The Use of Design as a Strategic Tool for Innovation:
An Analysis for Different Firms' Networking Behaviours

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ACKNOWLEDGMENTS: This paper is financed by National Funds provided by FCT- Foundation for Science and Technology through project UID/SOC/04020/2013. The authors are grateful to the anonymous referees for helpful suggestions and useful insights.

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ABSTRACT

Current research indicates that the use of design as strategic in companies is related to innovation and leads to competitiveness. This research aims to empirically analyse the relationship between firms' networking behaviours and their propensity to engage in design activities. Although much of the literature on networks focus on the relationship between the development of external linkages and innovation, we argue that SMEs' relationships with different agents and intermediaries, on diverse geographic scales, play an important role for how companies use design as an element of innovation. Using the Community Innovation Survey (CIS 2012) database for Portugal, a logistic regression was performed using the "strategic use of design" as a binary dependent variable. We found that firms' engagement in informal relationships with heterogeneous agents such as public customers, consultants or conference mates, are positively associated with the strategic use of design. The use of firms' internal assets as information sources also revealed to be significant. Regarding market relations, the results indicate that a geographic scaling-up contributes to increase the odds of a firm recognizing the strategic role of design for competitiveness.

KEYWORDS:

Design engagement; innovation; firms' networking behaviours; CIS

1. Introduction

Current research indicates that the use of design as an integrated element in companies is highly correlated with innovation and economic outcomes. Furthermore, the design integration tends to have a positive effect on the success of innovative products and it is found to be significantly related to other innovation activities, both internal and external (Galindo-Rueda & Millot, 2015). Design has developed rapidly in recent years, leading to concepts such as design management and design thinking. Although often associated with aesthetics, the potential of design lies in its broad and multidisciplinary nature, allowing a wide range of considerations in the development of products, services and systems. Its bridging capacity connects technology with the user and engineering with commercial issues, a process leading to transforming creativity into innovation (Brown, 2009).

In fact, research shows that design-driven companies are more innovative than others (Verganti, 2009). Companies that invest in design tend to be more profitable and grow faster. On a macro-economic level, there is a positive correlation between the use of design and national competitiveness, since design-driven innovation builds on existing strengths, heritage, diversity, authenticity and creative potential. Therefore, design-driven innovation is considered as a competitive advantage with potential for the future. Apart from transforming research into commercially viable products and services, design brings creativity closer to user needs and strengthens the communication between the different parts of innovation process – R&D, production and marketing. Hence, design acts as a bridge between ideas, research and technology, contributing to making products commercially acceptable, user-friendly and appealing (Commission of the European Communities, 2009).

This is a process involving a wide range of interactions along the product value-chain. The way firms make use of these interactions to learn and improve their design and innovative capacity may vary. The continuous capacity of firms to learn by interacting with others is seen by many academics as an important response in order for firms to avoid becoming locked into obsolete competitive trajectories (Cesário & Vaz, 2014). Case-studies across Europe present empirical and theoretical perspectives on how firms benefit from external linkages with other firms and economic agents (Alvarez *et al.*, 2009; Arndt & Sternberg, 2000; Cantner *et al.*, 2010).

Hence, considering the role of networking dynamics in innovation (Caloffi *et al*., 2015), one could expect that small and medium-sized enterprises' (SMEs) engagement in relationships with heterogeneous agents and intermediaries, from different geographic scales, plays an important role in how firms use design as an element of innovation. Against this background, this research aims, firstly, to discuss the role of design activities on product and process innovation, and secondly, to understand the relationship between different networking dynamics and the performance of design activities. More precisely, by focusing on a sample of Portuguese firms, the authors' main purpose is to understand to what extent different relational features may effectively be associated with the strategic use of design for the competitiveness of firms' innovation process.

The paper is structured as follows: section 2 clarifies the relationship between design and innovation, highlighting the different levels of engagement of design in firms; and section 3 reviews the importance of a firm's networking dynamics, confirming that the development of external linkages on wider geographic scales may be associated with different propensities to innovation and design activities. The remaining sections present the methodological procedures (section 4), the corresponding results (section 5) and conclusions (section 6).

2. Design Engagement and Innovation in Organizations

In the context of assigning meaning and differentiation to businesses, the design assumes a decisive role, as a discipline widely linked to industry and services seeking to find solutions for society. The design, focusing on the user, is a key tool for benchmarking solutions in different disciplines and markets (Cockton, 2005). Not limited to the physical appearance of the products, design has extended its reach to consumer experiences, production processes, interaction and enhancements, in order to generate new products and services as well as transform existing ones (Melles *et al*., 2012).

The European Commission is currently addressing efforts to encourage the use of design as a tool for innovation. Design is being approached as the link between technology, creativity and the user, and thus as a crucial tool to increase the scope of

innovation, in particular for European SMEs, aiming to enhance firms' and countries' competitiveness (Cunningham, 2008). Indeed, the last version (2010–2012) of the community innovation survey (CIS), which is the main statistical survey on firms' innovation in Europe, attributes to design a more preeminent role than the previous versions. In addition to querying firms about their use of design, the recent version assumes that design can be a method (e.g. design registration) that can be used by companies to maintain or increase the competitiveness of product and process innovations.

