LINKING DESIGN MANAGEMENT SKILLS AND DESIGN FUNCTION ORGANIZATION: AN EMPIRICAL STUDY OF SPANISH AND ITALIAN CERAMIC TILE PRODUCERS

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ABSTRACT

Design management is an increasingly important concept, research into which is very scarce. This paper deals with the fit between design management skills and design function organization, ranging from solely in-house to solely outsourced and including a mixture of the two. We carried out a survey in the Spanish and Italian ceramic tile industry, to which 177 product development managers responded. Our results revealed that companies have different degrees of design management skills depending on the approach to design function organization. Solely in-house design approach companies are the most skilled firms and solely outsourced ones are the least skilled. Despite the fact that the design function has apparently evolved towards outsourcing, this research supports the idea that, under certain conditions, the in-house design department is the best option in order to attain higher degrees of design management skills. Implications of the findings for both academics and practitioners are examined.

1. INTRODUCTION

In today's competitive environment, design is becoming increasingly important. Good design, though, does not emerge by accident but as the result of a managed process (Bruce and Bessant, 2002, p. 38). Apart from the development process leading up to the creation of an artifact or product, the concept of design has traditionally involved a series of organizational activities, practices or skills that are required for this development to be achieved (Gorb and Dumas, 1987). These practices have been considered by the literature as design management.

However, research into design management in theoretical (Kotler and Rath, 1984; Dumas and Mintzberg, 1989, 1991; Bruce and Morris, 1994; Walsh, 1996; Olson et al., 2000; Chiva, 2004) and empirical studies (Gorb and Dumas, 1987; Roy and Potter, 1993; Dickson et al., 1995; Roy and Riedel, 1997; Bruce et al., 1999; Ahire and Dreyfus, 2000; Swink, 2000; Perks et al., 2005) is extremely scarce. Although most of the research has identified or underlined some design management skills (e.g. Dickson et al., 1995), some (e.g. Bruce and Morris, 1994; Dumas and Mintzberg, 1989) have also underlined the importance of the role of design in the organizational structure. In today's competitive environment, the organization of the design function has evolved and new tendencies have been developed. Design outsourcing is becoming an important option for companies. According to Bruce and Morris (1994) there has been a considerable increase of design outsourcing in the UK. Related to that is the important increase in the design consultancy profession or the emergence of design management as a distinct management function.

Neither view of design management research – that focusing on skills and that emphasizing the organizational analysis of design management – has ever been empirically related. Analysis of this relationship would make it possible for us to understand the effect of organizational approaches to the design function on design management skills.

We will consider three different ways of organizing the design function (Bruce and Morris, 1994), solely in-house, solely outsourced, and a mixture of the two. In terms of design management skills, our research will be based on Dickson et al. (1995), who establish five main design management skills and propose a scale to measure them. The scale is, to our knowledge, the only one that measures these skills. The five main design management skills are: basic skills, specialized skills, involving others, organizational change and innovation skills.

Our research objective is to discover whether the in-house or outsourcing approaches to the design function are related to different levels of design management skills. We will also determine the best option for improving design management in companies.

In the sections that follow, we review the design management construct and develop hypotheses representing the relationships between the organizational approaches to design function and design management skills. Next, we describe the Spanish and Italian ceramic tile industry. Following this, we outline the methodological issues affecting the design of the empirical study and test our hypotheses. We conclude with a discussion of the results and their implications.

2. THEORETICAL BACKGROUND AND HYPOTHESES

Although design is essentially the application of human creativity to a purpose (Bessant, 2002; Carayannis and Coleman, 2005), it also implies the choice and configurations of elements, materials and components that give the product particular attributes of appearance, performance, ease of use, method of manufacture, etc. (Roy and Riedel, 1997), taking into account any functional, usage, manufacturing, and communication requirements (Kotler and Rath, 1984; Ulrich and Eppinger, 1995; Walsh, 1996). This involves not only the creative effort, but also a whole series of technical, strategic, and market aspects. These convergences and requirements involve complexity within the process, which requires certain management activities to support and sustain it.

Design management can be defined as the organizational and managerial activities or skills that optimize design process. The concept of design management is covered chiefly in theoretical papers (Dumas and Mintzberg, 1989, 1991; Bruce and Morris, 1994; Cooper and Press, 1995; Walsh, 1996; Bruce and Cooper, 1997; Veryzer et al., 1999; Joziasse, 2000; Jevnaker, 2000; Olson et al., 2000). Some empirical studies, however, deal with it implicitly, by defining certain activities associated with design (Roy and Potter, 1993; Roy and Riedel, 1997; Hise et al., 1989). Overall, design management is understood in several ways, highlighting different aspects or activities, and involves diverse typologies and connotations. In this paper we will consider two views of design management: the skills-based and organizational views.

2.1. THE SKILLS-BASED VIEW OF DESIGN MANAGEMENT

Dickson et al. (1995) suggest five design management skills, and analyze how these are managed by the CEOs of small, high-growth firms. Design management is conceptualized as a high-order construct made up of five first-order factors. These factors have a similar level of importance, they include many of the skills and activities underlined by the literature and are empirically supported. Our research is based on these five factors.

