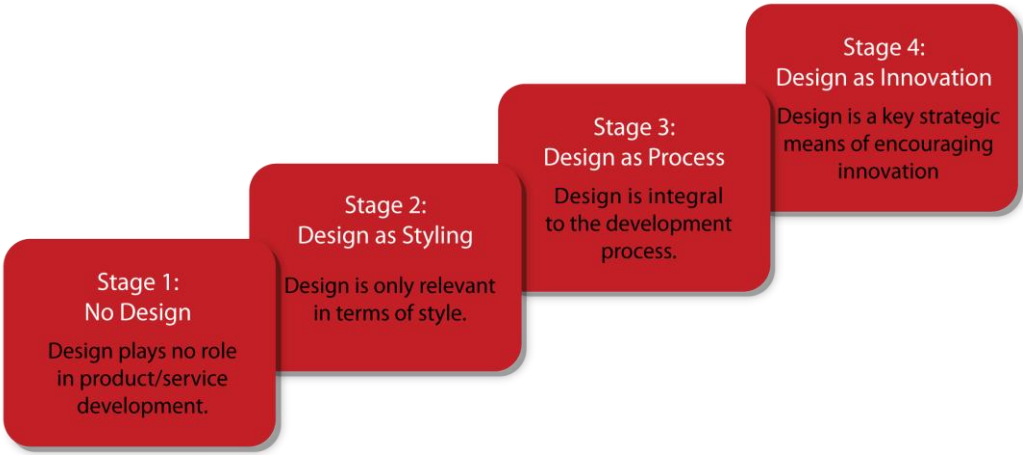

Figure 1 – The Danish Design Ladder (Kretschmar, 2003). Adapted illustration.

To a firm or organization at DDL's first stage, *No Design*, Design plays a negligible role in the company, since product development is performed by employees without design-specific education or experience. Additionally, user or stakeholder's perspectives do not influence the development process. In the second stage, *Design as Styling*, Design is used as a mean to develop the form, usability and aesthetics of a product. At this level design activities are developed by designers but most of the remaining people participating in the process have no particular design training or experience. The third stage, *Design as Process*, is achieved when firms are able to apply design as a methodology rather than a tool, within its projects. The design process can be adapted to the task and involves a strong consideration of users and stakeholder needs. In the final stage of the ladder, *Design as Innovation (or Strategy)*, Design plays a pivotal role in the strategic development and management of the company. In this stage top management is intrinsically involved in the design process in order to create value for all

aspects and stakeholders of the firm. Hence, the design process is not limited to products, but fused with the firm's key objectives, playing a role at every stage of the firm's development.

By linking performance data with investment in design, the survey revealed a correlation between high company performance and a higher ranking on the design ladder (Kretzschmar, 2003) and allowed the comparison of firms on a standard scale in terms of their perspective and application of Design. The DDL is a framework that can be used to determine the level of Design Maturity of an organization. Although it is generic and it does not provide insights or instructions on how to integrate design in a firm, the framework also serves as a model to explain that Design is more than merely product styling, allowing firms to reflect about the potential value and incorporation of Design into their business know-how and structure.

2.4. The De.:SID research project survey

The Portuguese research project De.:SID (2007) - *Design as a Company's Strategic Resource: a Study of the Impacts of Design*, funded by FCT - *Fundação para a Ciência e Tecnologia*[7], intended to make a diagnosis of Design's use inside the Portuguese Manufacturing Industry. One of its activities was the development of an on-line questionnaire, by a group of nine researchers from several scientific areas (Design, Economics, Management, Marketing, Engineering and Artificial Intelligence) and two partners: CPD – *Centro Português de Design*[8] and APD – *Associação Portuguesa de Designers*[9]. The questionnaire addressed firm's design activities and its role in the business between 2005 and 2007, mainly in terms of their perception of (a) Design usage; (b) Design's drivers and enablers; (c) management's attitude and action towards design usage; and (d) the evaluation of design's usage results and barriers (*cf.* Almendra *et al*., 2007; Urbano & Rodrigues, 2008). The questionnaire was sent to a sample

[7] Portuguese national funding agency for science, research and technology (free translation)
[8] Portuguese Design Centre (free translation)
[9] Association of Portuguese Designers (free translation)

of 1405 Portuguese manufacturing firms, of which 99 firms responded (7% response rate). The main findings are shown in the table I below:

TABLE I - MAIN FINDINGS OF DE.:SID SURVEY

Survey Topic	Conclusion
Design usage experience	Two thirds of firms with less than 19 years
Mental associations with Design	Innovation; product development; functionality
Drivers for Design usage	Firms' image/reputation; innovation capability
Design maturity level	Design as a competitive factor of the firm's business
Top management involvement	78% with a high or medium involvement with Design
Innovation projects leadership	14% lead by designers, only behind top managers
Design integration	Conceptual phase - 51%; Development phase - 26%
Design Impacts	Firm's image; communication with clients; customers' satisfaction
Barriers to Design usage	Resistance to change; high costs of using design

Each question had a score not visible to the respondents, allowing their design maturity diagnosis, using the DDL framework presented in section 2.3 above.

From the survey's results, the researchers concluded that Portuguese manufacturing firms, in general, still underestimated the potential of Design as a strategic resource. Among other factors, this conclusion was due to (a) the reduced experience of firms that use design; (b) the deficit of designers' participation both in the strategic level of design intervention and in innovation projects leadership; with (c) only half of the respondents integrating design in the concept phase, as well as (d) the main barriers identified by the firms to Design usage: resistance to change and high costs of design.

2.5. Definition of research questions (RQs)

Almost a decade after De.:SID's research, it is interesting therefore to update the assessment of Portuguese firm's Design Maturity. In order to provide insights to the research problem identified in section 1.2, a group of four research questions was formulated. It is believed that

gathering data to answer these questions will allow achieving the general objective and research problem. The research questions (RQs) are the ones presented below:

RQ1: *What is the perception of Design's role in Portuguese innovation-driven firms?*

RQ2: *Which and how design activities are most used by these firms?*

RQ3: *Is design activities' input considered significant in these firms' innovation activities?*

RQ4: *What are the main barriers to design activities identified by the same firms?*

3. RESEARCH METHODOLOGY

3.1. A descriptive study of Portuguese firms' Design Maturity

Following a deductive approach, some theoretical associations between Design and other concepts (e.g. Innovation, Quality), served as basis for this inquiry. In order to classify the current level of business firms' Design Maturity, the *Danish Design Ladder* (DDL) framework (Kretzschmar, 2003) was applied. The purpose of this research is descriptive, usually used to "to portray an accurate profile of persons, events or situations" (Robson, 2002, p.59) and to generate further knowledge about the current status of a subject of study (Gay & Diehl, 1992).

3.2. Research Design: a survey strategy

The Design Maturity phenomenon in a group of Portuguese firms is here studied following a survey strategy, using a cross-sectional and mono-method (Saunders *et al*., 1997), through a quantitative data collection technique (questionnaire), analyzed afterwards with a corresponding quantitative data analysis procedure (descriptive statistics).

3.2.1. Target Population: innovation-driven business firms

This research intends to focus in the business firms who actively search for innovation dynamics and value creation. Considering the associations between Design and Innovation presented in the literature review (section 2.2), it is innovation-driven firms that in theory have

a higher *awareness* of Design's potential and have also more invested resources in acquiring, developing and using design activities. This was confirmed in a 2008 survey of Swedish firms (SVID in European Commission, 2009) that concluded innovative firms are more likely than non-innovative firms to regard design as a strategy (a high stage on the DDL, *cf.* section 2.3). Furthermore, considering the time span available for this research it is more appropriate to focus on a smaller target population.