Hence, design is consolidated as a competitive tool for businesses, ensuring significant returns on institutional image and sales. For example, according to a survey conducted in England (Design Council, 2004), companies that invest in design experience higher performances then their competitors. Additionally, a study developed by World Economic Forum's Global Competitiveness (Raulik, 2006) shows the correlation between the potential competitiveness of a country and the efficient use of design, through comparison between economic development and investments in this area. These findings confirmed that the integration of design tools and techniques in the business sphere can help to deal with complex issues and challenges and lead to competitive advantages (Tschimmel, 2012). Thus, some countries have developed explicit policies of design at national level (e.g. Finland, Denmark, South Korea), while others primarily at regional and local (for example, France, Italy, Germany) (Commission of the European Communities, 2009). Some design systems are mainly financed by the government (e.g. Scandinavian countries, South Korea), while others are co-financed by the industry (e.g., USA, Italy, United Kingdom, Germany). Some programmes are conducted primarily by the government (e.g. South Korea), or private actors (e.g. USA) (Commission of the European Communities, 2009). Simultaneously, there are a significant number of detailed reports on design policies by countries (e.g. TrendChart on national and regional policies, design creativity and innovation oriented towards the user).

Considering the role of design within the functional structure of a company, it is possible to find different stages regarding the use of design. The Danish Denmark Centre developed a ladder model to analyse the level of engagement of design in firms (Danish Design Centre, 2003). This method makes an analogy using a staircase with

four steps of increasing complexity: 1 – no design; 2 – design as styling; 3 – design as process; and 4 – design as strategy (Galindo-Rueda & Millot, 2015).

Additionally, Koostra (2009) describes the structure of the Design Management Staircase Model. The researcher states that this model is based on a method comparable with the Design Ladder of the Danish Design Centre. The model aims to enable European businesses to assess and improve their design management capabilities, in order to increase their effective use of design and improve their competitiveness and business success. However, an essential implication of the Design Ladder is that only businesses that reach the highest level will benefit from the full potential of design (Ramlau & Melander, 2004). The Design Management Staircase model describes the characteristic design management behaviour and capability of businesses on four levels: 1) no design management; 2) design management as a project; 3) design management as a function; 4) design management as a culture. The level classification ranges from the lowest level (no design management) to design management used strategically as part of the business culture. On this last level, design is an essential part of their differentiation strategy, generating a distinct competitive advantage. For this reason, design is an integral part of the business processes with the involvement of a wide range of different departments. A design-literate top management reinforces the support and significant value of design in the entire business, as part of the business corporate culture.

These theoretical models highlight the ability of design to play a strategic role through innovation within an organisation. High stair level companies are open to the vast possibilities of design as creator of new markets and trends. From this perspective, the design is at the beginning of the process of innovation of a product and service, during its whole life cycle of use, rather than being a mere artifact in the production of purely aesthetic effects (Utterback, 2007).

3. Firm's Networking Dynamics Towards Design and Innovation

The literature confirms that firms which do not co-operate, and which do not formally or informally exchange knowledge, limit their long-term knowledge-base and, ultimately, reduce their ability to enter into exchange relationships (Hanna & Walsh, 2002, 2008; Pittaway *et al*., 2004). A diffusion of regional innovation policies

supporting networks of innovators has been witnessed in the last 20 years. The goal of these policies is to encourage firms, particularly SMEs, to collaborate with organisations possessing complementary knowledge (Caloffi *et al*., 2015). More specifically, regarding product and process innovation, positive associations were found in cooperation with customers, suppliers, the public sector and universities (Freel & Harrison, 2006). Although, in some cases, the effects are not as direct because there are sectoral and regional influences in terms of the efficiency with which such networking inputs are translated into innovative outputs (Love & Roper, 2001), it can be emphasised the importance of inter-organisational cooperation, corroborating the relevance of the open innovation model at the firm and regional levels (Belussi *et al*., 2010; Teirlinck & Spithoven, 2008).

Much of the literature on networks refers to issues such as embeddedness (Granovetter, 1985) and path dependence (Arthur, 1994; Dosi, 1997; Dosi *et al*., 1988; Nelson & Winter, 1982), recognising that geographic agglomerations are embedded in production or innovation networks through linkages which play an important role in supporting innovation and knowledge sharing (Shaowei *et al*., 2014). These arguments are in line with the idea that, although organisational proximity is important, it does not substitute the appealing direct face to face communication, namely because some types of knowledge are more mobile than others. While analytical knowledge, which results from the application of scientific laws, has a relatively constant meaning by location, the same is not true for the synthetic or symbolic knowledge[1], whose meaning is substantially variable (Gertler, 2008).

There is a vast academic literature showing that geographical proximity increases the likelihood that two agents will commit directly to sharing knowledge reciprocally (e.g. Frenkel *et al*., 2015), thus implicitly meaning the efficiency of local linkages. Nonetheless, it can also be argued that the development of external linkages on wider geographic scales may be associated with higher propensities to innovation and design activities as well.

As the drivers of globalisation are removing barriers which traditionally segmented the competitive environments of small and large firms, firms of all sizes are joining

[1] By synthetic knowledge Gertler (2008) refers to the the application or combination of existing knowledge, mainly through interactive learning with customers and suppliers; symbolic knowledge means creating meaning trough highly context specific learning-by-doing processes.

international networks (Dana, 2001). While some sectors often need to internationalise their activities, especially sales, at a very early stage of their development because of limited domestic markets (Cantwell, 1995; Keeble *et al.*, 1998), others do this in search of technical advances. Nachum and Keeble (2003) argue that firms need to identify a successful balance between localised sources of interaction and those in wider geographic areas, and to establish linkages on these different geographic scales in order for them to compete successfully.

Accordingly, it can be considered that SMEs' relationships with different agents and intermediaries, on diverse geographic scales, play an important role for how companies use design as an element of innovation (Monteiro-Barata, 2013).