The first skill involves managing basic activities in the design process so as to design high quality, manufacturability and low cost into products, and to ensure new products are designed and launched faster. All these skills are considered as basic or essential to the design process. Roy and Riedel (1997) found that commercially successful product development projects focused on product performance and quality and, where appropriate, technical or design innovation, and paid more attention to genuine product improvements than simply to cost reduction.

The second of these skills is the ability to manage certain specialized activities required by the product design process, such as the cost estimate of a new product during the design process, the ability to use the latest computer-aided design tools effectively, testing manufacturability of new products during the design process, and finding people with excellent design skills. As an example, Topalian (1994) and Cooper and Press (1995) stress the importance of the selection of design specialists and the designer selection criteria for the success of the design process.

Recently, Perks et al. (2005) carried out a multiple case study and proposed three roles for design in the new product development process. Certain skills were identified

for each role. In the first role, "design as a functional specialist", actions are associated with the traditional role of design: generation of ideas and themes, prototype design, use of CAD and product samples, etc. Designers in this category focus on deploying a set of traditional design skills: aesthetics, visualization and technical skills. They are similar to Dickson et al.'s basic and specialized skills.

The third skill entails involving customers and suppliers in the design process and getting new product ideas from customers. Gorb and Dumas (1987) underline the importance of the interaction of design with other actors and consider that the product design process requires the presence and active involvement of various participants, such as customers and suppliers.

The fourth skill is the ability to manage change, both generally and in relation to moving towards concurrent design and cross-functional team management. Dickson et al. (1995) include changing traditional ways of doing things, getting different functions in the firm to work together, and replacing sequential with concurrent design. Some authors (Kotler and Rath, 1984; Rothwell and Gardiner, 1989; Roy and Potter, 1993; Olson et al., 2000) underline the importance of design department communication with marketing, sales, engineering or research departments to stimulate dialog with other areas surrounding product development.

The fifth skill is the ability to manage innovation by quickly becoming aware of competitor innovations and imitations and finding new design ideas, not only "me-too" imitations. Kotler and Rath (1984) emphasize the relevance of managerial encouragement of creative design expertise. Rothwell and Gardiner (1989) maintain that one of the most important aspects of design management is a thorough knowledge of the company and its competitors, which represents an input for the innovation process. Olson et al. (2000) also state the importance of stimulating creativity. Bailetti and Guild (1991) argue that designers' depth of knowledge and diversity of background, multidisciplinary teams, and their involvement in the early planning stages are critical in the formulation of innovative new products.

Perks et al's (2005) second role of design management stresses "design as part of a multifunctional team"; designers' activities are dominated by communication and interfacing behaviors, which require personal, communication and teamwork development. In the third role, "design as process leader", design is seen as a major force for innovation, for proposing new markets and segments. Skills include observation, research, business and analysis. These latter two roles are similar to Dickson et al's involvement, organizational change and innovation skills.

2.2. THE ORGANIZATIONAL VIEW OF DESIGN MANAGEMENT

The organizational view focuses mainly on structural or organizational considerations. Although several papers have analyzed design management following this approach (e.g. Dumas and Mintzberg, 1989), Bruce and Morris (1994) present a short, clear and empirically-based typology. Bruce and Morris (1994) establish three approaches to design management: an in-house design function, the sole use of external expertise, and a mixture of in-house and external design expertise. The in-house design function implies the existence of a design department or area that may be included in a technical or commercial department or reporting directly to general management. External expertise or outsourcing means that purely design activities are

obtained from outside the companies: suppliers, consultancy, etc. However, design is managed within the firm. There is someone with responsibility for design: sourcing, commissioning, liaising with and evaluating external designers. A mixture of in-house and external design expertise refers to companies that have design departments but also obtain design work from outside the company. Our research will be based on these three approaches.

According to Bruce and Morris (1994), the strength of an in-house approach to design management is that designers are closely aware of company practices, are more integrated into the overall design and development team, are more committed to the firm, and are always on hand to give advice or deal with problems that may arise through the all stages of product development. However, the problem is that they may become complacent and fail to provide innovative ideas. By contrast, external design professionals might offer original ideas, as they will not be restricted by the politics and culture of the firm. However, this presents a problem related to communication and control difficulties: because they do not know the company well they can make basic design mistakes. In addition, external designers may be less committed to the company than insiders.

Although a combination of in-house and external design expertise could overcome some of the purely external problems, the difficulties in managing the external designers are still there and are an obstacle to this approach. The integration of in-house and external professionals has to be managed carefully to ensure that they are truly working together (Bruce and Morris, 1984). These authors mention that the tension between fear of giving away commercially sensitive information and the need to build up an open and trusting relationship is especially crucial.