3.2.2. Sampling: COTEC Portugal's Innovative SME Network

The sampling method used in this study was a non-probability, purposive, critical case technique (Saunders *et al.*, 1997). *COTEC Portugal's Rede PME Inovação*[10], with 226 participant firms, was selected as an appropriate sample of Portuguese innovation-driven firms. Created in 2005 by *COTEC Portugal - Associação Empresarial para a Inovação*[11], the network aims to promote the development of SMEs, through the development and practice of innovation activities. The network has a strong predominance of the *Information and Communication Technologies* sector with 81 firms, that represents 36% of the network's total participants, and of *Industrial equipments* (19 firms - 8%), *Agriculture and food* and *Plastics and Moulds* (both with 15 firms - 7%) sectors. The networks' participants are geographically based across fifteen Portuguese districts, although the two most represented districts, Lisbon (65 firms) and Oporto (44 firms), account for 48% of the network's total number of participants[12]. Being a network of SMEs, the group presents a certain homogeneity, in terms of firms' dimension, more similar to the Portuguese business context: in 2012, SMEs represented 99,9% of the Portuguese business context and 78,1% of its total employment (INE, 2014).

[10] Innovative SME Network (free translation)
[11] COTEC Portugal – Business Association for Innovation (free translation)
[12] <www.cotecportugal.pt> accessed in August 19th, 2014

3.2.3. Research data collection: self-administered online questionnaire

Considering the research objectives and resources limitations, the self-administered online questionnaire technique was selected. This technique has several advantages but also some limitations, that are highlighted in table II below:

TABLE II - ADVANTAGES & LIMITATIONS OF SELF-ADMINISTERED EMAIL QUESTIONNAIRE

ADVANTAGES	LIMITATIONS
Reaches a widely dispersed sample	Risk of questions misunderstanding due to absence of interviewer
Respondents more confortable due to the indirect sharing of answers with interviewer	Risk of gap between answers and real practice (Foddy, 1996; Fowler, 1993)
Low requirement of respondents' availability	Risk of survey forfeit before completion
Application of complex skipping logic and other features	Risk of respondents being different from adressed target
Process speed, cost and flexibility (Couper, 2000)	Risk of survey not accessible due to software updates/conflicts

An option was necessary between creating a new or adopting/adapting an existent questionnaire whose scope would match this research's requirements. De.:SID's questionnaire, presented in the literature review (section 2.4), was considered as appropriate since (a) it intended to study the same subject (Design Maturity); (b) it was tested and validated by a group of experts; and (c) it was designed for a similar group of respondents (Portuguese manufacturing firms).

Since the extension of De.:SID's questionnaire (52 questions) was inappropriate to this research's constraints, a group of 24 questions that directly addressed the firm's relationship with Design was selected from it and can be seen in full detail in appendix A.

Their correspondence with all four research questions is illustrated in table III below:

TABLE III – CORRESPONDENCE BETWEEN RESEARCH AND SURVEY QUESTIONS

Research questions (RQ)	Survey questions (SQ)
RQ1: What is the perception of Design's role in Portuguese innovation-driven business firms?	SQ9, SQ10, SQ11, SQ12, SQ13, SQ14, SQ15
RQ2: Which and how design activities are most used by these business firms?	SQ22, SQ23, SQ24, SQ25, SQ26
RQ3: Is design activities' input considered significant in these firms' innovation activities?	SQ27, SQ28, SQ29
RQ4: What are the main barriers to design activities identified by the same business firms?	SQ16, SQ17

De.:SID questionnaire's questions and main functionalities and logic were reproduced using Qualtrics survey platform[13]. The addition of SQ29, to measure firm's perception of Design presence in innovation activities, was the only change to the original questionnaire.

3.2.3.1. Pilot-survey

A pilot test was performed to refine the questionnaire and minimize the possibility of respondent's difficulties and other unpredicted errors. The pilot survey was sent on April, 2014 to 45 firms (20%) of COTEC's *Innovative SME Network*. The response rate of 24% made clear the need of a strategy to increase the interest on participating in the survey.

Thus Qualtrics survey platform was programmed to provide a brief diagnosis to each participant of its Design Maturity level following the DDL framework, as an immediate incentive for their participation.

3.2.3.2. Questionnaire administration

In the end of April, 2014, a personalized email was sent to the sample through Qualtrics survey platform presenting the study and requesting cooperation in the survey of a top manager or someone who participated in the strategic decision-making process of the firm. The time span of the research activities' phases is illustrated in table IV.

TABLE IV – RESEARCH ACTIVITIES TIMETABLE

Research Activities		Duration
Questionnaire	Preparation	January 2014 - April 2014
	Data collection	April 2014 - June 2014
	Data Analysis	July 2014 - August 2014

No definition of Design was provided since the goal was to understand respondent's main concepts and associations made with it. Two reminders were sent in May and June, encouraging participation before the deadline of June 30th. A 32,7% response rate was

[13] <www.qualtrics.com>, accessed in August 19th, 2014

achieved: 74 collected responses from a sample of 226 network participants, which is significant when compared to similar surveys: Designium's study (Nieminen *et al.*, 2005) with 19,6% and De.:SID (2007) survey with 6,6%.

Respondents' job roles were mainly CEOs but also quality, innovation, marketing and strategy managers. There were two unfinished surveys that were considered since they were near completion. Apart the display and skip logic cases, there were no unanswered questions due to the platform internal validations. Finally, 77% of the respondents displayed interest in receiving a copy of this research's final report.

3.2.3.3. Questionnaire validation procedures

Content validity of construct "Design Maturity" was reinforced since the basis of this research's questionnaire was De.:SID's questionnaire, previously developed, tested and validated by a multi-disciplinary group of experts (*cf.* Almendra *et al*., 2007; Urbano & Rodrigues, 2008). After data collection, *factorial validity*, a subcategory of construct validity, was assessed through Principal Components Analysis (PCA), a variable reduction technique that was applied to survey questions SQ15 and SQ17. Further details of PCA analyzes are disclosed in the results analysis section (section 4.5).

Regarding *external validity*, according to Saunders *et al* (1997) in a purposive sampling, the probability of each case being selected from the total population is not known and thus generalization cannot be done based on statistical grounds, but only on logic. Hence this research's results and respective findings are only applicable to the survey respondents and not possible to generalize to other research settings.

Regarding *reliability* procedures, the internal consistency was examined using Cronbach's alpha coefficient (Cronbach, 1951) to SQ15 and SQ17:

TABLE V – CRONBACH'S ALPHA COEFFICIENT

Survey Question	Construct	Nr of Questions	Cronbach's alpha
SQ15	Design's Market Impact	8	0,916
SQ15	Design's Internal Impact	6	0,844
SQ17	Financial Barriers to Design	3	0,817
SQ17	Knowledge Barriers to Design	4	0,896

As illustrated in table V, all Likert-scales used to measure constructs "*Design's Market Impact*" and "*Design's Internal Impact*" (in SQ15) and "*Financial Barriers*" and "*Knowledge Barriers*" (in SQ17) had a high level of internal consistency as determined by a Cronbach's alpha higher than 0,7 (DeVillis, 2003; Kline, 2005), what indicates SQ15 and SQ17 scale items were well grouped together to measure the respective underlying constructs. Further details of Cronbach's alpha analysis are disclosed in appendix C.

3.2.4. Data analysis: descriptive statistics & Design Ladder Framework

The Design Maturity level of the respondent firms' was reached by two complementing methods: (a) respondent's answers direct analysis: after the collection phase, data was automatically transferred from Qualtrics survey platform to SPSS - *Statistical Package for Social Sciences* software and analyzed using descriptive statistics, mainly with frequency results, drawn in tabular and graphical form to identify patterns and trends; (b) dependent variable *Design Ladder* built upon respondents' answers: using the collected answers as independent variables, a *score* not visible to the respondents was attributed to each response in Qualtrics survey platform (appendix A).

The scores were based in the De.:SID's (2007) survey. After the completion of the questionnaire, each respondent's *overall score* was determined by computing the average score of his answers to a final number between 1 and 4. Thus, the *Design Ladder* variable corresponds to each respondent's Design Maturity level, using the four levels of the DDL framework.

Regarding the *Design Ladder* variable referred above, all questions were scored with the exception of characterization questions (SQ1 to SQ8) and "*end of survey*" section (SQ18 to SQ21). Questions related to barriers to Design usage (SQ16 and SQ17) were also not scored due to the following reasons: (a) questions were not presented to all respondents due to skip logic and (b) stating barriers do not exist does not clarify if that perception is due to a more strategic view of Design or simply because Design activity is not used at all.