This idea is in line with the work of Hobday, Boddington, and Grantham (2012) which examine the changing role of design in business and policy, from the first generation technology push to the networking and systemic approaches. From the 1950s to the 1990s, design evolved from an aesthetic or surface activity to a visible and intrinsic innovation function, core to the development of radical new products and novel product categories. More recently, in the post–1990s, the "fifth generation systems integration and networking models" approach design as a core technical task and a contributor to business differentiation. Strategic design becomes both integral and systemic to new product development. In contrast with the first models, fifth generation design is originated from a multitude of sources, including customers, designers, engineering departments, design companies and marketing departments, often working in close collaboration with each other. Also, in a fifth generation approach, the design system would not only be viewed within the boundaries of a single country, as markets are increasingly international and different kinds of design occur within a changing global context. These models emphasize the learning which goes on within and between firms suggesting that design is fundamentally a distributed networking process and part of an embedded, networked 'open' innovation system (Hobday *et al.*, 2012).

A corroborating line of reasoning is presented by Bertola and Teixeira (2003). The authors examine the relation between design and three domains of knowledge – users', organizational and network knowledge – arguing that the challenge for designers and managers is to be able to apply design strategically to access the knowledge embedded in these three domains in order to promote and support innovation. The authors identify two strategies in which design acts as a knowledge agent: as a "knowledge integrator"

in larger firms, and as a "knowledge broker" in local smaller companies. In global corporations, internal and external design resources are combined. These firms rely both on knowledge developed internally, as well as on the network knowledge developed outside their boundaries. Even if there is a propensity to primarily rely on their internal assets to promote innovation, larger firms tend to interact with the knowledge diffused through networks existing outside the organization, in order to bring new experience inside the corporation. In small firms, design is responsible for capturing and representing the knowledge embedded outside the organization in 'users' communities' and 'local networks' In this context, design acts primarily as a 'knowledge broker' promoting knowledge flow from outside to inside the firm. Through design, companies access the knowledge needed to innovation activities. According to the authors, in local companies, network knowledge is a main source for design innovation, as small firms may demand more problem-solving services and consultancy, which are more likely to be available from local institutions from their external environment (Bertola & Teixeira, 2003). The authors acknowledge that design contributes to innovation (both in product and/or process) by collecting, analyzing and synthesizing the knowledge contained in those three domains.

This line of thought confirms the idea that the way firms interact with other agents outside their boundaries impacts on the manner how design is used as an element of innovation.

4. Data and Methodology

4.1. The CIS Instrument

For this study a secondary dataset was used from the CIS 2012 (DGEEC, 2014). The CIS, operation acronym in the Eurostat for Community Innovation Survey, is the main statistical survey (mandatory for EU member states) on innovation in companies. European Union employs this main statistical instrument to monitor Europe's progress in the area of innovation, which is conducted by national statistical offices. In Portugal, following the methodological recommendations of Eurostat, the CIS aims to directly collect information on innovation (product, process, marketing, and organizational) in companies based in Portugal. Data collection, corresponding to the period of 2010-

2012, was performed between June 3 and March 14, 2014, through an online electronic platform. The universe contemplates Portuguese companies with 10 or more employees belonging to sections B, C, D, E, F, G, H, J, K, M, Q of the NACE codes. The sample consisted of 9423 companies, based on census combination (for companies with 250 or more persons employed) and random sampling for other companies. Of the 7995 companies of the corrected sample, 6840 valid answers were considered, corresponding to a response rate of 86%.

4.2 Conceptual Framework

In this paper we look for the relationship between firm's networking dynamics and innovation and design. The CIS instrument provides useful information on how firms interrelated with its surrounding external environment in order to acess information considered important for the development of new innovation projects or the completion of existing ones. Firms may use external agents as information sources or engage in more formal cooperation activities, meaning their active participation with other enterprises or institutions on product and process innovation accomplishments.

Regarding these accomplishments, and according to CIS, a firm may be engaged in one or more of the following situations:

a) Product innovation: that occurs when a firm introduces to the market a new or significantly improved good or service. It does not need to be new to the market; however it must be new to the firm and it should not matter if it was originally developed by the firm or by other external partners.

b) Process innovation: that occurs when a firm implements a new or significantly improved production process, or new and significantly improved methods of supplying services, or supporting activity. Purely organizational or managerial changes are excluded. Again, this innovation does not need to be new to market; however, it must be new to the firm not mattering if it was originally developed by the firm.

c) Ongoing or abandoned innovation activities: that includes any innovation activities that did not result in a product or process innovation because the activities were rather abandoned or suspended before completion, or are still on-going.

Innovation activities include not only all types of R&D activities, but also the acquisition of machinery, equipment, buildings, software, and licenses; engineering and development work, design, training, and marketing, when they are specifically undertaken to develop and/or implement a product or process innovation (DGEEC, 2014).

Another conceptual clarification required regards the firms' propensity for design activities. Innovative firms were asked about the activities developed aiming product and/or process innovation. One of the innovation activities considered in CIS 2012 is the firm commitment in in-house or contracted out design activities (considered as the activities to design or alter the shape or appearance of goods or services).

Another important approach to design introduced for the first time in CIS 2012 regards the efficiency of design registration for the competitiveness of product and process innovations introduced. This information provides an important indicator of what can be named the level of ***firms' design engagement***, following the inspiration provided by the academic works on the ladder models of design (e.g. Koostra, 2009; Ramlau & Melander, 2004). These models suggest that there are a possible range of roles of design that are ordered from no design use to more integrated and sophisticated uses (please see section 2).

In this paper we use the information provided by the CIS-2012 instrument, which introduces the issue by asking: "How effective was the design registration (when existent) for maintaining or increasing the competitiveness of product and process innovations introduced during 2010 to 2012?" Similarly, a four level' effectiveness degree is possible, ranging from "0=Not used, not known, not applicable", to "3 = High effective". Although having in mind that only registrations are being considered, this last category offers close information on the use of ***design as strategy*** for the firms' innovation process.

4.3 Methodological Framework and Research Questions

This research assumes the importance of networking aptitudes on firms' innovative process and design use. The authors start by discussing the role of design activities on the innovative performance of firms before developing a more extensive analysis on the

relationship between the different ways firms interact with their external environment and their different levels of design engagement.

