CREATIVE INNOVATION IN SPANISH CONSTRUCTION FIRMS

Víctor Yepes[1], Eugenio Pellicer[2], Luis F. Alarcón[3] and Christian L. Correa[4]

[1]*Associate Professor*, ICITECH, Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain, email: vyepesp@upv.es

[2]*Associate Professor*, *School of Civil Engineering*, Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain, tel.: +34.963.879.562, fax: +34.963.877.569, email: pellicer@upv.es; Corresponding Author

[3]*Professor*, GEPUC, Pontificia Universidad Católica de Chile, Vicuña Mackenna 4860, Santiago, Chile, email: lalarcon@ing.puc.cl

[4]*Assistant Professor*, *Faculty of Engineering Sciences*, Universidad Católica del Maule, San Miguel 3605, Talca, Chile, email: clcorrea@ucm.cl

ABSTRACT

Small and medium-sized contractors are characterized by organizational structures that are highly focused on control. As a result, employees concentrate on day-to-day activities with little time or motivation to generate creative ideas. Generally, the technological improvements of these companies arise as a result of problem-solving at the construction site. Nevertheless, the actual status quo is changing. In fact, some Spanish public agencies are already considering innovation as an added value in public procurement; thus, large contractors are starting to systemize their innovative efforts. This means that small and medium-sized enterprises must modify their attitudes towards innovation in order to sustain their competitiveness. The implementation of a system that enhances innovation and acquisition of knowledge may be the solution to overcome this disadvantage. The authors analyzed the implementation of an innovation management system in a Spanish construction

firm of medium size for nine years. The system builds on a set of processes aimed to generate innovation projects that allow the contractor to document the innovation, not only for internal purposes related to knowledge management, but also for external ones associated with obtaining better results in public tenders. These processes are: (a) technology watch; (b) creativity; (c) planning and executing innovation projects; (d) technology transfer; and (e) protection of results. The last step is the feedback of the entire process through the assessment of the final outcomes. The implementation of the innovation system is ensured within the organization, through training of personnel, participation of stakeholders and encouragement of the innovation culture.

KEYWORDS: Construction, Innovation, Management, Process, System

INTRODUCTION

Innovation is an essential business management tool for organizations that wish to survive. But, can innovation be a strategy to strengthen the competitiveness of construction firms? Some would say that innovation is a trend, as was quality or environmental management some years ago (Romero and Serpell 2007; Kumar and Balakrishnan 2011). Even a casual observer, unaware of the reality of the construction industry, might think that this sector is stuck in the past and that it has little capacity to innovate (Blayse and Manley 2004; Taylor and Levitt, 2004). Currently construction companies have a high capacity to innovate but, unfortunately, are still far from the effort made by other industrial sectors (Villar-Mir 2001; COTEC 2009). For example, in 2012, innovation for the whole Spanish economy was more than six times the value for the construction industry (elaborated from INE 2014).

Applying the commitments made in 2000 by the European Union (CICYT 2003), the Spanish government launched a special program to reduce the gap in innovation investment with other developed economies (BOE 2005). Spain is one of the countries that offers the greatest tax incentives on innovation spending for enterprises (OECD 2006); currently, companies that invest in innovation can obtain tax incentives through the Spanish Law 4/2004 on Income Tax (BOE 2004). Additionally, since late 2006, the Spanish Ministry of Infrastructure rewards companies in the tendering process if they carry out innovation activities; this incentive can increase the final score of the tender by 25% (Correa et al. 2007; Pellicer et al. 2008).

In spite of the aforementioned figures, it would not be fair to state that construction companies are not innovative. These companies overcome major technological challenges around the world. Contractors face extremely complex challenges that are reflected in singular projects difficult to execute, solving the most diverse technical problems effectively (Nam and Tatum 1992 and 1997; Barlow 2000; Davis et al. 2009; Shapira and Rosenfeld 2011) using sound decision-making processes (Alarcón and Ashley 1996; Hartmann 2011; Torres-Machí et al. 2014). The key problem is that this contribution to knowledge is often not sufficiently systematized and disseminated throughout the company (Carrillo et al. 2004; Anumba et al. 2005; Ferrada and Serpell 2009). Seldom is the economic effort that these challenges pose really valued. It cannot be said, therefore, that construction firms are not innovative enough. Thus, the challenge is to standardize innovation to make it more effective and efficient.