Based on three case studies at companies with the three approaches, Bruce and Morris (1994) state that the choice of approach is undertaken on rather an *ad-hoc* basis and depends on personal preferences of individual managers, their previous experience or the relationship with design suppliers. Consequently, in order to suggest some hypotheses we should take the particular characteristics of the Spanish and Italian ceramic-tile industry into consideration. In this industry, enamel suppliers are the most important design suppliers as they usually offer designs at no cost to the ceramic tile producers, which has led to design being perceived as a non-competitive resource (Chiva and Alegre, 2004). The enamel companies usually offer very standard and similar designs to the tile producers. When companies aim to consider design as an essential resource they seem either to create an in-house department or to use other design suppliers, like design consultancies (Chiva et al., 2003; Chiva and Alegre, 2004), the latter being very unusual.

2.3. THE HYPOTHESES

Based on analysis of the literature on design management and of Spanish and Italian ceramic tile industry, in this section we aim to propose some hypotheses. The in-house approach to design management seems to be the most suitable approach for achieving design management skills, as designers are more accessible to product development managers or design managers, know the history and needs of the company much better, can easily be controlled and managed by design managers and are more committed to the firms. Bruce and Morris (1994) maintain that the management process with in-house design is not the same as the process of managing outsourced design. The latter is much more critical and difficult because of the potential

communication and control difficulties. However, some companies might achieve long-term relationships with external designers and make them committed, responsible and enthusiastic about their projects. Taking into account the specific situation of this industry, and particularly the importance of enamel companies as design suppliers, the in-house approach seems to be the easiest way to affirm the importance of design for a company and to develop design management skills.

In this paper, we explicitly set out to verify the limited theory linking the organization of design function and the design management skills. In line with our review of the literature concerning design management and the industry, we expect to find differences in design management skills depending on the design function approach. Furthermore, we expect that in-house approach may achieve the best results or attain the highest degree of design management skills. We also expect the external approach to have the worst results or achieve the lowest degree of design management skills, taking into account who the main design suppliers are (the enamel suppliers). We are therefore adopting the following research hypotheses:

- H1: In-house approach firms show the highest degree of design management skills.
- H2: External approach firms show the lowest degree of design management skills.

3. METHODOLOGY

3.1. SAMPLE AND DATA COLLECTION PROCEDURE

We are testing our hypotheses by focusing on a single industry: Italian and Spanish ceramic tile producers. Our knowledge of this industry is based on analytical reports from the Valencia Chamber of Commerce or the Spanish and Italian associations of ceramic tile producers (Ascer and Assopiastrelle) and also on some interviews with technicians from ITC-ALICER, the Spanish Centre for Innovation and Technology in Ceramic Industrial Design.

Italian and Spanish ceramic tile production in 2004 represented 77% (Ascer, 2005; Assopiastrelle, 2005) of EU production volume in 2004. The world's biggest ceramic tile producer is China, followed by Spain, Italy, Brazil and Turkey. The ceramic tile industry is largely globalized. However, Italian and Spanish firms are the largest and second largest exporters in the world, respectively. This is mainly due to their high-quality, value-added products achieved through the emphasis on design, technology and corporate image (Valencia Chamber of Commerce, 2004). Such firms have substantially common traits. Most of them are considered to be SMEs, as they do not generally exceed an average of 250 workers and they tend to be geographically concentrated in industrial districts: Sassuolo in northern Italy and Castellón in eastern Spain (Valencia Chamber of Commerce, 2004). However, Italian companies seem to have a relatively better corporate image than the Spanish ones, to focus on the higher segments of the market and to emphasize design and marketing. In the last few years, the number of Italian companies has been reduced and their size has increased due to a process of mergers and acquisitions. Spanish companies seem to be relatively smaller and more numerous.

Knowledge manifests itself in different ways in different industries. The innovation phenomenon could differ from one industry to another because of technology issues, such as product technology or the production process. Pavitt (1984) suggested that industrial sectors differ greatly in the sources of technology they adopt, the uses of the technology they develop, and the methods used by successful innovators to appropriate the benefits of their activities. As a result, Pavitt produced a classification with four technological categories, including firms with common traits and conditions: supplier-dominated firms, scale-intensive firms, specialized suppliers, and science-based firms. Further research confirmed that, as well as the innovative opportunities open to a firm, the determinants of innovation results are strongly conditioned by these technological trajectories (Pavitt, Robson & Townsend, 1989; Pavitt, 1990; Souitaris, 2002).

Recently, Souitaris (2002) applied Pavitt's technological trajectories to a sample of Greek manufacturing firms. He found that science-based firms, together with specialized supplier firms, had significantly higher rates of innovation than supplier-dominated firms and scale-intensive firms. Science-based firms produced the highest number of innovative products (incremental and radical) and had by far the highest average number of patents.

Features of the ceramic tile industry suggest it belongs to the scale-intensive and the science-based trajectories of Pavitt's taxonomy (Pavitt, 1984; Pavitt, 1990). In the production of ceramic tiles, technological accumulation is mainly generated by (1) the design, building and operation of complex production systems (scale-intensive trajectory), and (2) knowledge, skills and techniques emerging from academic chemistry research (science-based trajectory).