The review of the literature suggests the importance of external linkages, recognising that small firms are frequently fragments of extended networks with different possible partners and geographic scales. By accessing other markets, assets and economic agents, firms not only release themselves from the limits of local and internal competences, but are also aware of new and more demanding market conditions that constitute a stimulus to innovation, creativity and design.

In the scope of the present paper, a sample of Portuguese firms from CIS 2012 was used. Firms' networking dynamics were assessed by observing their behaviour regarding market interactions and the use of external linkages as sources of information and/or partners of cooperation for the development of innovative activities.

Although we emphasise the social facet of networking (mostly associated with informal linkages), in this paper we also consider market transactions as network activities, based on the idea that, ultimately, all market transactions appear as the outcome of previous social connections along the value-chain (horizontally and vertically). According to Staber (2011), 'marketless' conceptions of social networks are overstated and need to be balanced with a stronger concern for the role of competition in the social embeddedness of small firms. Figure 1 summarises the proposed methodological framework.

(Please insert) Figure 1. Methodological Framework

According to these considerations, the following research questions were addressed in this paper:

RQ1: What is the role of design on product and process innovation?

RQ2: How different networking dynamics impact on firms' design engagement?

5. Results

5.1 Characteristics of the Sample

The Portuguese subsample of CIS-2012 includes a total number of 6840 firms, with the sectoral distribution presented in table 1. The majority of firms has up to 49 employees (74.8% of the 5776 firms with valid size information) and almost half of the sample firms (48.8%) affirm that performed product, process or have ongoing innovation activities. Within this group, 26.5% engaged in cooperation relationships aiming innovation activities, and 32.5% develop in-house or contracted out design activities towards product/process innovation.

(Please insert) Table 1. Characterisation of the Sample

5.2 The Role of Design for Innovation and Competitiveness

Before concentrating in the relation between networking and performance of design activities, a discussion on the role of design on innovation is previously presented.

The data analysis indicates that the type of innovation, whether related to product or process, is not independent from the development of design activities aiming at product and/or process innovation. The null hypothesis (*innovation is independent from design propensity*) for both types of innovations was rejected for the qui-square tests (product innovation: chi-square = 287.462, *p*-value = 0.000; process innovation: chi-square = 7.842, *p*-value= 0.005), which indicates a relationship between the two variables. From the group of firms that introduced a product or a process innovation, 42% and 34%, respectively, were engaged in in-house or contracted out design activities.

Among the different possible methods contributing to the competitiveness of product and process innovations presented by CIS 2012, design registration occupies a modest position (0.55 out of 3). Figure 2 provides the mean values of a four level' effectiveness degree, ranging from "0= not used" to "3= high effective" with respect to the effectiveness of different instruments to the competitiveness of product and process innovations.

(Please insert) Figure 2. Effectiveness of the competitiveness of product and process innovations

According to previous studies developed in Portugal, concerning design as a strategic resource to companies (Monteiro-Barata, 2012), this research highlights design as a crucial driver of the innovation dynamics in firms. However, our findings are also in line with the idea that Portuguese companies are still underestimating the potential of design as a strategic resource and that few firms are approaching design management as a culture. Indeed, from the 3341 Portuguese firms developing product, process or ongoing innovations, 985 made use of design registration, of which only 224 (22.7%) considered it high effective (Figure 3).

(Please insert) Figure 3. Effectiveness of "design registration" for the competitiveness of product and process innovations

Although there is a growing trend in the use of design, this is not an optimized and properly integrated process into organizational internal strategies. Branco (2006) points out the major causes of failure that may be at the origin of these low results of some of the Portuguese SMEs, as following: (1) the lack of sophistication in technology and management instruments in most companies leads to "lack of sensitivity to the use of design" at various levels; and (2) not the appreciation of design as an essential management tool, since the formulations/strategic options for the development of a project /product in particular.

The next section provides a more comprehensive analysis of the relationship between these different levels of "design engagement", namely the strategic use of design and the ways firms interact with their external environment. The different types of relational features considered in the present paper - information sourcing, cooperation and market interactions - were taken into consideration for the analysis, together with additional information on firms' sector and size.

5.3 Firms' Networking Dynamics and Design Engagement

The main objective of this section is to understand to what extent the different relational features considered may effectively be associated with the strategic use of design for the competitiveness of firms' innovation process, following the inspiration provided by the academic works on the ladder models of design.

The aim is to explore the actual relationship between these different networking dynamics and the presence and role attributed to design activities, as an element of firms' innovation. The authors endeavour to contribute to a more precise understanding of the respective relevance of each of them (or some of them) as they correspond to significantly different modes of external interaction, which can result in different impacts on firm behaviour. Our focus will be on the group of firms that demonstrate greater "design engagement" and attribute a strategic role to this activity, aiming to understand which relational features may effectively be associated with this behaviour.

5.3.1 The variables

The sub group of the 3341 companies that developed product, process, or have ongoing innovation activities (48.8%) (N=6840) was selected in order to observe the impact of networking dynamics on higher levels of design engagement.

Among these firms, a group of 224 considered design registration as high effective to the competitiveness of product and process innovation. This information was used to distinguish between firms using design as strategy from firms that do not. Table 2 presents the dataset variables in the analysis.

(Please insert) Table 2. Variables in the dataset

Regarding cooperation on any innovation activities, firms may cooperate with eight different partners (variable PARTCOOP) at different geographical scales (variables COOP1, COOP2… COOP8). Information for new innovation projects may come from eleven different sources (variables INFSOURCE1, INFSOURCE2, INFSOURCE3… INFSOURCE11), each one with different possible degrees of importance. Finally, firms may sell their goods and/or services in different geographic markets (variable MARKT).