An adequate regulatory environment can help to enhance innovation (Hardie et al. 2014). Therefore, to encourage innovation in the Spanish economy, the set of standards UNE 166000 was published in 2006 by AENOR (Correa et al. 2007; Pellicer et al. 2008). These standards aim to help companies standardize innovation management. They consider innovation as a process that can be standardized in a similar way to quality or environmental management (Dulaimi 1995; Gann and Salter 2000; Perdomo-Ortiz et al. 2006 and 2009; Coelho and Matias 2010; Casadesús et al. 2011). Innovation, therefore, is a process that can be normalized using the methodology "Plan-Do-Check-Act" (Terziovski and Sohal 2000; Pellicer et al. 2008 and 2012; Casadesús et al. 2011). A predecessor of this Spanish Standard is the BS 7000-1 (BSI 1989), which could be considered as an academic report addressing topics in innovation management related to engineering design. Following the criteria of the UNE 166002, the Portuguese Government issued the standard NP 4457 in 2007 (Teixeira et al. 2009). Other countries, such as France (Peetri et al. 2013), have pursued a parallel path, with standards on the implementation and control of strategic intelligence systems (FDX50-052:2011). Anyway, the consensus needed to issue a European standard has not been reached yet (Peetri et al. 2013).

The implementation of a system that enhances innovation and knowledge acquisition is described in this paper. The authors analyzed the implementation of an innovation management system in a medium-sized Spanish construction company during a nine-year period. The system is built on a set of processes aimed to generate innovation projects that allow the contractor to document the innovation, not only for internal purposes related to knowledge management, but also for external ones associated with obtaining better results in public tenders. This paper is the last of a series on innovation management in construction firms developed by the authors during a nine-year period in cooperation with a medium-sized Spanish contractor. Some of these works have already been published: (1) a literature analysis and concept framework (Correa et al. 2007); (2) an introduction of the Spanish set of standards UNE 160000 and its application to the Spanish construction industry (Pellicer et al. 2008); (3) the strategic analysis of the firm selected for the case study (Pellicer et al. 2010); (4) the generation of a model that maps the case study (Pellicer et al. 2012); and (5) the external validation of that model through a survey and interviews to certified companies (Pellicer et al. 2014). Nevertheless, the part of our research that has not yet been published is the detailed description of the processes that involve the implementation of the system in the selected case study. Therefore, the purpose of this paper is to describe and analyze the processes that comprise creative innovation management system in a medium Spanish contractor, using a case study of the implementation as reference that lasted nine years; after the case study is described, the outputs of the implementation at the company are analyzed, comparing data collected through the research period.

This paper is structured as follows. First, the research method is explained as well as the basic inputs of the case study. Later, the innovation system is illustrated with descriptive charts, consisting of five processes: (a) technology watch; (b) creativity; (c) planning and executing innovation projects; (d) technology transfer; and (e) protection of results. Once the system is described, the outputs of the company are discussed and analyzed. Finally, conclusions from the implementation of the system in the company are drawn.

METHOD AND SOURCES

At the beginning of this research there was only one Spanish contractor certified under the UNE 160002 standard, thus an exploratory analysis was the only feasible option; due to the complexity of the implementation, the research team decided on an in-depth single case study. A medium-sized contractor, fairly representative of the Spanish companies of its type, was selected; details about this selection are explained in Pellicer et al. (2010 and 2012). The internal analysis of the selected company reveals an enterprise with a workforce of 400 employees in eight regional offices, not considering the subcontractor and other external services. It has long proven its experience in the civil engineering and building sector, being its annual turnover around four hundred million Euros. At the time when the research started, the company had not yet taken into consideration innovation as a business strategy. For the analysis of this study, a qualitative research method was used. Project management, in general, and its application to the construction sector in particular, is currently seen as a social behavior (Cicmil et al. 2006), so the case study approach is suitable for its analysis (Yin 2003).