We consider the ceramic tiles industry to be appropriate for our analysis given the numerous studies available which highlight its innovative nature. The results of the 2002 INE (Spanish Statistics Institute) Technological Innovation Survey (INE, 2004) reveal that nearly half the tile manufacturers are innovative in their products. Several recent studies (Oltra et al., 2002; Alegre et al., 2005) have analyzed new products in the ceramic tile industry and have found enamels and design to be the most important areas of product improvement. New enamels provide better product features, such as non-slip properties or better frost resistance. Novelty in design is focused on new sizes and appearance. Alegre and colleagues (2005) depicted ceramic tile production as a mature sector in which radical innovation is rather unusual, although incremental innovation is a frequent and widespread phenomenon.

By focusing our data collection on a single industry, the ceramic tile industry, we reduce the range of extraneous variations that might influence the constructs of interest. Analyzing one single sector has the advantage that it avoids a common problem in inter-sectoral product studies: that of technological and economic diversity of products (Acs & Audretsch, 1993; Coombs et al., 1996; Santarelli and Piergiovanni, 1996). According to Bruce and Morris (1994), the choice of approach depends on several aspects related to the company and to the industry. We therefore avoid the industry effect. We recognize the shortcoming of such sampling, but we believe that the advantages of this approach outweigh the disadvantages of limited generalizability.

The field work was carried out from June to November 2004. The questionnaire was addressed to product development managers or managers with some responsibility for design (e.g. design managers). A pre-test was carried out on four technicians from ALICER, the Spanish Centre for Innovation and Technology in Ceramic Industrial

Design, to ensure that the questionnaire items were fully understandable in the context of the ceramic tile industry.

Target respondents were contacted by phone. A quick presentation of the research framework and objectives was provided in order to stimulate the participation of target respondents. It was also emphasized that responses were absolutely confidential as data would be presented in academic and industry forums in an aggregated fashion. Moreover, following Malhotra (1993), we offered a feedback report on the survey results to the participating firms. This feedback report was found to be especially motivating because there is a high level of rivalry in this industry. If target respondents were interested in participating in the research, an interview was scheduled so they could answer the questionnaire.

Our study obtained a total of 177 completed questionnaires. The sample obtained represents around the 50% of the population under study (Chiva and Alegre, 2004; Valencia Chamber of Commerce, 2004). Both the number of responses and the response rate can be considered satisfactory (Spector, 1992; Williams et al. 2004).

To check for non-response bias, we compared the number of employees of respondents and non-respondents. This comparison did not reveal any significant differences, indicating that non-response bias should not be a problem.

	Number of Employees						
	(1) Fewer than 25	**(2) Between 25 and 49**	**(3) Between 50 and 99**	**(4) Between 100 and 199**	**(5) Between 200 and 300**	**(6) Over 300**	**Total**
Italian Firms	5	12	19	17	7	20	80
Spanish Firms	6	20	40	18	8	5	97
Total	11	32	59	35	15	25	177

Table 1. Size and location of sample firms

3.2. MEASUREMENTS

Our measurements are shown in the Appendix.

