

# EVALUATING THE PERFORMANCE OF THE MANAGEMENT OF INNOVATION IN CONSTRUCTION COMPANIES: A CASE STUDY

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## Abstract

The lack of innovative organizations is a characteristic of developing countries and a society without them is constrained in its development and growth. The competitiveness of a country depends largely on the capacity of its industries to innovate and improve. Lately, in the construction industry there have been changes that have created a growing concern for innovation and have transformed it into an important requirement to obtain competitive advantage in the future. Despite its need there are barriers; innovation in construction is very difficult and the associated risk is almost unacceptable to the sector's culture. This leads to deficiencies in the performance of innovation management so it's required to have a performance evaluation system for this important role in the construction, capable of identifying existing weaknesses and allowing the generation of plans for improvement. For this purpose, an evaluation system has been structured, based on six factors which drive innovation: organizational structure, culture and human capital management, knowledge management, research and development, technology used and partnering. The evaluation done with this system will generate proposals for actions to develop those innovation drivers which underperform. This paper describes the preparation of the evaluation system, shows the results of a case studies of three construction companies and the main conclusions from the analysis of the results. The study reviews the importance of the six innovation drivers and validates the applied evaluation system. The ultimate goal is that the developed system becomes a lever for the development and improvement of innovation capabilities of construction firms.

Keywords: construction companies; evaluation; innovation; innovation drivers; management.

## 1 INTRODUCTION

A society without innovative organizations does not develop and is doomed to backwardness and poverty (Schumpeter, 1978), and its scarcity is a characteristic of developing countries (Matos, 2007). The competitiveness of a country depends on the capacity of its industries to innovate and improve, and additionally, companies also get competitive advantage if they can innovate (Porter, 1991) and to measure the competitiveness, the efficiency of the company is one of its five determinants (Benzaquen

et al, 2010). These advantages exist because it is increasingly difficult for a company to increase their productivity, therefore to further improve their performance it requires a greater participation of innovation (Drucker, 2007).

The construction is often considered the lag of other sectors, both in terms of their inherent abilities to innovate and inability to adopt innovations of other areas (Harty, 2008). Lately, changes have been generated in the construction industry, increasing the importance of innovation and transforming it into a requirement to obtain competitive advantages in the future, where innovation moves from a random activity to a process developed and implemented, which is set in the culture, strategy and in the organization of the construction company (Girmscheid and Hartmann, 2003). Furthermore, it must be treated as a system based on the entire company is focused on innovation (Simpson et al, 2006).

Despite its necessity, Blázquez (2005) noted that innovation in construction is very difficult and the risk is almost unacceptable. Serpell (2002) has identified that there is distrust of ideas and proposals for change and innovation. Most companies do not consider the investments in R&D attractive because they have not understood it as a key competitive factor (Correa et al, 2007). This demonstrates the shortcomings in the performance of management innovation and the importance of an evaluation system oriented to the construction, able to identify the deficit, and allowing the generation of improvement actions. To meet these goals, the evaluation system must include (1) a maturity model for managing innovation, (2) data collection methods for the evaluation and (3) a generator of best practice proposals. According to this, we will develop four case studies: three to implement an evaluation system and one to deepen in the generator of proposals.

## **2 THEORETICAL BACKGROUND**

A maturity model provides a systematic framework for conducting benchmarking and performance improvement (Demir and Kocabas, 2010). These strategically lead the organization and link it to the continuous improvement, requiring a deep understanding of the current position of the organization and its aspirations for the future (Brookes and Clark, 2009; Demir and Kocabas, 2010).

The CMMI approach permits the improvement and evaluation using two representations: continuous and layers. This research has followed the layers representation, for being a systematic and structured approach to improving, where the achievement of each layer allows the development of an infrastructure for innovation management right for the next phase, i.e., to achieve each maturity level ensures that it has established an adequate foundation for the next level of maturity, allowing incremental and lasting improvement (Chrissis et al, 2009). This representation allows defining the way of improving an organization characterized by different levels of maturity, where each layer provides a set of properties that characterize the different organizational behavior (Chrissis et al, 2009). But there may be a question: if we focus on improving those aspects poorly evaluated by applying the best practices, what about the daily works? And as said Ponti (2009), the only thing you should do is ensure that the innovation tasks are aligned to company

strategy, i.e., to generate business value. In this way, we will ensure that the company continues doing what should be done, with the addition of continuous innovation.