The case study research used the following information sources (Pellicer et al. 2010 and 2012): (1) participant observation for short periods; (2) monthly meetings with company executives; (3) archival analysis of internal documents; (4) external survey of Spanish contractors regarding their perception of innovation in construction (first year of research); (5) internal surveys of company's senior executives (first three years of research); (6) internal survey of company staff (during the second year of the research); (7) survey of suppliers and subcontractors (during the second year of the research); and (8) workshop for experts and key managers held bi-annually since the third year of the research. Utilizing these sources, chains of evidence were generated. Internal validity refers to the causality logic of the qualitative study (Yin 2003); it is achieved using four approaches (Pellicer et al. 2012): (a) multiple sources of information as stated previously; (b) triangulating facts from different sources; (c) contrasting theory to observed reality (or pattern-matching); and (d) explaining the phenomena under study in a logical way (or explanation-building). Finally, external validity (Yin 2003) was accomplished by surveying and interviewing managers of seven Spanish contractors with an innovation management system already certified by the UNE 166002 standard; a detailed description of how this external validity was achieved can be found in Pellicer et al. (2014).

The firm under study has significant tangible and intangible resources. The tangible ones are common to other large and medium-sized firms and include elements such as regional offices, vehicles and equipment, coating and concrete mixing plants, mobile plants and financial capital, among others (Pellicer et al. 2010). In comparison to smaller firms, a larger company has a greater financial capacity to cover the expenditure involved in innovation and to assume the risks inherent to such activities (Seaden et al. 2003). The firm under study has three primary intangible resources (Pellicer et al. 2010): (1) its select group of skilled staff who are well-suited for reaching the company's objectives; (2) its know-how or years of experience in the public works and building sector; and (3) its being recognized throughout the country for its capacity to successfully carry out the construction projects awarded. Finally, the company has been awarded quality-assurance, environmental management as well as health and safety standards certificates.

At the beginning of this research, the company's chief officers were aware of the competitive advantages of engaging in innovation, they had not undertaken any actions in that direction. Consequently, investment in innovation activities was scarce with respect to other large contractors. More specifically, there was no specific department for the research and development of new products or processes, nor to focus efforts on benchmarking from the technological point of view. The absence of a specific innovation department also reduced the success of the innovation activities (Orozco et al. 2010). Another indicator of the company's deficient innovative culture was reflected in the few actions taken to participate in national or international organizations that promote innovation in the construction sector, such as the Spanish Construction Technology Platform (www.construction2030.org/ptec.php). The company did not seem willing to take risks, and that impedes innovation (Tatum 1989).

The company's loss of competitiveness was its greatest threat. Such a detrimental effect could render the company unable to tender for contracts with a higher added value. Therefore, it was at a disadvantage in public tenders due to its scarce innovation activities compared to other medium and large contractors. The company's lack of innovation could also make its product portfolio obsolete (Shapira and Rosenfeld 2011). The company's reputation and prestige as a versatile, pioneering enterprise might also be affected by its lagging competitive performance from the technological point of view (Kangari and Miyatake 1997).

Nevertheless, the company could benefit from the tax incentives the government offers to firms that carry out innovation activities (BOE 2004). Moreover, technology watch could be used to identify the novel technology requirements essential for the future of the business.

Similarly, a system focused on management of innovation helping to acquire and distribute knowledge could also reduce these threats and transform this scenario into an excellent opportunity for success. Taking into consideration the new rules regarding procurement enforced by many Spanish public agencies, innovation was valued in competitive procurement as a key asset (Correa et al. 2007; Pellicer et al. 2008). Exploiting this opportunity, the company decided to implement the innovation system to create a competitive advantage in the market. The upper management aimed to create a robust innovation strategy based on the new standards on management of innovation projects, UNE 166001 (AENOR 2006b), and innovation systems, UNE 166002 (AENOR 2006c). Even though this strategy was revealed to the employees at the beginning of the research, some managers did not appreciate it. Nevertheless, the innovation culture pervaded the organization gradually, as confirmed by the different surveys and interviews developed during the research period.

INNOVATION MANAGEMENT SYSTEM

Set of Standards UNE 166000

To encourage innovation in the Spanish economy, the experimental set of standards UNE 166000 was available in 2002 by AENOR (the body responsible for developing Spanish standards); in 2006 the final versions of the three main standards were published (Correa et al. 2007; Pellicer et al. 2008). These standards intend to systematize the innovation management, especially in small and medium-sized companies. These standards include four parts: terminology and definitions (AENOR 2006a), innovation projects (AENOR 2006b), management systems (AENOR 2006c), and technology watch (AENOR 2011); there is also an application guide for the UNE 166002 standard (AENOR 2010).