4. RESULTS ANALYSIS

4.1. Respondents' general characteristics

Regarding the demography of the 74 respondents, about 72% are concentrated in three Portuguese administrative districts: Lisbon (24 respondents), Oporto (15) and Aveiro (14). The remaining 28% are distributed between 10 districts (table XXIV).

A significant group (74%) started their business activity until the late nineties and beginning of the XXI century and 19 firms started operating in the last decade (table XXV). The respondent firms operate mainly in the sectors of Information and Communication Technologies (20 respondents), Consultancy (15) and Agriculture and food (5) which accounts for 47% of the respondents (table XXVI).

About 80% have less than 150 employees, being the most relevant class: "10 to 50 employees" (50%) (table XXVII). In the period 2011-2013, the most represented business volume class (31 firms) was "one million to five million" Euros (table XXVIII) and its main origin (91%) were from other business firms and governmental entities (8%) (table XXIX).

The respective tables of the respondents' general characteristics are presented in Appendix B.

4.2. Respondents' perception of Design's role (RQ1)

The following section analysis the results of survey questions SQ9 to S15 that aims to respond to RQ1: *What is the perception of Design's role in Portuguese innovation-driven business firms?*

The first design related survey question (SQ9) addressed the five most immediate mental associations made with Design, from a group of concepts, illustrated in table VI.

TABLE VI – MAIN CONCEPTS ASSOCIATED WITH DESIGN

	Score	N	Frequency	Percent	Rank
Product development	3	74	51	68,9%	1º
Innovation	3	74	51	68,9%	1º
Marketing	2	74	49	66,2%	3º
Brand building	3	74	48	64,9%	4º
Functionality	2	74	32	43,2%	5º
Concept development	3	74	24	32,4%	6º
Quality	4	74	23	31,1%	7º
Aesthetics	1	74	22	29,7%	8º
Trendy issues	1	74	19	25,7%	9º
Technological development	2	74	18	24,3%	10º
Costs saving	4	74	13	17,6%	11º
Sustainability	4	74	7	9,5%	12º
Research	4	74	6	8,1%	13º
Formgiving	1	74	5	6,8%	14º
Process	2	74	2	2,7%	15º
Other. Which one?	1	74	0	0,0%	16º

Product development and Innovation share the first place of associations made with Design. Marketing, Brand building and Functionality complete the five most selected associations with Design.

According to these results, the association between Design and Innovation, which was the reason for selecting COTEC Portugal's *Innovative SME Network* as this research's sample, is confirmed. SQ10 requested to rate each of the five options selected in the previous question, where one (1) was the "weakest" association and five (5) was the "strongest" one. The results are illustrated in table VII below.

TABLE VII – RATING OF ASSOCIATIONS WITH DESIGN

Main concept	Score	N	Min Value	Max Value	Average	Standard Deviation	Coefficient Variation	Rank
Product development	3	51	1	5	3,51	1,51	0,43	1º
Brand building	3	48	1	5	3,29	1,49	0,45	2º
Aesthetics	1	22	1	5	3,18	1,56	0,49	3º
Marketing	2	49	1	5	3,14	1,40	0,45	4º
Concept development	3	24	1	5	3,08	1,10	0,36	5º
Innovation	3	51	1	5	3,04	1,34	0,44	6º
Functionality	2	32	1	5	3,03	1,20	0,40	7º
Formgiving	1	5	1	5	2,80	1,79	0,64	8º
Costs saving	4	13	1	4	2,69	1,38	0,51	9º
Research	4	6	2	5	2,67	1,21	0,45	10º
Process	2	2	2	3	2,50	0,71	0,28	11º
Quality	4	23	1	5	2,48	1,16	0,47	12º
Trendy issues	1	19	1	5	2,21	1,51	0,68	13º
Technological development	2	18	1	5	2,17	1,25	0,58	14º
Sustainability	4	7	1	5	2,14	1,57	0,73	15º

Product development, with an average of 3,51, remained as the strongest association, contrary to Innovation, ranked now in sixth place with an average of 3,04. Brand building (3,29) and Marketing (3,14) continue in the top five. Aesthetics and Concept development complete the five strongest associations.

Despite SQ9 results, when the ranking of those associations (SQ10) is considered, data suggests the association between Design and Innovation is not considered as the most important. Additionally, Sustainability and Research, the two most strategic concepts in the list, were among the least selected and ranked options.

SQ11 inquired about the 10 most relevant factors that act as an engine (drivers) to Design's usage in a business context. Following other studies, as Designium (Nieminen *et al.*, 2005) and De.:SID (2007), the drivers were grouped in the following categories: Clients, Competition, Firm, Industry, Strategy, and Suppliers. Table VIII below displays the results.

TABLE VIII – MAIN DRIVERS OF DESIGN INSIDE THE FIRMS

Driver	Category	Score	N	Frequency	Percent	Rank
Differentiation strategy	Strategy	2	74	70	94,6%	1º
Image / reputation	Firm	2	74	64	86,5%	2º
Product / Service	Firm	2	74	62	83,8%	3º
Company culture	Firm	4	74	61	82,4%	4º
Quality requested by the clients	Quality	4	74	51	68,9%	5º
Internationalization	Strategy	4	74	47	63,5%	6º
Competitors innovation capactiy	Competition	4	74	46	62,2%	7º
Diversification strategy	Strategy	3	74	44	59,5%	8º
Product's life cycle	Industry	3	74	41	55,4%	9º
Clients' complexity	Clients	3	74	39	52,7%	10º
Level of rivalry in the industry	Industry	4	74	35	47,3%	11º
Technology used in the industry	Industry	3	74	35	47,3%	11º
Top Management	Firm	4	74	30	40,5%	13º
Learning and Competences	Firm	4	74	22	29,7%	14º
Clients / Suppliers business power	Industry	2	74	22	29,7%	15º
Company's dimension (production scale)	Firm	4	74	18	24,3%	16º
Competitors competences	Competition	3	74	18	24,3%	17º
Costs saving	Strategy	3	74	16	21,6%	18º
Process	Firm	3	74	15	20,3%	19º
Suppliers' complexity	Suppliers	1	74	4	5,4%	20º

In the respondents' context, the main drivers are in a descending order of importance: differentiation strategy (94,6%), firm's image or reputation (86,5%), firm's product or service (83,8%), firm's culture (82,4%) and, finally, quality requested by clients (68,9%). These results are in accordance with De.:SID's findings: the reason for Design's use is more related with the firm's sphere of influence and less on the firm's industry, contrary to what was observed in the Designium survey (Nieminen *et al.*, 2005). Since the experience in Design usage affects not only the intensity of its usage but also its results (Nieminen *et al.*, 2005), SQ12 asked the number of years the respondent's firm used Design. Table IX below shows the existence of a diversified range of Design experience among respondents:

TABLE IX – RESPONDENT'S YEARS USING DESIGN

	Frequency	%	% Cumulative
Less than 10	30	40,5%	40,5%
10 to 19	29	39,2%	79,7%
20 and more	15	20,3%	100,0%
Total	74	100,0%	
Missing	0	0,0%	
Total	**74**	**100,0%**	

In terms of Design experience 40,5% of the firms have less than 10 years, of which two have no experience at all. 39,2% of firms have between 10 and 19 years of experience and 20,3% use Design for more than two decades, where one firm affirms to have 107 years of Design experience, using Design since its first year of business.SQ13 and SQ14 were related with the perception of Design in the firms. SQ13 inquired the Design activity regarding the period between 2011 and 2013 and SQ14 inquired the prevision for the next three years. The options were directly related with the four stages of DDL.