5.3.2 The binomial logistic regression model

The quantitative contribution of each one of the previous predictors to the dependent variable (DESIGNSTRAT) was compared using a binomial logistic regression model, constructed by iterative maximum likelihood estimation (MLE), as given by the following equation:

$$
\begin{aligned}
&logit(\mathrm{DESIGNSTRAT}_i) \\
&\quad = \alpha + \beta_1 PARTCOOP + \beta_2 COOP1 + \beta_3 COOP2 + \beta_4 COOP3 \\
&\quad + \beta_5 COOP4 + \beta_6 COOP5 + \beta_7 COOP6 + \beta_8 COOP7 + \beta_9 COOP8 \\
&\quad + \beta_{10} INFSOURCE1 + \beta_{11} INFSOURCE2 + \beta_{12} INFSOURCE3 \\
&\quad + \beta_{13} INFSOURCE4 + \beta_{14} INFSOURCE5 + \beta_{15} INFSOURCE6 \\
&\quad + \beta_{16} INFSOURCE7 + \beta_{17} INFSOURCE8 + \beta_{18} INFSOURCE9 \\
&\quad + \beta_{19} INFSOURCE10 + \beta_{20} INFSOURCE11 + \beta_{21} MARKT
\end{aligned}
$$

For any binomial logistic regression, the predicted dependent variable is a function of the probability that a particular subject will be in one of two categories. In this case, we mean the probability that sample firms use design as a strategic tool for the competitiveness of innovation ($\mathrm{DESIGNSTRAT}_i = 1$). The logistic regression will predict the logit, that is, the natural log of the odds given by:

$$logit(\mathrm{DESIGNSTRAT}_i) = ln\{P(\mathrm{DESIGNSTRAT}_i = 1)/[1 - P(\mathrm{DESIGNSTRAT}_i = 1)]\}$$

Section 5.3.3 presents the results for the set of recommended procedures and statistical tests developed to assure the adequacy of the model.

5.3.3 Adequacy of the model and goodness-of-fit

The assumptions required for statistical tests in logistic regression are far less restrictive than those for OLS regression. There is no formal requirement for multivariate normality, homoscedasticity, or linearity of the independent variables within each category of the dependent variable (Spicer, 2005). However, the problem of multicollinearity, which relates to very high correlations among the independent variables, does apply to logistic regression. High multicollinearity is a problem as it

affects the reliability of the coefficients. In this case, the highest correlation registered among two independent variables was 0.745, which does not represent a problem.

The model's goodness-of-fit was assessed using the Omnibus test of model coefficients. In this case, the model containing the twenty one independent variables was compared with the model containing only the constant. In other words, we are testing whether knowledge of the different relational features considered improves our ability to predict the strategic use of design by firms. The null hypothesis that the coefficients of the variables are all jointly equal to zero was rejected (p = 0.000). Complementarily, the Hosmer and Lemeshow Test was also performed – the null hypothesis that the model adequately fits the data was not rejected (p = 0.138). The overall percentage of correctly predicted cases by the present model is 93%, which is highly reasonable.

5.3.4 Results of the estimation of a logistic regression model

Following these procedures, the logistic regression results are presented. Table 3 lists the logistic coefficients, the Wald statistic, its significance and the odds ratio, for the final independent variables in the model.

Logistic coefficients are unstandardized and therefore not directly comparable with each other. They are interpreted as the expected change in the propensity of a firm to use design as strategy for a unit change in the associated explanatory variable, holding all the other variables constant. Logistic coefficients are easier to interpret when converted to an odds ratio using the exponential function (EXP(B)). The odds ratios are simply measures of effect size and are used to comment on their relative sizes when comparing independent variables effects.

The Wald statistic is used to test the significance of individual logistic regression coefficients for each independent variable (that is, to test the null hypothesis that a particular coefficient is zero).

Of the list of independents initially considered, the following ones are statistically significant: Main Market (MARKT), Information sources: Inside the Firm (INFSOURCE1); Public customers (INFSOURCE4); Consultants (INFSOURCE6); Conferences and Exhibitions (INFSOURCE9) and Cooperation for innovation with: universities (COOP7). All the others variables are not statistically significant.

(Please insert) Table 3. Results of the estimation of a logistic regression model with the final independent variables

As stated earlier, the analysis of the odds ratios allows comparing the effect size of each one of the independents on the odds of the dependent. In other words, among the significant predictors, it is possible to identify which ones produce bigger positive (odds ratios > 1) or negative (odds ratios < 1) effects on the odds of a firm using design as a strategic tool.

For instance, for every 1-unit increase in market geographical scale, the odds of a firm using design as strategy increase 18,9%. Also, for every 1-unit increase in the importance attributed to internal sources, public customers, consultants or conferences as sources of information for innovation activities, the odds of a firm making a strategic use of design increases 46%, 16,5%, 22,3% and 97,7%, respectively. To note that, a 1-unit increase in the geographical scale of academic cooperation for innovation produces a 30% decrease in the odds of a firm attributing an important role to design registration for the effectiveness of product or process innovations. These results confirm that different networking dynamics are associated with different firm behaviors and provide an interesting understating of which aspects of relational features are in fact associated with higher levels of design engagement. More than the commitment in more formal cooperation activities, it is the use of some external agents as information sources that seems to play a higher influence on the role attributed by firms to the use of design as a strategic tool.

Additional information on firms' sector and size was explored in order to complement this information and better characterized the small group of firms that strategically uses design.

Industry differences reveal to be statistically different between the two groups. The null hypothesis – the strategic use of design is independent from firms' sector – was rejected (chi-square = 35.685, *p*-value = 0.000) indicating a dependence relationship.