As stated in the Introduction, the innovation management system under the UNE 166000 set of standards considers innovation as a process that can be standardized in a similar way to quality or environmental management. Particularly, the UNE 166002 standard aims to integrate the innovation management system within the quality management system developed under the ISO 9001 standard, the environment management system (ISO 14001), and the health and safety management system (OHSAS 18001), among others. Especially interesting is the link between the quality and innovation management systems, and their assimilation by the overall business management system of the company. Quality and innovation management processes can be improved with the help of standardization, but knowledge management is not yet a standardized process. Thus, construction companies have tools that allow them to improve business management in order to enhance their competitiveness. However, even though companies have enough experience managing quality processes, it is decisive for them to address their innovation and knowledge management processes.

The ISO 9001 standard can be the foundation of continuous improvement at the firm; many companies now apply these standards to their business processes in the construction industry (Bubshait and Al-Abdulrazzak 1996; Koehn and Datta 2003; Romero and Serpell 2007). Nevertheless, the main problem is continuous and methodical innovation (Orozco et al. 2010), because random efforts and occasional ideas are not enough. If the management of innovation is systematized, as many other managerial activity (Pellicer et al. 2014), using the

UNE 166002 standard for example, then innovation can be considered a continuous process also. Both quality and innovation could facilitate business competitiveness also (Prajogo and Ahmed 2007; Santos-Vijande et al. 2009; Duarte et al. 2013). Knowledge is another vital asset for a construction firm; both quality (Ribière and Khorramshahgol 2004; Živojinović and Stanimirović 2009) and innovation (Quintero-Campos 2010) are related to knowledge. The feedback from the quality and innovation systems comprises the knowledge management system of the company (see Figure 1). This relationship, already proposed by the authors (Pellicer et al. 2008), was partially validated by Santos-Vijande et al. (2009) using a survey of 163 small and medium enterprises in the Spanish manufacturing industry.

Overall Description of the System

The standard UNE 166002 establishes the basis for the systematization of innovation in companies (AENOR 2006c). The UNE 166002 standard is process-based, using the methodology “plan-do-check-act” (Deming 1994). Regarding our case study, the company under analysis started the procedure of implementing the innovation system to stop the main threat of staying behind its traditional competitors (contractors of medium and large size) and even to exploit the opportunity of taking some advantage over them. However, the company pursues these goals in spite of keeping its hierarchy unchanged; the firm has not set up an innovation department yet, but it is using the current organizational structure to perform the new tasks.

<FIGURE 1 HERE>

The innovation management system forms part of the overall management system of the business that includes organizational hierarchy, planning, responsibilities, records, procedures, processes and resources. Its purpose is to develop, implement, execute, review and maintain the company's innovation policy (AENOR 2006c). The two main goals of an innovation system are: (a) to increase the technological competitiveness of the company, favoring an innovative spirit and creativity; and (b) to improve internal knowledge management in the company, obtaining added value for its clients. To achieve these goals, a methodology must be designed and its own organizational structure should be established.

In relation to the methodology, the innovation system designed is divided into five processes: (1) technology watch; (2) creativity; (c) planning and executing innovation projects; (d) technology transfer; and (e) protection of results. This proposal complies with the Spanish standard UNE 166002 (AENOR 2006c). Furthermore, an external certification of each individual innovation project can be obtained by a public or private organization officially recognized by the Spanish government (Pellicer et al. 2008). In the following sub-sections, each one of these five processes will be described; they comprise the company's actual management system, which complies with the UNE 166002 standard.

The company develops a procedure to implement the system that involves three stages: (a) diffusion of the innovation system among the organization's personnel; (b) certification of the innovation management system applying the UNE 166002 standard; and (c) developing and promoting an innovative culture through daily operation and exploitation of the system. These stages correspond to those proposed previously by Lewin (1951): unfreezing; change or transition; and freezing. The construction company is aware that implementing a new process poses specific problems, which must be considered to ensure that the organization can achieve the expected benefits as far as possible (Shapira and Rosenfeld 2011).

Technology Watch

Technology watch is a systematic and organized effort to observe, collect, analyze, disseminate and retrieve accurate information relevant to the business environment (AENOR 20011). Technology watch aims to detect opportunities or threats so as to anticipate changes with minimal risk in making decisions. Therefore, it is bound to the strategy of the company. Furthermore, the technology watch is a mechanism that facilitates brainstorming; as a consequence, the information generated may be made available to all employees.