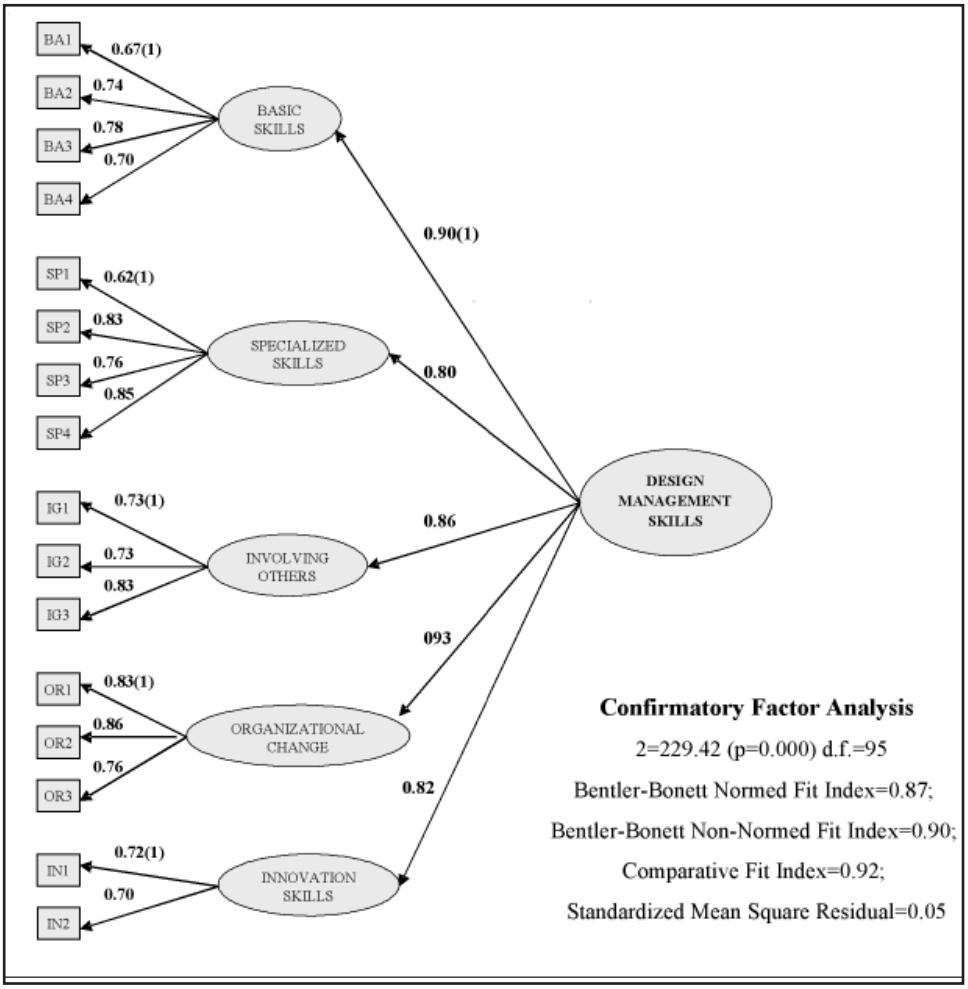
3.2.1. Design Management Skills

In order to measure design management skills, we used Dickson et al.'s (1995) dimensions and items. We asked product development managers whether the design issue is one that they manage well or whether it is one that they have trouble managing. Seven-point Likert scales were used to operationalize the five dimensions: basic, specialized, involving others, organizational change and innovation skills. The use of the Dickson et al.'s design management skills scale goes some way towards ensuring the reliability of the questionnaire, as its validity and reliability have already been proven.

However, in order to further check the scale's reliability and validity, we carried out a Confirmatory Factor Analysis (CFA) and we assessed three reliability coefficients: Cronbach's Alpha, Composite Reliability (CR) and Average Variance Extracted (AVE).

CFA was used to further check the goodness of the measurement scale. CFA assumes that the factor structure is known *a priori*. The factor structure for design management is based on Dickson et al. (1995). The objective of CFA is to empirically verify or confirm a factor structure which is based on an underlying theory (Sharma, 1996; Hair et al., 1998). The CFA was performed using EQS 6.1 software.

Figure 1 shows the CFA results; confirming that all scale items were loaded significantly and above the recommended minimum 0.40 on their hypothesized construct factors (Ford et al., 1986; Hair et al., 1998). The chi-square statistic is significant, but other relevant fit indices suggest a good overall fit.



(1) The parameter was made to equal 1 to fix the latent variable scale. Parameter estimates are standardized. All parameter estimates are significant at a 95% confidence level (t≥1.96).

Figure 1. Confirmatory Factor Analysis

Reliability is the ratio of the true score's variance to the observed variable's variance. Traditionally, scale reliability has been evaluated by means of the Cronbach's alpha coefficient. However, a high alpha does not guarantee that all the values obtained in the items are derived from the existence of a single latent variable (DeVellis, 1991). Hence, it is not advisable to use the Cronbach's alpha coefficient in isolation to evaluate the reliability of a measurement scale. Accordingly, we appraise reliability using three indicators: the Cronbach's alpha coefficient, composite reliability (CR), and average variance extracted (AVE). Table 2 shows the reliability evaluation for each dimension, which in general is highly satisfactory: the composite reliability values and the

Cronbach's alpha coefficients above 0.7 and the AVE indices exceeding the minimum standard of 0.5 (Nunally, 1978; Hair et al., 1998; Iglesias, 2004). The Basic Skills dimension shows an AVE slightly below the recommended threshold, but the other reliability indices corroborate satisfactory reliability. The Innovation Skills dimension also shows a Composite Reliability that is slightly below the recommended threshold, but, again, the other reliability indices corroborate satisfactory reliability.

Design Management Skills Scale	Cronbach's alpha	Composite Reliability	Average Extracted Variance
Basic Skills (4 items)	0.81	0.89	0.47
Specialized Skills (4 items)	0.87	0.85	0.59
Involving Others Skills (3 items)	0.81	0.81	0.59
Organizational Change Skills (3 items)	0.86	0.86	0.67
Innovation Skills (2 items)	0.70	0.67	0.51

Table 2. Reliability coefficients: Cronbach's alpha, Composite Reliability, and Average Extracted Variance

3.2.2. Design Function Organization: Classification of firms

As we have already mentioned, we will consider three different ways of organizing the design function (Bruce and Morris, 1994): solely in-house, solely outsourced, and a mixture of the two. In order to classify firms within these three groups, we asked the Product Development Managers two questions. First, have you got a design department or area? Second, do you purchase or obtain design externally?

When firms had a design department and did not acquire or obtain design externally, they were included in group 1: In-house. When firms had a design department and acquired or obtained design externally they were included in group 2: Mixture. When firms had no design department and acquired or obtained design externally, they were included in group 3: External.

Table 3 describes the firms according to the organization of the design function. As we can see, in-house firms are mainly Italian and are larger. By contrast, external firms are mainly Spanish and are smaller.