TABLE X – PERCEPTION OF DESIGN IN THE FIRM (2011-2013)

	Score	Frequency	Percent	Cumulative Percent	Rank
As an inexistent activity	1	2	2,8%	2,8%	4º
As an activity for product's physical shape refinement and materialization	2	24	33,3%	36,1%	2º
As a business competitive factor and core competence of the company	3	25	34,7%	70,8%	1º
As a catalyst activity of continuous innovation	4	21	29,2%	100,0%	3º
Total		72	100,0%		
Missing		0	0,0%		
Total		**72**	**100,0%**		

Table X above illustrates that Design is perceived by 97% of the firms as present in the firms' business. 35% indicate Design as a *business competitive factor and a core competence*, 33% consider it as an activity mostly used in the *product's shape refinement and materialization* and 29% state Design acts as a *catalyst of continuous innovation*. Only two firms state Design activity was not developed in the last three years, what is coherent with SQ12 results.

TABLE XI – PERCEPTION OF DESIGN IN THE FIRM (2014-2016)

	Score	Frequency	Percent	Cumulative Percent	Rank
No	1	4	5,4%	5,4%	4º
As an activity for product's physical shape refinement and materialization	2	20	27,0%	32,4%	3º
As a business competitive factor and core competence of the company	3	24	32,4%	64,9%	2º
As a catalyst activity of continuous innovation	4	26	35,1%	100,0%	1º
Total		74	100,0%		
Missing		0	0,0%		
Total		**74**	**100,0%**		

SQ14 results are displayed in table XI above. Comparing answers between SQ13 and SQ14, the intention to use *Design as an innovation driver* increases 6%, becoming the most selected option. The usage of Design as a core competence (32%) and as a product's shaping activity (27%) decreases. The intention of not developing Design activities increases from 3% to 5%.

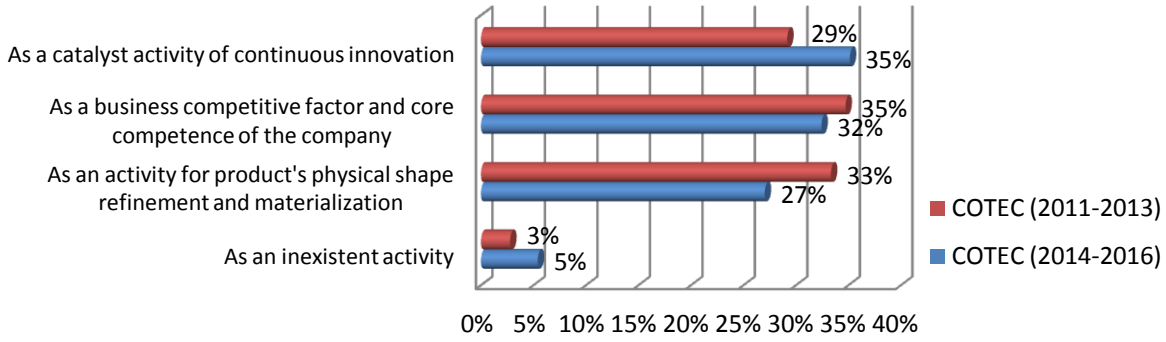

Figure 2 – Design's perceived role in the Firm. Comparison of SQ13 and SQ14

In figure 2 above, the reinforcement of the relationship of Design and innovation dynamics is more clearly shown. The respondents with no Design activity during 2011-2013 and with no foreseen evolution for 2014-2016, skipped questions related with design usage and were directly guided to SQ16 related with barriers to Design usage inside the firms.

SQ15 inquired respondents how they evaluated the impact during the period between 2011 and 2013 of Design's usage about a group of parameters, using a Likert-scale from 1 to 5. A PCA was run on a 14-question questionnaire that measured design's usage impact on 69 firms.

The suitability of PCA was assessed prior to analysis. Inspection of the correlation matrix showed that all variables had at least one correlation coefficient greater than 0,3. The overall Kaiser-Meyer-Olkin (KMO) measure was 0,86 with individual KMO measures all greater than 0,7, classifications of "middling" to "meritorious" according to Kaiser (1974).

Bartlett's Test of Sphericity was statistically significant ($p < 0,0005$), indicating that the data was likely factorizable.

PCA revealed three components that had *eigenvalues* greater than one and which explained 45,4%, 17,4% and 7,8% of the total variance, respectively. Only when a two-component solution was applied the interpretability criterion was met. As such, two components were retained. The two-component solution explained 62,8% of the total variance. A Varimax orthogonal rotation was employed to aid interpretability. The rotated solution exhibited "simple structure" (Thurstone, 1947).

Data interpretation was consistent with the design attributes the questionnaire was designed to measure with strong loadings on the eight "*market impact*" items on Component 1 and on the six "*internal impact*" items on Component 2 (*cf.* table XXXI in Appendix D). Table XII illustrates the results of SQ15 which are discussed below:

TABLE XII – DESIGN'S IMPACT IN FIRM

	Score	Impact	N	Min Value	Max Value	Mean	Std. Deviation	Coefficient Variation	Rank
Firm's Image	2	Market	69	2	5	4,33	0,78	0,18	1º
Communication with Clients	4	Market	69	1	5	3,93	0,99	0,25	2º
Entrance in New Markets	3	Market	69	1	5	3,61	1,22	0,34	3º
Increase in the number of new customers	4	Market	69	1	5	3,51	1,02	0,29	4º
Sales Increase	3	Market	69	1	5	3,45	1,04	0,30	5º
Increase in the products' Quality	4	Internal	69	1	5	3,30	1,09	0,33	6º
Increase in Market Share	3	Market	69	1	5	3,29	1,10	0,33	7º
More client's retention	4	Market	69	1	5	3,29	1,02	0,31	7º
Increase of products in portfolio	2	Internal	69	1	5	3,19	1,15	0,36	8º
Positive variation in return on investment	4	Market	69	1	5	2,88	1,17	0,41	9º
Increase in firm's productivity	3	Internal	69	1	5	2,68	1,09	0,41	10º
Reduction of the complexity of internal processes	3	Internal	69	1	5	2,39	1,13	0,47	11º
Reduction of costs per produced unit	3	Internal	69	1	4	2,13	1,07	0,50	12º
Environmental impact reduction	4	Internal	69	1	5	2,04	1,13	0,55	13º

Firms perceive Design to have a higher impact in market/customers related parameters, such as *firm's image*, *communication with clients*, *facilitating entrance in new markets*, *increasing the number of new customers* and their *sales volume*. The more internal or traditional parameters as the reduction of *internal processes complexity*, *costs per produced unit* and *environmental impact* have a perceived lower impact.

These results are consistent with other questions' results related with the mental associations with Design (brand building and marketing, in SQ9 and SQ10), usage drivers (differentiation strategy and firm's Image/reputation, in SQ11).

4.3. Design activities mostly used by respondent firms (RQ2)

The following section analysis the results of survey questions SQ22 to S26 that aims to respond to RQ2: *Which and how design activities are most used by these business firms?*

SQ22 inquired the respondents about the origin of Design activities. Table XIII below shows a total of 46 firms (66%) use both internal and external services, 20 firms (29%) use it exclusively inside and 4 firms (6%) only use design services acquired outside the firm.

TABLE XIII – SOURCE OF DESIGN ACTIVITY

Source of design activity	Score	Frequency	Percent	Valid Percent	Cumulative Percent
Only Internal	3	20	27,0%	28,6%	28,6%
Only External	2	4	5,4%	5,7%	34,3%
Both internal and external	3	46	62,2%	65,7%	100,0%
Total		70	94,6%	100,0%	
Missing		4	5,4%		
Total		**74**	**100,0%**		

It is not possible to assess if Design has a strategic role in the firm strictly based on the origin of design activity or service. Thus it is also important to understand the type of design activity or service the firm develops or acquires.

SQ23 inquired respondents about the used Design disciplines. The Design disciplines most developed internally are the conceptual, product and model development, activities whose inputs are usually used in an early phase of the development process. Comparatively, the Design services most acquired externally are communication design, brand building design and exhibition design, mostly used to build and develop a firm's identity and brand in the market.

The topic of the people that most directly work with Design was inquired by SQ24 and shown in table XIV below.