In the literature there are proposals of maturity models associated with innovation (Narasimhalu, 2006; Essmann and Preez, 2009; Natayama, 2005; Toole et al, 2010), but (1) some are incomplete, (2) others occupy many attributes making them unsustainable over time, (3) none of them fits the reality of the construction industry in Chile and have no method of evaluation. But authors agree that there are a number of factors driving innovation in an organization (Wan et al, 2005; Bowonder et al, 2010; Kyläheiko et al, 2010; Yam et al, 2010; Jiménez-Jiménez and Sanz-Valle, 2010; Manley et al, 2008;), which makes possible the construction of a maturity model for managing innovation.

To collect relevant data about a variable involved in research, there are a variety of tools or techniques, each with different characteristics, where there are two options: (1) choose an instrument already developed and available, which is adapted to the requirements of the research study or (2) build a new measurement tool (Hernández et al, 2007). In the event that the data is coded into categories identified by numbers, we have a quantitative analysis, however if the data is collected with the purpose of making contextualized descriptions or describing and evaluating a situation arising from the observation of an interview, we will have a qualitative analysis (descriptive, contextual) (Hernández et al, 2007; Anderson et al, 2010).

Lately, researchers have increasingly turned to combining qualitative and quantitative techniques (mixed methods approach) to improve the quality of research, to expand the scope and to improve the analytical capacity of their studies, allowing (1) assurance of the verification of data, (2) the complementary of strengths and weaknesses of different approaches, making less likely the loss of something important and error generation (or to make mistakes) and (3) the joint interpretation of data qualitative and quantitative (Sandelowski, 2000; Johnson and Christensen, 2010; Creswell, 2009; Johnson and Onwuegbuzie, 2004; Johnson et al, 2007).

### **3 RESEARCH PROBLEM STATEMENT**

#### **3.1 Approach to the problem**

The aims of this research can be set in its overall objective: to develop a system to evaluate the state of innovation management in construction companies. To do this, we must (1) make a maturity model for managing innovation, (2) identify data collection methods for assessment under the mixed methods approach (or approaches combining qualitative and quantitative) and (3) make a generator of best practice proposals. To satisfy each one of them we must follow the schema of Figure 1.

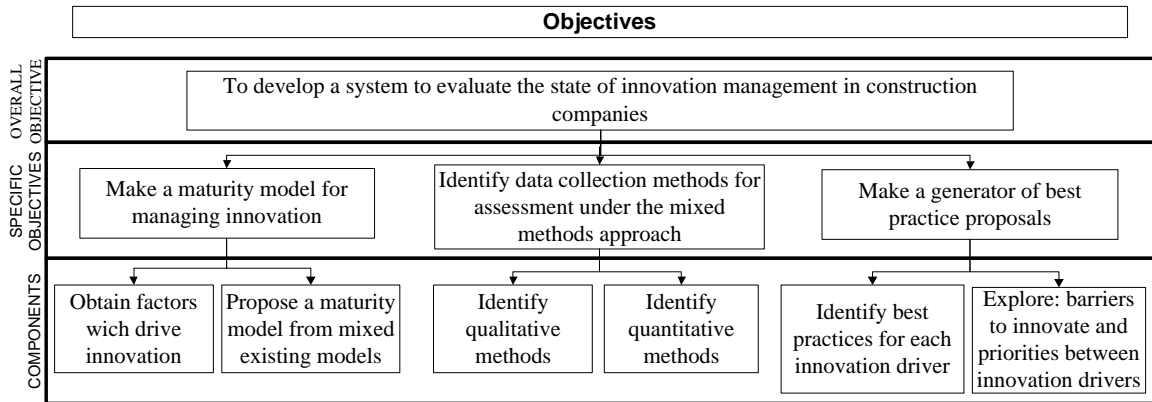


Figure 1: Schema of the research objectives

Thus, we can present the problem with the following questions: (1) How to evaluate the maturity of innovation management in a construction company? (2) How to improve the maturity of innovation management in a construction company?

The hypotheses that underlie these questions are: (H1) the use of qualitative methods would be as essential as the use of quantitative methods, to evaluate the maturity of the management of innovation, (H2) the maturity of the management innovation of the construction companies would be influenced mainly by six factors, (H3) if we inquire into the organization of a construction company, both the company and the researchers will find that the main lever to improve the maturity of the innovation management is the human resource.

The expected outcomes of this research are: (1) the preparation of an evaluation system for the management of innovation, (2) reaffirm the importance of a number of factors driving innovation, (3) identify barriers to innovation of the companies studied, (4) explore where one perceives the importance of innovation within a construction company and (5) generate proposals for best practices for managing innovation in the companies studied.

### 3.2 Justification of research

Harty (2008) says that in the construction industry within the improvement and innovation themes, the complex contexts and the different perspectives that characterize the construction are not taken into account, which highlights the lack of a central drive to reconcile conflicts and overcome the resistance to the implementation. Now, getting a highly innovative company depends primarily on whether the organization knows how to devise, maintain and profit from an innovation system (Ponti, 2009).