Figure 4 allows to observe that, among firms that use design strategically, there is a higher incidence of firms from health industry; financial, insurance and related activities; wholesale, retail trade, transportation and storage; and the production of coke,

chemicals and related products, when compared with the incidence of these sectors on the total sample.

(Please insert) Figure 4. The strategic use of design by firm's sector

Regarding firm's size, the null hypothesis of independence was not rejected (chi-square = 2.354, *p*-value = 0.308) meaning that the use of design as strategy by firms is not dependent on firms' dimension in terms of number of employees. In fact, only slightly differences (not statistically significant) were found between the two groups, with a prevalence of lower design propensities among smaller firms (figure 5).

(Please insert) Figure 5. The strategic use of design by firm's size

6. Discussion and Conclusion

This study performed a binary logistic analysis in order to understand to what extent the development of different external linkages is associated with the strategic use of design for the competitiveness of firms' innovation process. The analysis was based on the Community Innovation Survey (CIS-2012) database for Portugal, which provides useful information on how firms interrelate with their external environment in order to access information considered important for the development of new innovation projects. We focused on the group of firms that demonstrate greater "design engagement" and assign a strategic role to this activity, aiming to understand which external linkages are associated with this behaviour.

Borrowing the ladder models of design use in firms, we concentrate our attention on firms using design strategically, by incorporating design management as a culture amongst the entire business and thus benefiting the full potential of design (Galindo-Rueda & Millot, 2015; Koostra, 2009). Companies that are in these high stair levels are attuned to the vast possible path of design as creator of new markets and trends. In this perspective the design is at the beginning of the process of innovation of a product and

service, during all its life cycle of use, rather than being a mere artefact in order to produce purely aesthetic effects (Utterback, 2007).

In this research, we not only confirm that both product and process types of innovation have a relationship with the development of design activities, which is in line with current literature focusing the role of design in innovation (Bertola and Teixeira, 2003; Galindo-Rueda & Millot, 2015; Commission of the European Communities, 2009), we also conclude that different relational attitudes are associated with different levels of design engagement.

For instance, we found that firms' engagement in informal relationships with heterogeneous agents such as public customers, consultants, or conference mates, are positively associated with the strategic use of design as an element of innovation. All these agents, in different ways, revealed to be important sources of information for firms. Moreover, the development of informal contacts with them is associated with better design performances.

Besides the openness to external relationships with these agents, the use of firms' internal assets as information sources also revealed to play a determinant role in this context. As in Cohen and Levinthal (1989), the findings confirm that the firms' capacity to explore the knowledge provided by external linkages depends heavily on the openness towards new opportunities which, in turn, depends on the firm's knowledge stock and on the qualification of their employees (Pinto *et al.*, 2015).

Regarding market relationships, we also found that export propensity is positively associated with higher levels of design engagement, creating a market scaling–up that contributes to increase the odds of a firm recognizing the strategic role of design for competitiveness.

An opposite effect is produced by the geographical scaling–up of more formal academic cooperation towards innovation. This result is not completely surprising as we learn from the work of Hobday *et al.* (2012) that the public sector in general, including universities, are rarely the main actors in the design–innovation system, as design is primarily the responsibility of firms, no matter their size. Academia is clearly important (e.g., in the supply of graduates) as part of the wider innovation infrastructure, but are rarely responsible for directly generating design ideas or concepts to the industrial sector.

These findings suggest that companies should recognize that design is an important driving force behind competitive innovation. One way they can do this is by becoming co-creators with designers and implementing design strategy as a process of innovation within their own companies. For that, firms need to explore their external environment and like Cesário and Vaz (2014), and Freel (2003) this research also argues that firms' openness (through markets and competition pressures) is positively associated with design performance.

While the relationship between networking activities (as expressed in CIS data) and innovative performance is an already largely debated and studied theme, the relationship between networking and design is yet a barely explored subject. Although our results are in line with previous research arguing that different modes of external interaction have different impacts on firm performance, mostly innovative performance (Caloffi *et al*., 2015), the analysis of the impacts specifically on design performance is, however, a new field of study.

As an exploratory research, this study brings a new subject to the academic debate and hopefully contributes to launch the basis to further empirical investigations about the way external environments, with the correspondent policy implications, impacts on this important and strategic tool, which is design.

Firms that have characteristics favouring the design integration in their products and services, as well in their own environment, are more likely to make progress in relation to changes or pressures of their environment and have a culture leading to innovation and to competitiveness (Mozota, 2003), a conclusion that can contribute to the debate of public policies and business practices. Hence, the company's culture should integrate design as a method of creating value, rather than a tool for inventing solutions. At this level of understanding, firms' cultural perception mitigates the traditional tendency to expect an immediate and measurable outcome from the application of design processes. Instead, design is now acknowledged to create value for all stakeholders through short term outputs or long term outcomes.