TABLE XIV – PEOPLE THAT MOST DIRECTLY WORK WITH DESIGN

	Score	Frequency	Percent	Valid Percent	Cumulative Percent	Rank
People from Research and Development	4	22	29,7%	31,9%	31,9%	1º
People from product development	3	21	28,4%	30,4%	62,3%	2º
People from marketing and sales	3	18	24,3%	26,1%	88,4%	3º
People from the production development, including technology	4	7	9,5%	10,1%	98,6%	4º
Others*	1	1	1,4%	1,4%	100,0%	5º
Total		69	93,2%	100,0%		
Missing		5	6,8%			
Total		**74**	**100,0%**			

Design activities interacts the most with people from R&D, product development and marketing and sales. The next question (SQ25) inquired respondents about the phase of the development process Design is first introduced. Only 55,1% of the respondents integrate Design in the conceptual phase and 36% integrate it in the development phase (table XV).

TABLE XV – PROCESS PHASE WHEN DESIGN STARTS TO BE USED

	Score	Frequency	Percent	Valid Percent	Cumulative Percent	Rank
Concept	4	38	51,4%	55,1%	55,1%	1º
Development	4	25	33,8%	36,2%	91,3%	2º
Post-production	2	4	5,4%	5,8%	97,1%	3º
Detailing	3	1	1,4%	1,4%	98,6%	4º
Pre-production	3	1	1,4%	1,4%	100,0%	4º
Total		69	93,2%	100,0%		
Missing		5				
Total		**74**				

About 9% of the respondents use Design on a later development phase, where its impact can be less strategic for the success of products and processes. SQ26 addressed the involvement of top or senior management with Design activity.

Of the 69 respondents, 58% have a high involvement and 34,8% have a medium involvement with design activities. Hence, about 92,8% of the respondents have a permanent follow-up or at least do participate in Design's decision-making moments. The results are displayed in table XVI below.

TABLE XVI – TOP MANAGEMENT INVOLVEMENT WITH DESIGN

	Score	Frequency	Percent	Valid Percent	Cumulative Percent	Rank
High involvement (permanent follow-up)	4	40	54,1%	58,0%	58,0%	1º
Medium involvement (participates in decision-making moments)	3	24	32,4%	34,8%	92,8%	2º
No involvement	1	3	4,1%	4,3%	97,1%	3º
Low involvement (intervenes only in moments of crisis)	2	2	2,7%	2,9%	100,0%	4º
Total		69	93,2%	100,0%		
Missing		5				
Total		**74**				

4.4. Design importance in firms' innovation activities (RQ3)

The following section analysis (SQ27 to SQ29) aims to respond to RQ3: *Is design activities' input considered significant in these firms' innovation activities?* SQ27 intended to identify the project leaders of new R&D, Innovation and Design projects. Being areas that allow differentiation from competitors and creating competitive advantages, top managers were naturally the main leaders, especially in a SME business context (table XVII).

TABLE XVII – FUNCTIONS WHO LEAD INNOVATION PROJECTS

	Score	Frequency	Percent	Valid Percent	Cumulative Percent	Rank
Top managers	3	24	32,4%	34,8%	34,8%	1º
Product engineers	3	13	17,6%	18,8%	53,6%	2º
Product managers	3	10	13,5%	14,5%	68,1%	3º
Marketeers	3	8	10,8%	11,6%	79,7%	
Designers	4	8	10,8%	11,6%	91,3%	
Specialized technicians	2	4	5,4%	5,8%	97,1%	
Others. Which ones?	1	2	2,7%	2,9%	100,0%	
Total		69	93,2%	100,0%		
Missing		5	6,8%			
Total		**74**	**100,0%**			

Although the association of Design and Innovation has been stated previously, results from SQ27 and table XVII above seem to suggest designers do not usually lead innovation projects, sharing the fourth place with marketers, behind product engineers and product managers. Interestingly, these results do not follow De.:SID's findings where, although the target population of that study was not innovation-driven firms, designers were the second group

leading innovation projects with only top managers above them. SQ28 inquired about the respondents' innovation rate for the product and process spheres, regarding the last three-year period (2011-2013), illustrated by table XVIII:

TABLE XVIII – RESPONDENTS' INNOVATION RATE IN PRODUCTS AND PROCESSES

	Score	N	2011	2012	2013	Average	Rank
Products improvement	n.a.	64	68,75%	82,81%	95,31%	82,29%	1º
Products introduction	n.a.	64	70,31%	84,38%	85,94%	80,21%	2º
Processes improvement	n.a.	63	61,90%	74,60%	93,65%	76,72%	3º
Processes introduction	n.a.	49	61,22%	79,59%	75,51%	72,11%	4º

Since the respondents integrate an *Innovative SME Network*, the innovation rates were significant as expected. Table XVIII shows respondents focus more resources on product innovation rather than on process innovation and more emphasis on improvement activities rather than on generating new products/processes. Afterwards, SQ29 inquired the presence of Design in these activities, in a percentage, in the development of each sphere.

TABLE XIX – DESIGN'S PRESENCE IN INNOVATION ACTIVITIES

Innovation sphere	0%	25%	50%	75%	100%	Total	Mean	Std. Deviation	Rank
	1	2	3	4	5				
Products introduction	2	8	16	25	13	64	3,61	1,05	1º
Products improvement	3	12	20	21	8	64	3,30	1,06	2º
Processes introduction	5	19	14	8	3	49	2,69	1,06	3º
Processes improvement	9	23	17	10	4	63	2,63	1,11	4º

Design is more used in the product sphere than in the process sphere. In both spheres, Design is more used to create new products and processes than to improve them (table XIX).

4.5. Firm's evaluation of barriers to Design usage (RQ4)

The following section analysis the results of survey questions SQ16 to SQ17 that aim to respond to RQ4: *What are the main barriers to design activities identified by the same firms?*

From the 74 respondents inquired, 22 respondents (30%) considered the existence of barriers (SQ16). A list of possible barriers (SQ17) was presented afterwards to these 22 respondents.

Originally the list had fourteen barriers that were subjected to a PCA. The suitability of PCA was assessed prior to analysis. Inspection of the correlation matrix showed that all variables had at least one correlation coefficient greater than 0,3. The overall Kaiser-Meyer-Olkin (KMO) measure was 0,71 with individual KMO measures all greater than 0,5, classifications of 'miserable' to 'middling' according to Kaiser (1974). Bartlett's Test of Sphericity was statistically significant ($p < 0,0005$), indicating that the data was likely factorizable.

PCA revealed two components that had *eigenvalues* greater than one and which explained 46,5% and 31,9% of the total variance, respectively. Only when a two-component solution was applied the interpretability criterion was met. As such, two components were retained. The two-component solution explained 78,4% of the total variance. A Varimax orthogonal rotation was employed to aid interpretability. The rotated solution exhibited 'simple structure' (Thurstone, 1947). The interpretation of the data was consistent with the design attributes the questionnaire was designed to measure with strong loadings on the four *knowledge barriers* items on Component 1 and on the three *financial barriers* items on Component 2 (*cf.* table XXXI in Appendix D). Thus, the analysis focused only these seven parameters. Two main barrier groups reflected both components identified in PCA: economic-financial and business barriers (table XX).

TABLE XX – FIRMS PERCEIVED BARRIERS TO THE USE OF DESIGN

	Barrier group	N	Mean	Std. Deviation	Coefficient Variation	Rank
High Costs of Design	Economic-financial	22	3,32	1,29	0,39	1º
Lack of awareness about the opportunities created by Design	Business	22	3,14	1,39	0,44	2º
Uncertainty regarding the outcomes of Design	Business	22	3,05	1,36	0,45	3º
Difficulties in financing	Economic-financial	22	3,00	1,35	0,45	4º
Difficulty differentiating products and processes	Business	22	2,95	1,33	0,45	5º
Fear of change implementation	Business	22	2,91	1,34	0,46	6º
Low return on Investment	Economic-financial	22	2,59	1,50	0,58	7º

Globally, business barriers more related to the lack of knowledge or experience in working with Design, represent a greater obstacle to the use of Design (general average of 3,01) than the economic-financial barriers (general average of 2,97). Individually, the most significant barrier is *high costs of Design* (3,32) followed by the *Lack of awareness about the opportunities Design creates* (3,14) and *Uncertainty regarding the outcomes of Design* (3,05). As the *high costs* barrier is usually indicated as one of the main obstacles in innovation surveys (GPEARI[14], 2006; DGEEC[15], 2014), also observed in De.:SID's (2007) survey, the second and third obstacles are more interesting, since they indicate the competitive advantages that Design provides in a business context are still ignored or underestimated by some firms and thus additional research on this topic is required and possibly beneficial to innovation-driven firms.