**(1) Fewer than 25 employees; (2) Between 25 and 49; (3) Between 50 and 99; (4) Between 100 and 199; (5) Between 200 and 300; (6) Over 300 employees.*

	Total Sample		In-house		Mixture		External	
Number of firms	177	100%	39	22%	67	37,9%	71	40,1%
Location	80 (It)	45,2%	32 (It)	82%	30 (It)	44,7%	18 (It)	25,4%
	97 (Sp)	54,8%	7 (Sp)	18%	37 (Sp)	55,3%	53 (Sp)	74,6%
Average number of employees (from 1 to 6)*	3,48		4,35		3,86		2,64	

Table 3. Description of the firm according to organization of the design function

As well as the two questions mentioned above, we asked further questions to go into their design function organization in greater depth. We asked the product development managers, if they had a design department, where it was included or which department it was responsible to. Four options were given: included in the technical department, included in the marketing department, reporting to general management, and other. We also asked them to indicate who in their company had greatest responsibility for making design decisions. Six options were given: marketing department or manager; R&D department or manager; technical department or manager; design department or manager, general management and others.

We also asked the product development managers if they purchased or obtained design externally, to indicate the proportion of designs obtained externally as a percentage of the firm's total products, and the source of external designs. For the latter, four options were given: design consultancy, firm's suppliers, technology institutes and other.

3.3. DATA ANALYSIS

We began our data analysis with descriptive statistics. We took into account the 16 items on the design management skills questionnaire plus the 5 groups of skills: basic, specialized, involving others, organizational change and innovation skills.

We then carried out an ANOVA analysis with SPSS 13.0 software in order to find out statistical significant differences between the means of the different groups of firms. This methodology has already been used by Alegre et al. (2004) among others.

We also carried out descriptive statistical analysis concerning the design function organization of the Spanish and Italian ceramic tile producers.

4. RESULTS

As we described in Table 3, we divided our sample into three groups: 39 in-house firms (sample firms with design departments that do not obtain design externally), 67 mixture firms (sample firms with design departments that also obtain design externally), and 71 external firms (sample firms without design departments that obtain design externally). Following our hypotheses, we assume that in-house firms show the best design management skills and external firms show the worst design management skills.

As we can see in Table 4, there are statistically significant differences ($p<0.05$) between the three groups of firms for all design management skills: basic, specialized, involving others, organizational change and innovation skills. One assumption of ANOVA is that the variances of the groups are equivalent. When considering three groups, the Levene statistic rejected the null hypothesis that the group variances are equal. However, when considering two groups (in-house design and external design), there were still statistically significant differences ($p<0.05$) between the two groups of firms for all design management skills, and the Levene statistic could not reject the null hypothesis that the group variances are equal.

Results confirm consistently that in-house design firms show the greatest emphasis on all skills, and external design firms show the least emphasis on all skills. Hypotheses H1 and H2 are therefore confirmed, as we can state that the in-house approach favors the development of design management skills and the external approach obstructs the development of design management skills.

	Total Sample (N=177)		In-house (N=71)		Mixture (N=39)		External (N=67)		ANOVA
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Significance level
Basic skills	5.07	1.16	5.78	0.77	5.08	1.08	4.67	1.24	0.000*
1. Designing quality into products.	5.31	1.27	5.74	1.01	5.46	1.04	4.94	1.49	0.003*
2. Designing manufacturability into your products.	5.19	1.50	6.10	1.02	5.11	1.50	4.76	1.53	0.000*
3. Designing low cost into your products.	4.97	1.51	5.69	0.95	4.84	1.66	4.70	1.50	0.003*
4. Designing and launching new products faster.	4.79	1.55	5.58	0.99	4.89	1.52	4.25	1.63	0.000*
Specialized skills	4.81	1.46	6.01	0.77	4.97	1.19	4.00	1.49	0.000*
5. Using the latest computer-aided design tools effectively.	4.67	1.88	5.89	0.94	5.19	1.67	3.48	1.81	0.000*
6. Estimating the true cost of new products during the design process.	4.89	1.65	5.92	1.03	4.97	1.61	4.26	1.69	0.000*
7. Finding people with excellent design skills.	4.74	1.69	6.05	1.09	4.80	1.40	3.95	1.76	0.000*
8. Testing manufacturability of new products during the design process.	4.95	1.62	6.20	0.80	4.92	1.53	4.29	1.65	0.000*
Skills in involving others	5.12	1.27	5.69	0.93	5.24	1.28	4.69	1.29	0.000*
9. Involving customers in the design process.	4.83	1.60	5.66	1.03	4.88	1.71	4.32	1.55	0.000*
10. Involving suppliers in the design process.	5.16	1.50	5.61	1.49	5.32	1.38	4.76	1.54	0.009*
11. Getting new product ideas from customers.	5.37	1.38	5.79	1.03	5.53	1.36	4.98	1.47	0.006*
Skills in organizational change	4.99	1.29	5.88	0.79	5.13	1.19	4.37	1.28	0.000*
12. Changing traditional ways of doing things.	4.98	1.32	5.81	0.83	5.13	1.22	4.40	1.35	0.000*
13. Getting different functions in the firm to work together.	4.95	1.48	5.82	1.02	4.97	1.46	4.46	1.51	0.000*
14. Replacing sequential with concurrent design.	5.05	1.55	6.13	0.93	5.29	1.30	4.25	1.63	0.000*
Innovation skills	5.13	1.34	5.76	1.09	5.38	1.03	4.56	1.49	0.000*
15. Finding new design ideas – not just me-too imitations.	5.17	1.56	5.68	1.29	5.62	1.20	4.46	1.74	0.000*
16. Quickly becoming aware of competitor's innovations and imitations.	5.09	1.47	5.82	1.18	5.13	1.34	4.66	1.58	0.000*