As illustrated in Figure 2, the surveillance process involves several stages: identifying means and sources, gathering and analyzing information, deciding on relevance by an appropriate evaluation, categorizing and storing information in the company management system. Although the process of technology watch is included in the UNE 166002 (AENOR 2006c), this process has a specific standard (UNE 166006) for its development (AENOR 2011).

<FIGURE 2 HERE>

The first phase is to collect relevant information existing in regular information sources (magazines, websites, newsletters, software, etc.), as well as specific ones (visits to exhibitions, lectures, etc.), managed by different departments of the company. This requires the identification a priori of the needs, according to the company's strategic analysis. The search strategy and actions to perform must also be fully established. Each of the selected sources has a specialist in charge, in order to examine the information assigned. When an interesting document, article or news report is discovered, it should be included in the document management software available. The evaluation of information must be carried out according to the relevance, reliability, relevance and quality. Thus, the specialist responsible for the source of information summarizes the document (record of technology watch), providing search descriptors and classifying it within the system. The categorization of information is done through filtering and homogenization, according to the functionality or importance. In addition, the company recognizes the prevalence of certain issues as well as the existence of key factors arising from the overall strategy of the company.

The information contained in the database system is available to all employees and partners in order to solve problems at construction sites or simply to generate innovative ideas applicable to the business organization.

Creativity

Creativity is the generation of ideas, by company employees, and contributes to improving the organization in accordance with the strategic guidelines established. The information required for the generation of ideas can come from the analysis of weaknesses, threats, strengths and opportunities in innovation, or from particular problems that arise at the construction site. Hence, of all stakeholders, the employees directly involved in the execution of the works (site managers) are a main part of the system.

The recording of ideas takes place in a database. The technical and economic feasibility of an idea and its affinity with the strategic lines previously established by the company are valued by key factors. The idea is assessed by a special committee for innovation activities, taking into account cost, schedule, resources, technical capacity and expected benefits; the contribution to meeting the company's strategy is also included. Depending on the company's ability to undertake projects and the quality of ideas, some will be chosen for further development. Therefore, the selected ideas are regarded as preliminary innovation projects, also called briefs. The periodicity of the process depends on the timing set by the company: quarterly, annual or biannual.

The innovation committee appoints a technician in charge of generating the preliminary innovation brief. If the idea is not his/hers, it is advisable to work closely with the author of the idea. The brief includes details regarding the person in charge, objectives, scope, design description, design characteristics, needs (resources, time and costs), basic graphic schemes, preliminary state of the art, risks assumed, and probability of success. The latter is considered as the likelihood of achieving the innovation certification (Pellicer et al. 2008).

The innovation projects to eventually be developed by the company are selected by the upper management. Normally, the estimate of the risk assumed in each case and the likelihood of subsequent success in achieving certification under the UNE 166001 are taken into consideration. This process is depicted in Figure 3.

<FIGURE 3 HERE>

Planning and Executing Innovation Projects

This process moves from the detailed project design to actual implementation at the construction site or in the company, as summarized in Figure 4. When a problem-solving issue is involved, the project is designed at the same time as works are carried out at the construction site; this case is quite frequent, since the work at the construction site should never stop. This process is the responsibility of the project manager, who is usually the same person accountable for the preliminary brief.

<FIGURE 4 HERE>

The project manager must prepare a detailed report of the planning of the innovation project prior to its execution. This report includes the methodology, schedule and budget. Also, it is the project manager's responsibility to make progress reports of the projects if necessary. These follow-up reports are reviewed regularly by the company's upper management. Upon completion of the project, the project manager must prepare a final report, specifying the objectives which were reached. This report contains the following sections: executive summary, state of the art, technical developments proposed, description and justification of innovation activities, scheduling, organizational structure, budget, control, quality assurance, and protection of the results. Every report must include the minimal contents to meet the requirements of the Spanish government (BOE 2004) or certifying agencies (AENOR 2006c) to obtain tax benefits, on the one hand, or the certification document, on the other hand.

As discussed earlier, the project implementation at the construction site is the basis of the whole process. During project implementation at the construction site, the innovation project becomes a tool of competitiveness for the company and, therefore, determines whether it is a failure or a success. Responsibility for the implementation of the innovation lies with the construction manager at the site or with the department head that implements the innovation at the firm. Generally, a group is formed under his/her leadership. As stated previously, many times there is the added difficulty of developing the innovation design while executing the works at the construction site.