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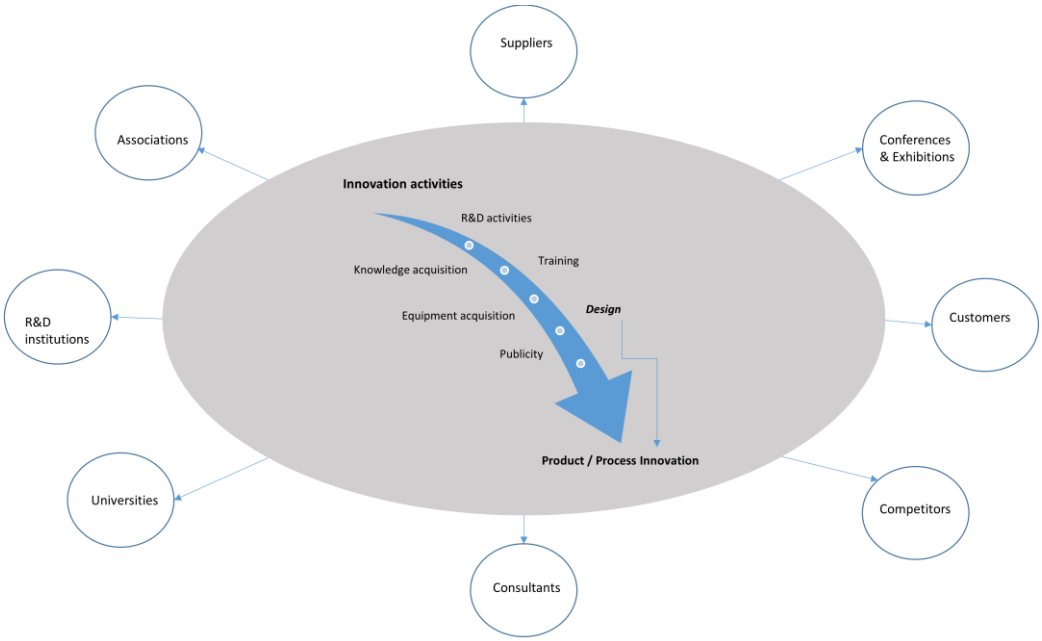

Figure 1 - Methodological Framework

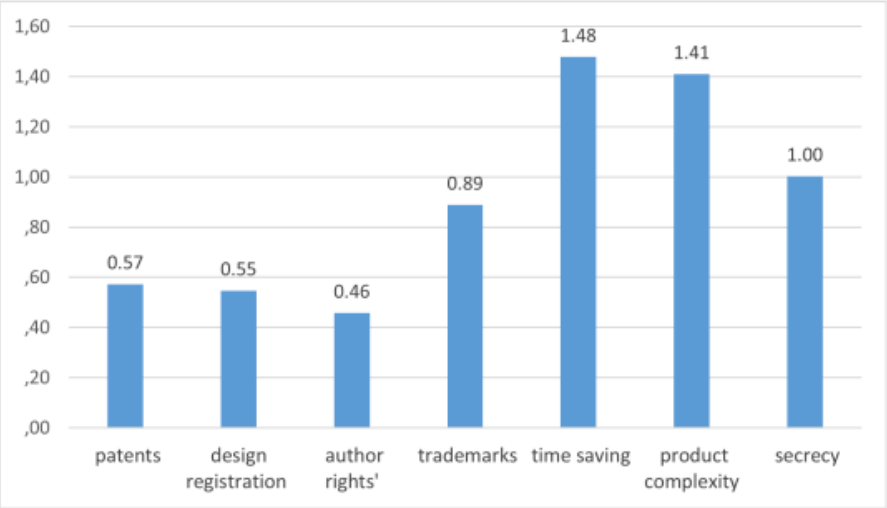

Figure 2 - Effectiveness of the competitiveness of product and process innovations

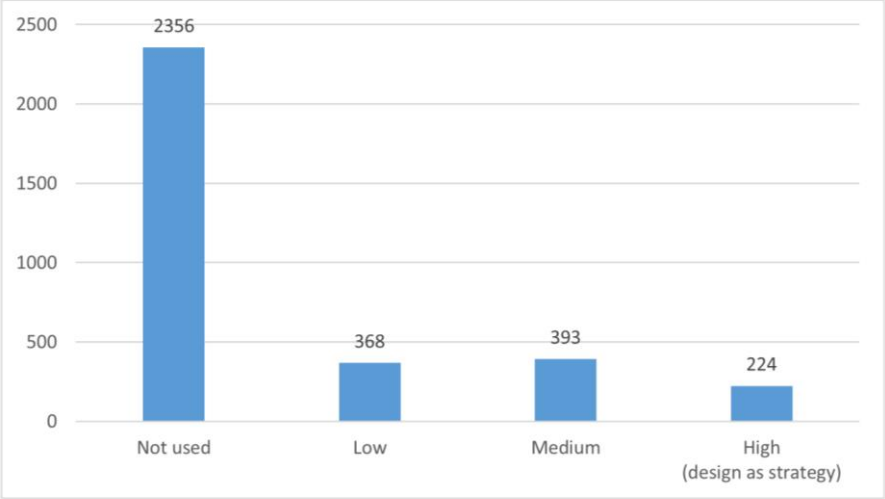

Figure 3 - Effectiveness of "design registration" for the competitiveness of product and process innovations