** Statistically significant differences (P<0.05)*

Table 4. Survey results: descriptive statistics and one-factor ANOVA

Table 5 describes the in-house, mixture and external approaches in greater depth. Concerning the department the design area is responsible to, there are important differences between in-house and mixture approaches. In-house firms seem to include their design departments mainly in the technical area (46.2%), although some have them in the marketing area (23%). However, in the mixture firms, design departments are included more or less equally in the technical (35.8%) and marketing areas (38.8%), although the latter seems to have a more important role. This is confirmed when they are asked who has the greatest responsibility for making design decisions. 45% of the mixture firms said that the marketing department or manager had. However, in-house firms stated that the design department (36.1%) and research and development department (25%) had greatest responsibility for design. Following the tendency of the mixture firms, 51.7% of external firms stated that the marketing department or manager had the greatest responsibility for design. In-house firms therefore seem to give more responsibility to the design department and seem to follow a technical/ R&D approach. By contrast, external firms give responsibility to the market, probably designing what marketing or their customers ask for, with little or no modification.

	Total Sample		In-house		Mixture		External	
Design Department or Area	106 firms	100%	39 firms	36.8%	67 firms	63.2%	-------	
Where it is included, or which department it is responsible to.	Technical 39.6%	Marketing 33% / G.Manag. 27.4%	Technical 46.2%	Marketing 23% / G.Manag. 30.8%	Technical 35.8%	Marketing 38.8% / G.Manag. 25.4%	-------	
Who has greatest responsibility for making design decisions.	Marketing: 40.2% R&D: 11.7% Technical: 11.7% Design: 13% G. Manag.: 23.4%		Marketing: 13.9% R&D: 25% Technical: 5.6% Design: 36.1% G. Manag.:19.4%		Marketing: 45 % R&D: 10% Technical: 6.7% Design: 11.7% G. Manag.: 26.6%		Marketing: 51.7% R&D: 5.2% Technical: 20.7% Design: ---- G. Manag.: 22.4%	
Design obtained externally	138 firms	100%	-------		67 firms	48.5%	71 firms	51.5%
Percentage of designs obtained externally out of the firm's total products	Mean 72.53%	S.D. 33.58	-------		Mean 44.76%	S.D. 27.82	Mean 98.67%	S.D. 6.89
Source of external design (choose the most important option)	Design Consultancy: 29.8% Firm Suppliers: 66.4% Technological Institutes: 0.8% Others:3 %		-------		Design Consultancy: 38.5% Firm Suppliers: 58.5% Technological Institutes: 1.5% Others: 1.5%		Design Consultancy: 21.2% Firm Suppliers: 74.2% Technological Institutes: --- Others: 4.6%	

Table 5. Design Function Organization of Spanish and Italian Ceramic Tile Producers

Concerning the source of external design, only external firms mainly obtain design from their suppliers (74.2%). In the Spanish and Italian ceramic tile industry, enamel suppliers have traditionally offered designs at no cost to ceramic tile producers, which has led to design being perceived as a non-competitive resource. As we can

see, many companies with no design department seem to obtain free design from the enamel companies. Although 58.5% of mixture firms follow the same tendency, more of these companies seem to co-operate with design consultancies. This would explain somewhat why the external approach does not achieve the same degree of design management skills. Although this approach is much more difficult because of the potential communication and control difficulties, some companies might avoid these difficulties by choosing long-term relationships with external designers in order to make them committed, responsible and enthusiastic about their projects, and this is only possible when design is paid for and perceived as a competitive resource.

5. DISCUSSION

In this study, we investigated the relationship between design management skills and design function organization. We have considered three different ways of organizing the design function (Bruce and Morris, 1994), solely in-house, solely outsourcing, and a mixture of the two. Regarding design management skills, our research was based on Dickson et al.'s (1995) five main design management skills: basic, specialized, involving others, organizational change and innovation skills. Our findings indicate that the in-house approach obtains the highest degree of design management skills and the external approach to the design function achieves the lowest degree of design management skills. Consequently, the in-house approach seems to be the best option to improve design management. However, this is so, mainly due to the source of external designs in this industry.

Concerning the source of external designs, external and mixture firms mainly obtain designs from their suppliers, principally the enamel suppliers who have traditionally offered designs at no cost to ceramic tile producers. This low use of design consultancy prevents them attaining the same results as the in-house firms. Suppliers do not develop long-term relationships and are not as committed to, responsible for or enthusiastic about the customers' projects as design consultants might be. In sum, we might conclude that companies that consider design as a competitive resource and invest in it (by developing a design department), improve their design management skills.