4.6. Design Maturity using the Danish Design Ladder framework

As previously mentioned (section 3.2.4), a Design Maturity score was attributed to the respondent firms, creating thus a variable called *Design Ladder*, that is described next.

TABLE XXI – DESCRIPTIVE STATISTICS OF DESIGN LADDER VARIABLE

		Statistic	Std. Error
Mean		2,57	0,06
Median		2,59	
Mode		1,24[a]	
Std. Deviation		0,51	
Skewness		-0,67	0,28
Kurtosis		0,30	0,55
Range		2,41	
Minimum		1,24	
Maximum		3,65	
Percentiles	25	2,33	
	50	2,59	
	75	2,98	

a. Multiple modes exist. The smallest value is shown

For interpretation purposes, the resulting values of this variable are here treated as integers. For this reason, the mode cannot be interpreted since there are several repeated values, where the

[14] < http://www.dgeec.mec.pt/np4/207/>, accessed in August 27th, 2014
[15] <http://www.dgeec.mec.pt/np4/207/>, accessed in August 27th, 2014

smallest is 1,24. As table XXI illustrates, from a possible score between 1 and 4, the *Design Ladder* variable has an average of 2,57 and a standard deviation of 0,51. This average means the respondents' overall and aggregated Design Maturity corresponds to the DDL's third stage *Design as Process*, as also illustrated by table XXII below:

TABLE XXII – RESPONDENTS' DESIGN MATURITY LEVEL

	Frequency	Percent	Valid Percent	Cumulative Percent	Rank
Non Design	4	5,4%	5,4%	5%	3º
Design as Style	19	25,7%	25,7%	31%	2º
Design as Process	50	67,6%	67,6%	99%	1º
Design as Innovation	1	1,4%	1,4%	100%	4º
Total	**74**	**100,0%**	**100,0%**		

The frequencies illustrate that respondents' overall Design Maturity (*Design as Process*) is shared by 67,6% of firms. The remaining respondents are distributed among the second stage: *Design as Styling* (25,7%) and the first stage: *Non-Design* (5,4%). The highest stage in terms of Design's strategic comprehension (*Design as Innovation*) is the least represented stage with only one firm (1,4%). Table XXIII below compares SQ13 results with *Design Ladder* variable:

TABLE XXIII – COMPARISON DESIGN LADDER VS FIRMS' PERCEPTION (SQ13)

		Firms' perception (SQ13)				Total
		Inexisting	Physical shape	Core competence	Continuous innovation	
Design Ladder	Non Design	2	0	0	0	**2**
	Design as Style	0	14	2	4	**20**
	Design as Process	0	10	23	16	**49**
	Design as Innovation	0	0	0	1	**1**
	Total	**2**	**24**	**25**	**21**	**72**

Data suggests a difference between firm's perception (SQ13) and the actual importance and usage (*Design Ladder* variable) of the role Design has in their business.

The green highlighted fields illustrate cases where the perception of respondents about Design's role in their firms is lower than their actual maturity indicates (10 cases).

On the other hand, the red highlighted fields reflect respondents who believe Design has a higher role in their firms than their Design Maturity indicates (22 cases).

As an example, from the 21 respondents that classified design activity in their firms as a *catalyst activity for continuous innovation* (SQ13), only one respondent is actually in the corresponding DDL stage (*Design as Innovation*), while 16 are actually in the third stage and 4 in the second stage. Both cases (green and red fields) reveal a lack of knowledge and experience in working with Design. However, the red cases are more concerning since their idea of Design's role appears to be unconsciously not followed by their firms' actions, what might hinder the opportunities Design can create and their respective outcome/impact in their firms.

5. CONCLUSION

5.1. Main conclusions

This research applied a survey strategy, based on the De.:SID survey (2007), to a group of 226 innovation-driven SMEs, with the purpose of describe the current Design Maturity level of Portuguese innovation-driven firms, using DDL framework (Kretzschmar, 2003). The conclusions are based on the respondents' collected answers and they need to be tested and enriched in future researches. Nevertheless, interesting insights about the importance Design can have in a business context could be extracted.

Design's *role inside Portuguese innovation-driven firms* (RQ1): First, Design is more associated with concepts such as *Product Development*, *Brand Building* and to Aesthetics. *Innovation* was indeed the second most referred association. However, when firms rank the associations according to its importance, *Innovation* dropped to the sixth place (SQ10). This fact indicates the association between Design and Innovation is acknowledged, although it is

not the most important one. Second, Design is mostly used (SQ11) due to its potential to build firm's *differentiation, image and reputation*. This is in accordance with other research's findings (De.:SID 2007). Third, although respondent's evidence a short experience in working with Design (SQ12), firms perceived Design's role in the last three years (SQ13) as a *business competitive factor and a core competence* (34,7%). A very similar number of respondents (33,3%) affirms, however, Design simply as a tool for the *product's shape refinement and materialization.* This perception is expected to follow a more strategic shift in the next three year period, with Design becoming mostly a *driver of continuous innovation* (SQ14).

The fourth and final finding regarding Design's perception is that its main impact (SQ15) is on the *firms' image*, in *communication with clients* and facilitating firm's *entrance in new markets*, which is consistent with the firm's mental associations and drivers.

***Design usage by the firms* (RQ2):** On one hand, firms affirm top managers have, in general, a *high involvement* with design activities (SQ26), and the people who most directly work with Design (SQ24) are *R&D* and *product development* professionals, which suggests Design's input is considered in the decision-making level of the firm (Cautela & Zurlo, 2008). On another hand, only 55% of these firms integrate Design in the *concept phase* of a design process (SQ25), where the remaining 45% miss thus parts of its strategic contribute.

***Design importance in the firms' innovation process* (RQ3):** Design is more used in the *product innovation sphere* than in the *process innovation sphere*, emphasizing the creation of new products and processes (SQ29). Additionally, designers' leadership and coordinating skills, acting as *gatekeepers* and *knowledge brokers* (Walsh & Roy, 1985; Mozota, 2003), are not recognized by the respondents (SQ27). Respondents' innovation projects are lead in first place by top managers, followed by product engineers, product managers, only then by

marketers and designers. Interestingly, these results do not follow De.:SID's (2007) findings, where designers were second in innovation project leadership, only behind top managers.

***Barriers to design activities* (RQ4):** Specifically for the 22 respondents who considered the existence of barriers, more than economic or financial lack of resources, the most significant barriers were *high costs of Design*, followed by the *lack of awareness about the opportunities Design creates* and *uncertainty regarding the its outcomes*.

***Design Maturity using the Design Ladder framework*:** A dependent variable was created based on the survey responses in order to correspond to DDL framework (*cf.* section 3.2.4). According to this variable, respondents' design maturity is at the third stage: *Design as Process*. The highest stage in terms of Design's strategic perception and usage - *Design as Innovation* - was the least represented stage, with only one result.

Moreover, data suggests a difference between firm's perception (SQ13) and the actual importance and usage (*Design Ladder* variable) of the Design role in their business, which reveals a certain lack of knowledge and experience in working with Design.

5.2. Research Limitations and future recommendations

The findings and conclusions above presented are limited to the group of 74 innovation-driven business firms who participated in the survey, due to the sampling method used in this study, a non-probability, purposive, critical case technique (Saunders *et al.*, 1997). They cannot be statistically extrapolated to the rest of COTEC Portugal's network, neither to other group of business firms. Recommendations for future research include studies of other populations or samples, using similar and different research strategies, to further test and expand this research's findings and conclusions. Follow-up interviews to study in-depth the Design Maturity in the innovation-driven firms here in scope would add significant insights.