Technology Transfer and Protection of Results

Technology transfer is the process of acquiring, transferring, sharing, licensing, accessing or positioning innovative knowledge on the market (AENOR 2011); the main steps are specified in Figure 5. This set of actions is oriented to take advantage on the open market of the results of innovation activities (Shapira and Rosenfeld 2011). It is directly related with the commercial and social exploitation of intellectual property. Whenever the transfer of technology is feasible, risk should be assessed; if they are too high, the idea must be abandoned. Otherwise, the type of technology transfer will be determined as one of cooperation, transmission or delivery of services. A contract is signed, if necessary, to finalize the agreement.

<FIGURE 5 HERE>

The construction company also seeks to protect sensitive innovation information when contracting with employees, firms or institutions. Specific agreements are developed for cooperation contracts, as well as those for employees, to include confidentiality clauses regarding sensitive information. Figure 6 summarize the process of protection of results.

<FIGURE 6 HERE>

Feedback and Assessment of Results

The standard UNE 166002 is designed to integrate the innovation management system with other management systems already existing in the company, especially standard ISO 9001 on quality management. This characteristic eases the implementation and enables the continuous improvement of the system.

The case study company is currently working to develop a database that contains the final reports for innovation projects, as well as the recommendations of the site managers. This database can be accessed by all members of the organization. However, the knowledge management system is not yet fully developed in the company.

In addition, this contractor has set performance indicators for the system and each of its processes. These indicators allow for the understanding the innovative behavior of the system, meeting the objectives set by upper management. These indicators include: regular sources of information; records of technology watch that lead to ideas; accumulated ideas; projects that obtain certification or administrative protection; other contractors certified by

UNE 166002; official tenders that consider the evaluation of innovation projects; ideas approved as briefs (1st selection); briefs approved as projects (2nd selection); average cycle of innovation; and agencies, institutions or companies that maintain cooperation agreements in innovation with the company.

RESULTS OF THE IMPLEMENTATION

Once the five processes of the implemented system are described in detail, some quantitative outputs from the construction firm (case study) are presented and discussed. The evolution of significant outputs of the performance of the company under study during the nine-year period (2006 to 2014) is shown in Table 1 (there is only partial data for 2014). The key data displayed regards to revenues, profit before taxes, and employees with university degree, employees working at the innovation department, and innovation projects that have been certified by an external body. To understand this data, two important events took place during this period: first, the economic crisis that had an effect of great consequences on the Spanish construction industry since 2008 in building construction and since 2009 in civil engineering works (Torres Machí et al. 2013; Oviedo-Haito et al. 2014); second, the company implemented the system in 2007, and was certified in 2008 by an external body. Furthermore, in order to allow a comparison of the industry as a whole with the company under analysis, production indexes for the Spanish construction industry, distinguishing between civil engineering works and building construction, are also displayed in Table 1; these indexes are issued by the Spanish Government in coordination with Eurostat (SEOPAN 2014).

<TABLE 1 HERE>

Analyzing the figures on Table 1, it can be seen that, from 2006 to 2009, the profits almost reached thrice its starting value, whereas the revenues raised only one third and the construction industry was pretty steady, at least in civil engineering works, in which the company is more focused. Furthermore, there was also a spectacular increase in certified projects with three additional technicians working in the innovation department, whereas the personnel with university degrees in the whole company had a similar increase. These results show the achievement of implementing an innovation management system in a medium-sized construction company, at least from the point of view of the outputs (innovation projects), even though this does not necessarily mean that there is a direct relation between profits and innovation; further investigation is needed to conclude this. Anyway, this success highlights that innovation is far from being the result of inspiration or flashes, which can arise at any given time; in contrast, innovation can be considered as a management process that allows for planning and control (Pellicer et al. 2012).

Considering the 2010-2014 period, the revenues decreased as well as the profits (even there were losses in 2012), while production declined dramatically in the Spanish construction industry. However, the innovation department stood firm for three years (2010-2012) in spite of the crisis, keeping the same personnel and producing a similar number of projects for this period. In 2013 there was a reduction of personnel and projects in the department; nevertheless, the company achieved its best result so far: a project financed by the Spanish Center for Industrial Technological Development (belonging to the Spanish Ministry of Economy and Competitiveness) was awarded to the firm’s consortium; this project’s goal was to build and test a prototype of eco-efficient building (Guillén et al. 2014). In 2014, the company recovered its regular path increasing personnel and innovation projects. The firm was involved in tenders for some European R&D projects under the H2020 program (http://ec.europa.eu/programmes/horizon2020/). During this time, it generated spin-offs companies to develop and implement innovative products using nanomaterials; the company also certified new materials and products based on life cycle assessment in accordance with the international standard ISO 14025.