Furthermore, the findings of this empirical study help to provide a more complete picture of the three approaches to design function organization. In-house firms seem to stress the importance of the design department and the research and development department as having greatest responsibility for making design decisions. The design department is usually included in the technical area. By contrast, the mixture and external firms underline the importance of the marketing department or managers for making design decisions.

As companies have different degrees of design management skills, depending on the approach of design function organization, and this also depends on the industry, design management research should be contextualized or analyzed in its organizational context.

Research that analyses the relationship between design management skills and organization is likely to prove particularly valuable at a practical level. Managers can introduce the organizational characteristics that will enhance design management skills in the knowledge that these might have implications for design effectiveness and corporate performance. The whole design management literature suggests that design

management has an impact on design effectiveness, a theory that some research (Ahire and Dreyfus, 2000) has empirically validated. Furthermore, Herstenstein et al. (2005) provide strong evidence that good design is related to corporate performance.

The measurement scale used for design management skills can be applied by managers in order to carry out an internal audit of their company. The design management construct provides managers with the specific issues (each of the five dimensions) that should be examined if design management skills are to be enhanced.

Our results must be viewed in the light of the limitations of the study. As with all cross-sectional research, the relationship tested in this study represent a snapshot in time. While it is likely that the conditions under which the data were collected will remain essentially the same, there are no guarantees that this will be the case. Because we have carried out a single industry analysis, our study has benefited from the advantage of dealing with firms that are likely to be economically and technologically homogeneous.

Apart from the characteristics of the industry, we should refer to the type of design developed in this industry: it is mostly related to appearance. All this obviously limits the generalization of our results. However, even though the research is based on a single industry, conclusions and the analysis of the link between design management skills and design function organization in the Spanish and Italian ceramic tile industries can be interesting for any company. We believe that the reasoning concerning the conditions determining the choice of the best design function organization in a company can be worth noting by any company. However, companies from similar industries could benefit more from the results. Future research might analyze the link between design management skills and design function organization in other industries. Due to the importance of contextualizing the design management research, future research lines might explore other organizational characteristics such as human resource management practices or innovation approaches. The way people and innovation are managed may be strongly related to the effectiveness of design management.

6. CONCLUSION

Although the organization of the design function has apparently evolved towards outsourcing (Bruce and Morris, 1994: 586), this research supports, under certain conditions, the importance of in-house design department to attain higher degrees of design management skills. The main contribution of this study is the analysis of the relationship between the two views of design management research, those that focus on skills and those that emphasize the organizational analysis of design management. This study seeks to contribute towards filling a gap in the literature on the design management skills and design organization relationship. In particular, statistical evidence was found that suggests a positive relationship between both of them. This analysis allows us to understand the relationship of the organizing approaches to design function with design management skills. In sum, we devote attention to the study of design in its organizational context (Lakemond and Berggren, 2006; Eppinger and Salminen, 2001).

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APPENDIX: Questionnaire

1.	Have you got a design department or area?			Yes	No	
2.	If you have design department, where is it included or which department is it responsible to?	It is included in the technical area	It is included in the marketing area	Responsible to general management	Other	
3.	Please indicate who in your company has greatest respon sibility for making design decisions.	Marketing Dept. or Manager	R&D Dept. or Manager	Technical Dept. or Manager	Design Department or Manager	General Management	Other
4.	Do you acquire or obtain design externally?			Yes	No	
5.	Percentage of designs obtained externally out of the firm's total products.			percentage: %		
6.	Source of external design (choose the most important option)	Design Consultancy	Firm's Suppliers	Technology Institutes	Others:	

Indicate whether each of these new product design issues is one your firm manages well or whether it is one your firm has trouble managing.

Manages poorly						Manages extremely well
1	2	3	4	5	6	7
7.	Designing quality into products.					1-2-3-4-5-6-7
8.	Designing manufacturability into your products.					1-2-3-4-5-6-7
9.	Designing low cost into your products.					1-2-3-4-5-6-7
10.	Designing and launching new products faster.					1-2-3-4-5-6-7
11.	Using the latest computer aided design tools effectively.					1-2-3-4-5-6-7
12.	Estimating the true cost of new products during the design process.					1-2-3-4-5-6-7
13.	Finding people with excellent design skills.					1-2-3-4-5-6-7
14.	Testing manufacturability of new product during the design process.					1-2-3-4-5-6-7
15.	Involving customers in the design process.					1-2-3-4-5-6-7
16.	Involving suppliers in the design process.					1-2-3-4-5-6-7
17.	Getting new product ideas from customers.					1-2-3-4-5-6-7
18.	Changing traditional ways of doing things.					1-2-3-4-5-6-7
19.	Getting different functions in the firm to work together.					1-2-3-4-5-6-7
20.	Replacing sequential with concurrent design.					1-2-3-4-5-6-7
21.	Finding new design ideas - not just me-too imitations.					1-2-3-4-5-6-7
22.	Quickly becoming aware of competitors' innovations and imitations.					1-2-3-4-5-6-7