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APPENDICES

Appendix A – Self-administered On-line Questionnaire

I) General characterization of the firm (*note: scores not visible to the respondents*)

SQ2. **Indicate company's legal denomination**

SQ3. **Indicate the starting year of company's activity**

SQ4. **Indicate Portugal's administrative district where your company is based:** (select one option from the following list)

SQ5. **Indicate the activity sector of the company**: (select one of the following options)

SQ6. **Indicate the number of employees at the end of:**

	2011	2012	2013
10 to 50 employees			
51 to 100 employees			
101 to 150 employees			
151 to 200 employees			
201 to 250 employees			
> 250 employees			

SQ7. **What was the company's sales volume at the end of:**

	2011	2012	2013
200.000 to 1.000.000 €			
1.000.001 to 5.000.000 €			
5.000.001 to 10.000.000 €			
10.000.001 to 50.000.000 €			
> 50.000.000 €			

SQ8. **Which of the following customers represents the highest sales volume for your company's products and/or services during the three-year period 2011-2013?** (Select only one of the following options)

- Other companies (B2B - Business to business)
- Final consumers (B2C - Business to consumers)
- Governmental entities

II) Perception of the importance of the use of design (*note: scores not visible to the respondents*)

SQ9. **In your personal opinion, what is the immediate association(s) you made with Design?** (Select only five of the following options)

	Score		Score		Score
Formgiving	1	Functionality	2	Quality	4
Brand building	3	Innovation	3	Costs saving	4
Concept development	3	Research	4	Sustainability	4
Product development	3	Marketing	2	Trendy issues	1
Technological development	2	Process	2	Other. Which one?	1
Aesthetics	1				

SQ10. **For the selected categories, rate them in ascending order, being one (1) the "weakest" association and five (5) the "strongest" one.**

SQ11. **From the following group of factors, select only the ten (10) most relevant factors that act as an engine to Design's usage in a business context:**

	Score		Score		Score
Learning and Competences	4	Product's life cycle	3	Competitors innovation capactiy	4
Company culture	4	Level of rivalry in the industry	4	Competitors competences	3
Company's dimension	4	Clients / Suppliers business power	2	Diferenciation strategy	2
Image / reputation	2	Technology used in the industry	3	Diversification strategy	3
Product /Service	2	Quality request by the clients	4	Internationalization	4
Process	3	Clients' complexity	3	Costs saving	3
Top Management	4	Suppliers' complexity	1		

SQ12. **How long has the company been using Design?** Nr. of years: _____

SQ13. **How do you define design's role in your company during the three-year period 2011-2013?** (Select only one of the following options)

	Score
As an inexisting activity	1
As an activity for product's physical shape refinement and materialization	2
As a business competitive factor and core competence of the company	3
As a catalyst activity of continuous innovation	4

SQ14. **In the following three-year period, 2014-2016, will your company integrate design activities in its procedures?** (Select only one of the following options)

	Score
No	1
As an activity for product's physical shape refinement and materialization	2
As a business competitive factor and core competence of the company	3
As a catalyst activity of continuous innovation	4

III) Attitude and action of the firm's management towards design use (*note: scores not visible to the respondents*)

SQ22. **Does the company orders design activities inside and/or from outside of the company?** (Select only one of the following options)

	Score
Only from inside	3
Only from outside	2
Both from inside and from outside	3

SQ23. **In the three-year period 2011-2013, what services have you used and/or purchased from design firms?** (Select only the applicable options)

	Not applicable	Score	Internally Developed	Score	Externally Acquired	Score
Model Building		0		4		3
Product Development		0		4		3
Communications Design		0		4		3
Concept Design		0		4		3
Brand Design Building		0		4		3
Exhibition Design		0		4		3
Package Design		0		4		3
User Interface Design		0		4		3
Environmental/Interior		0		4		3
Fashion and Textile Design		0		4		3
Service Design		0		4		3
Digital and Multimedia Design		0		4		3
Design management		0		4		3
Strategic Design		0		4		3
Others. Which ones?		0		4		3

SQ24. **Who are the people from the company that most directly work with Design?** (Select only one of the following options)

	Score
People from product development?	3
People from Research and Development?	4
People from the production development, including technology?	4
People from marketing and sales, including post-sale service?	3
Others. Which ones?	1

SQ25. **In what phase of the process does Design appear?** (Select only one of the following options)

	Score
Concept	4
Development	3
Detailing	3
Pre-production	3
Post-production	2

IV) Identification of the drivers and enablers of design used by the firm (*note: scores not visible to the respondents*)

SQ26. **How do you define company's senior management involvement with Design activity?** (Select only one of the following options)

	Score
No involvement	1
Low involvement (intervenes only in moments of crisis)	2
Medium involvement (participates in decision-making moments)	3
High involvement (permanent follow-up)	4

SQ27. **Identify who lead new R&D, Innovation and Design projects that the company develops?** (Select only one of the following options)

	Score
Designers	4
Product Engineers	3
Product Engineers	3
Top Managers	3
Marketeers	3
Specialized technicians	2
Others. Which ones?	1

SQ28. **In the last three-year period, did your company innovate by introducing new products or processes or by achieving relevant improvements in them?** (If yes, indicate the respective years)

	Design's presence			
	2011	2012	2013	Score
Introduced products:				n.a.
Introduced processes:				n.a.
Improved products:				n.a.
Improved processes:				n.a.

SQ29. **Considering your answer to the last question, how do you classify in a percentage Design's presence in the development of each of those cases?**

	Design's presence (%)									
	0%	Score	25%	Score	50%	Score	75%	Score	100%	Score
Products introduction:		0		1		2		3		4
Processes introduction:		0		1		2		3		4
Products improvement:		0		1		2		3		4
Processes improvement:		0		1		2		3		4

V) Firm's evaluation of Design results and barriers to the use of Design (note: scores not visible to the respondents)

SQ15. **During the three-year period of 2011 to 2013, how do you evaluate the impact of Design's usage by the company in each of the following parameters?** (Rate each of the following parameters from one (1) to five (5), being one (1) "zero impact" and five (5) "very high impact")

	Score (x rating)	1	2	3	4	5
Increase of products in portfolio	2					
Increase in firm's productivity	3					
Increase in the products' Quality	4					
Increase in Market Share	3					
Sales Increase	3					
Increase in the number of new customers	4					
Communication with Clients	4					
Entrance in New Markets	3					
Firm's Image	2					
More client's retention	4					
Reduction of the complexity of internal processes	3					
Reduction of costs per produced unit	3					
Environmental impact reduction	4					
Positive variation in return on investment	4					

SQ16. **Do you believe there are barriers to Design activities in the company?** (Select only one of the following options)

- Yes
- No

SQ17. **Indicate which are the barriers that most prevent the usage of Design:** (Rate each of the following options from one (1) to five (5), being one (1) the option of "no importance" and five (5) "very important")

	Importance of Barriers to Design				
	1	2	3	4	5
Low return on Investment					
High Costs of Design					
Difficulties in financing					
Small market size					
Low qualification of employees					
Lack of State support					
Lack of leadership skills on the part of Designers					
Lack of Time					
Uncertainty regarding the outcomes of Design					
Fear of change implementation					
Lack of awareness about the opportunities Design creates					
Difficulty differentiating Products and processes					
Lack of Demand					
Other barriers. Which one?					

SQ18. **Being the questionnaire finished, it is possible to have a diagnosis regarding the perception and utilization of Design at company.**

The answers provided previously indicate, in an ascending order from 1 to 4, that the company is in stage ____.

This stage is to be understood following the "Design Ladder" framework, developed by the Danish Design Center, in 2003.