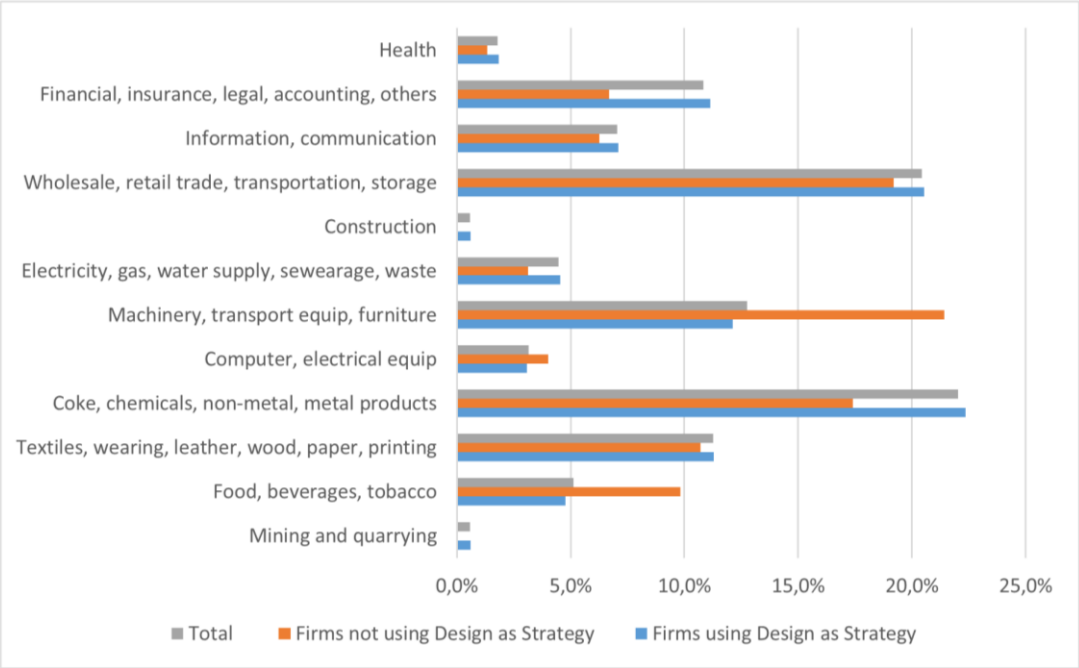

Figure 4 - The strategic use of design by firm's sector

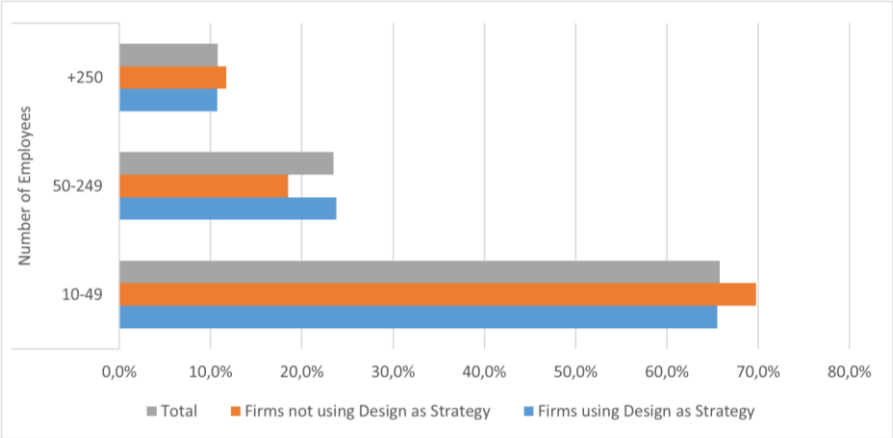

Figure 5 - The strategic use of design by firm's size

Table 1 Characterisation of the Sample

Variables	No. of Firms	%
Nace code		
Mining and quarrying	73	1,1
Food, beverages, tobacco	323	4,7
Textiles, wearing, leather, wood, paper, printing	889	13,0
Coke, chemicals, non-metal, metal products	1436	21,0
Computer, electrical equip	144	2,1
Machinery, transport equip, furniture	808	11,8
Electricity, gas, water supply, sewearage, waste	284	4,2
Construction	36	,5
Wholesale, retail trade, transportation, storage	1642	24,0
Information, communication	376	5,5
Financial, insurance, legal, accounting, others	735	10,7
Health	94	1,4
Total	6840	100,0
Number of employees		
10-49	4320	74.8
49-250	1073	18.6
>250	383	6.6
Total	5776	100
Product/Process/Ongoing innovation activities		
No	3499	51.2
Yes	3341	48.8
Total	6840	100
Cooperation towards innovation activities		
No	2456	73.5
Yes	885	26.5
Firms with Product/Process/Ongoing innovation activities	3341	100
Design developed as an innovation activity		
No development of design activities	2254	67.5
Development of design activities	1087	32.5
Firms with Product/Process/Ongoing innovation activities	3341	100

Source: Own elaboration based on CIS 2012 data.

Table 2 Variables in the dataset

Database variables		
Variable	**Description**	**Codification**
Dependent variable		
DESIGNSTRAT	Design Registration considered HIGH effective to innovative performance	0=No; 1=Yes
Independent variables		
PARTCOOP	Most important partner of Cooperation on innovation activities	0=No Cooperation; 1=Other firms from the group; 2=Suppliers; 3=Private customers; 4=Public customers; 5=Competitors; 6=Consultants; 7=Universities; 8=R&D institutions (nominal)
COOP (1-8)	Cooperation for innovation with: **1.** Other firms from the group **2.** Suppliers **3.** Customers (private sector) **4.** Customers (public sector) **5.** Competitors **6.** Consultants **7.** Universities **8.** R&D institutions	0=None; 1=National firms; 2=National & European firms; 3=National & European & ROW firms (ordinal)
INFSOURCE (1-11)	Importance of the following information sources for innovation activities: **1.** Inside the firm **2.** Suppliers **3.** customers (private sector) **4.** customers (public sector) **5.** competitors **6.** consultants **7.** university **8.** R&D institutions **9.** conferences & exhibitions **10.** publications **11.** associations	1=Not used; 2=Low; 3=Medium; 4=High (ordinal)
MARKT	Main Market	1=Local/Regional Market; 2=National Market; 3=European Market; 4=Other Countries (ordinal)

Source: Own elaboration based on CIS 2012 data.

Table 3 Results of the estimation of a logistic regression model with the final independent variables

Predictors	Description	B	Wald	Sig.	EXP(B)
MARKT	Main Market	0,173	4,315	0,038	1,189
INFSOURCE1	Information source: Inside the firm	0,379	10,879	0,001	1,460
INFSOURCE4	Information source: customers (public sector)	0,153	4,898	0,027	1,165
INFSOURCE6	Information source: consultants	0,201	6,879	0,009	1,223
INFSOURCE9	Information source: conferences & exhibitions	0,682	65,207	0,000	1,977
COOP7	Cooperation for innovation with: universities	-0,357	5,958	0,015	0,700
Constant	Constant	-6,908	197,434	0,000	0,001

Source: Own elaboration based on SPSS output.