As a final validation, in 2014, the research team performed a series of informal interviews with five relevant managers of the company. All of these senior managers had more than 15 years of experience within the firm, and they got managerial positions currently; the interviews lasted around one hour each and they were recorded. The managers were asked about their satisfaction with the implemented system as well as the evolution of the system and the company throughout the years; they provided some key examples of implementation and lessons learned too. The interviewees had realized that innovation did not depend on impulsive actions in order to solve a specific problem or put into practice a brilliant idea; on the contrary, it could be systematized and standardized. According to these senior managers, systematization of innovation helped the assimilation of new ideas and the use of and spread of new knowledge. Originally, the main source of creativity came from problems at the site involving, for example, the use of laser equipment in order to control the position and geometry of complex steel pieces, or the construction of a deck bridge using pre-assembled girders. The other important source of ideas at that time was the demands from the clients, including modular prefabrication for schools, or resurfacing a highway with high rubber content binders. However, later projects, as the ones described in the previous paragraph, followed the path set in this paper, starting with the process of technology watch, and ending with the transfer of technology and protection of results.

The interviewed managers ranked the innovation department highly, arguing that, in spite of the crisis and even that the company was losing money for a while, it was kept functioning at good pace and achieving excellent outputs for the company. They understood that many projects increased the productivity at the field, such as the optimization of fabrication, transport, and placement of asphalt mixes, or the enhancement of falsework removal from concrete structures used in underground parking lots. Other projects improved the information flow: between offices and sites using mobile devices, with suppliers and subcontractors through a computer-aided system, or within the stakeholders at the site by the means of an innovative planning and control procedure. Because of these interactions with other agents through the innovation projects, the managers felt that, after several years, the company was seen as innovative by clients, at least at the regional level. As a general rule, they perceived the implementation of the innovation management system as a success.

CONCLUSIONS AND LIMITATIONS

The authors have carried out a nine-year research on innovation management in construction companies in cooperation with a medium-sized Spanish contractor. The authors' previous work dealt with the literature analysis and concept framework, the introduction of the Spanish set of standards UNE 160000, the strategic analysis of the firm selected for the case study, the generation of a model, and its external validation through a survey and interviews to managers of certified companies. This paper comprises the detailed description of the processes that involve the implementation of the system in the selected case study.

This innovation management system builds on a set of processes aimed to generate innovation projects that allow the company to document the innovation, not only for internal purposes related to knowledge management, but also for external ones associated with obtaining better results in public tenders. Once the innovation system is designed, its implementation is ensured within the organization. This involves the active and permanent participation of all stakeholders affected by the system. The goal should be that, once in operation, the system does not become a burden for the company. Companies can be benefited by previous implementation and experience given by the quality, environmental, and health and safety systems.

This experience demonstrates that it is difficult to make changes that affect the behavior of employees, in particular, and stakeholders, in general. Change involves moving the organization from the current scenario to a new level, and keeping it there. At every stage it is necessary to train staff in innovation activities and to maintain the constant incentive of the innovative attitude. Furthermore, the implementation of an innovation management system, regarding this case study, led to an organizational change; consequently, the construction firm streamlined its internal processes. One of the more intangible outputs was the beginning of a profound change in corporate culture facing innovation.

Some questions are still pending. The main limitation of this research is the use of a single case study. First, a substantial number of construction firms with the system already implemented are needed in order to check the results obtained for this particular case study. This would allow for generalization of results and for drawing conclusions of a broader nature. However, there is no enough number of Spanish contractors with an innovation management system implemented yet. Thus, we plan to develop a broad survey of Spanish contractors in the near future. On the other hand, other issues can be also raised about how strong the current economic crisis in Spain affects the results, as well as how the incipient cultural change in the organization can face new challenges in the firm, primarily based on diversification and internationalization of activities.

Furthermore, the researchers also intend to undertake several studies on the possibility of implementing these standardized innovation management systems in different environments such as Latin America, with different characteristics compared to Spain, cooperating with the local industry as well as with colleagues of each of the countries involved. In order to do so, the degree of maturity of innovation management in construction in other countries, such as Chile, Argentina, Colombia, and Mexico, has to be previously examined.

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