Appendix B – Respondents' General Characteristics

TABLE XXIV – RESPONDENTS' MAIN LOCATION

Administrative District	Frequency	Percent	Cumulative Percent	Rank
Lisboa	24	32,4%	32,4%	1º
Porto	15	20,3%	52,7%	2º
Aveiro	14	18,9%	71,6%	3º
Leiria	5	6,8%	78,4%	4º
Braga	3	4,1%	82,4%	5º
Faro	3	4,1%	86,5%	6º
Santarém	2	2,7%	89,2%	7º
Setúbal	2	2,7%	91,9%	8º
Viseu	2	2,7%	94,6%	9º
Évora	1	1,4%	95,9%	10º
Guarda	1	1,4%	97,3%	11º
Viana do Castelo	1	1,4%	98,6%	12º
Vila Real	1	1,4%	100,0%	13º
Total	**74**	**100,0%**		

TABLE XXV – RESPONDENTS' STARTING YEAR ACTIVITY

	Frequency	%	% Cumulative
Until 1981	13	17,6%	17,6%
1982 to 1993	17	23,0%	40,5%
1994 to 2003	25	33,8%	74,3%
After 2003	19	25,7%	100,0%
Total	**74**	**100,0%**	

TABLE XXVI – RESPONDENTS' SECTOR OF ACTIVITY

Sector of Activity	Frequency	Percent	Cumulative Percent	Rank
Information and communication technologies	20	27,0%	27,0%	1º
Consultancy	10	13,5%	40,5%	2º
Other	7	9,5%	50,0%	3º
Agriculture and food	5	6,8%	56,8%	4º
Electronics	4	5,4%	62,2%	5º
Metal-mechanics	4	5,4%	67,6%	6º
Cork	3	4,1%	71,6%	7º
Industrial equipments	3	4,1%	75,7%	8º
Plastics and moulds	3	4,1%	79,7%	9º
Advertising and marketing	2	2,7%	82,4%	10º
Aeroespace engineering	2	2,7%	85,1%	11º
Chemistry and paints	2	2,7%	87,8%	12º
Civil construction	2	2,7%	90,5%	13º
Domestic appliances	2	2,7%	93,2%	14º
Ceramics	1	1,4%	94,6%	15º
Design	1	1,4%	95,9%	16º
Footwear	1	1,4%	97,3%	17º
Pencils production	1	1,4%	98,6%	18º
Textile and clothing	1	1,4%	100,0%	19º
Total	**74**	**100,0%**		

TABLE XXVII – RESPONDENTS' CLASSES OF EMPLOYEES (2013)

Nr of Employees (2013)	Frequency	Percent	Cumulative Percent	Rank
10 to 50	37	50,0%	50,0%	1º
51 to 100	16	21,6%	71,6%	2º
101 to 150	6	8,1%	79,7%	4º
151 to 200	7	9,5%	89,2%	3º
201 to 250	5	6,8%	95,9%	5º
> 250	3	4,1%	100,0%	6º
Total	74	100,0%		
Missing	0	0,0%		
Total	**74**	**100,0%**		

TABLE XXVIII – RESPONDENTS' BUSINESS VOLUME (2011-2013)

Business Volume	2011	2012	2013
200.000 to 1.000.000 €	15	14	12
1.000.001 to 5.000.000 €	31	31	31
5.000.001 to 10.000.000 €	15	15	16
10.000.001 to 50.000.000 €	12	13	14
> 50.000.000 €	1	1	1
Total	74	74	74
Missing	0	0	0
Total	**74**	**74**	**74**

TABLE XXIX – RESPONDENT'S TYPE OF CUSTOMERS (2011-2013)

Type of customer	Frequency	Percent	Cumulative Percent	Rank
Other companies (B2B - Business to business)	67	91,0%	91,0%	1º
Govermental entities	6	8,0%	99,0%	2º
Final consumers (B2C - Business to consumers)	1	1,0%	100,0%	3º
Total	74	100,0%		
Missing	0			
Total	**74**	**99,0%**		

Appendix C – SPSS Output of Cronbach's Alpha Coefficient Analysis

a) Reliability analysis of SQ15, construct "Internal Impact":

Case Processing Summary

		N	%
Cases	Valid	69	93,2
	Excluded[a]	5	6,8
	Total	74	100,0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,844	0,846	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Increase of products in portfolio	12,55	19,428	,410	,230	,859
Increase in firm's productivity	13,06	17,202	,722	,604	,799
Increase in the products' Quality	12,43	17,896	,635	,479	,816
Reduction of the complexity of internal processes	13,35	18,024	,589	,427	,825
Reduction of costs per produced unit	13,61	17,036	,764	,764	,791
Environmental impact reduction	13,70	17,538	,646	,691	,814

b) Reliability analysis of SQ15, construct "Market Impact":

Case Processing Summary

		N	%
Cases	Valid	69	93,2
	Excluded[a]	5	6,8
	Total	74	100,0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,916	0,915	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Increase in Market Share	25,00	32,294	0,873	0,844	0,893
Sales Increase	24,84	33,165	0,852	0,812	0,895
Increase in the number of new customers	24,78	33,584	0,825	0,771	0,897
Communication with Clients	24,36	36,382	0,591	0,395	0,916
Entrance in New Markets	24,68	31,956	0,799	0,689	0,899
Firm's Image	23,96	39,013	0,492	0,328	0,922
More client's retention	25,00	34,971	0,700	0,534	0,908
Positive variation in return on investment	25,41	33,921	0,670	0,499	0,911

c) Reliability analysis of SQ17, construct "Financial Barriers":

Case Processing Summary

		N	%
Cases	Valid	22	29,7
	Excluded[a]	52	70,3
	Total	74	100,0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,817	0,825	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Low return on Investment	6,32	6,227	0,545	0,347	0,887
High Costs of Design	5,59	5,872	0,807	0,703	0,616
Difficulties in financing	5,91	6,182	0,683	0,637	0,735

d) Reliability analysis of SQ17, construct "Knowledge Barriers":

Case Processing Summary

		N	%
Cases	Valid	22	29,7
	Excluded[a]	52	70,3
	Total	74	100,0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,896	0,897	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Uncertainty regarding the outcomes of Design	9,00	14,095	0,633	0,406	0,915
Fear of change implementation	9,14	12,600	0,842	0,765	0,840
Lack of awareness about the opportunities Design creates	8,91	12,468	0,817	0,708	0,848
Difficulty differentiating Products and processes	9,09	13,039	0,796	0,669	0,857

Appendix D – SPSS Output of Principal Components Analyses (PCA)

TABLE XXX – SQ15 PRINCIPAL COMPONENTS AFTER PCA ANALYSIS

Rotated Structure Matrix for PCA with Varimax Rotation of a Two Component Questionnaire		
Items	Rotated Component Coefficients	
	Component 1	Component 2
Increase in the number of new customers	**0,865**	0,178
Increase in Market Share	**0,863**	0,297
Sales Increase	**0,850**	0,288
Entrance in New Markets	**0,828**	0,237
Communication with Clients	**0,724**	-0,043
More client's retention	**0,661**	0,456
Positive variation in return on investment	**0,643**	0,437
Firm's Image	**0,641**	-0,086
Reduction of costs per produced unit	0,126	**0,864**
Increase in firm's productivity	0,159	**0,814**
Increase in the products' Quality	-0,033	**0,765**
Environmental impact reduction	0,230	**0,750**
Reduction of the complexity of internal processes	0,137	**0,698**
Increase of products in portfolio	0,172	**0,505**

Note: major loadings for each item are bolded.

TABLE XXXI - SQ17 PRINCIPAL COMPONENTS AFTER PCA ANALYSIS

Rotated Structure Matrix for PCA with Varimax Rotation of a Two Component Questionnaire		
Items	Rotated Component Coefficients	
	Component 1	Component 2
Lack of awareness about the opportunities Design creates	**0,918**	-0,068
Fear of change implementation	**0,916**	0,061
Difficulty differentiating Products and processes	**0,899**	-0,018
Uncertainty regarding the outcomes of Design	**0,735**	0,418
High Costs of Design	-0,107	**0,931**
Difficulties in financing	0,010	**0,874**
Low return on Investment	0,236	**0,760**

Note: major loadings for each item are bolded.