To implement a formal approach to innovation management, or improve an existing one, there is needed a frame of reference against which to compare their current practices, where the best practices can be defined in terms of maturity (Hillson, 1997). The usefulness of this research stems from the need to develop an evaluation system of innovation management, considering the characteristics of construction. To this end, we will construct a model of maturity contextualized in the areas of innovation in the specific environment of the building, in terms of approach, content, training evaluations and improvement activities. Because innovation involves change and that change is the genesis of reality, and companies must constantly change to legitimize their existence and

ensure their results (Ponti, 2009), the evaluation system will focus on overcoming resistance to change, providing the infrastructure to cope with a changing world.

For their part, Lim and Ofori (2007) argue that (1) authors agree on a key principle: innovation is the main source of wealth creation, (2) the cost of innovation is often considered high for companies in general and in particular for the construction industry, where development and testing of innovation can be costly. In practical terms, the application of this evaluation system will reveal the state of innovation management in a company to identify its shortcomings, i.e., to know how prepared a company is to innovate. Having this knowledge allows us to propose the best practices associated with those innovation drivers in deficit, in order to support the continuous development of the company to better cope with innovation.

During the course of this investigation, we have identified the innovation drivers from a literature review and the approval of professionals from the construction sector, providing a theoretical value of knowledge with regards to the determinants of innovation in construction. Also, it is proposed that the performance measurement include the analysis of qualitative and quantitative aspects, suggesting that the mix of methods of data collection give a result more complete when we want to evaluate the status of a company, because it allows us to extend the scope and improve the evaluation and the analytical capacity.

## **4 RESEARCH METHODOLOGY**

The focus of the research is centered in how to assess the management maturity of the innovation in a construction company, and from this, proposing the best practices. To perform this maturity measure, information will be collected, measured and concepts related to innovation management are going to be assessed. But the scope of this research goes beyond the description of the innovation management state (maturity level), and also aims to find the causes of the innovation management state, explaining why certain levels of maturity occur and under what conditions. To obtain an explanation, we need to consider both an analysis evaluation of driving factors of innovation, and an information collection within the company.

According to the scope, the proposal aims to develop an evaluation system, so, it has been decided to incorporate in this research approaches of transactional non-experimental research (ex post facto), for the following reasons: (1) the research will be performed without deliberate manipulation of the driving factors of innovation (variable) and (2) the situation will be observed as occurs in the natural context of the companies, then will be analyzed and (3) data and information will be collected at one time only, in a unique moment. Accomplishing with these points, we will be closer to the variables hypothesized as “reals” and, in consequence, we will have a major external validity (Hernández et al, 2007). And, specifically, to ensure the validation of the evaluation system, the research strategy will also incorporate case studies, which is appropriate in our situation because according to Hernandez et al (2007) and Yin (1994) a case studies: (1) require deep evaluation, searching for an understanding of its nature, and circumstances, its context

and qualities, adjusting to what the interest of this research it is not generalize, but deepen in the matter (2) are useful to develop intervention processes and generate recommendations of action courses to follow, supporting one of the objectives in the research: to generate proposals of best practices, and (3) in this research, are not controllable and contemporary events are addressed thus satisfying the need to explore a current issue as presented in reality.

The development methodology of the evaluation system includes (1) creating a maturity model of innovation management, (2) identifying data collection methods for the assessment: both qualitative and quantitative and (3) developing a generating proposals engine of best practices.

- Based on identified maturity models in literature, has created a maturity model of innovation management, according to a combination of those models and CMMI model in a unique framework. This framework is given by innovation drivers found in the literature, the approach of innovation related to each driver and the context of construction.

- In terms of data collection methods, were selected and developed those that fit with the requirements of the research study, such as: including various answer alternatives, contextualizing and delimiting these possible answers to assess more precisely each factor at each maturity level, to deepen on the situation of the factors within the company and about the perception of innovation value. Considering the importance of the reliability and validity of data collection instruments for research results, we conducted a test case, whose results led to make the necessary adjustments to ensure both validity and reliability. Furthermore, within the application procedure of the evaluation system has been considered a validation stage within the company to ensure the consistency of results.

- Finally, to develop a generating proposals engine of best practice, we have relied in the literature to follow the best practices related to each innovation driver, which is consistent with the objectives of each level of maturity, ensuring the base necessary to go forward to the next maturity level.

According to this, it was performed a case studies where this evaluation system was implemented in three construction companies. In each company was applied the evaluation system to a group of professionals and executive of the company. The group's diversity was kept regarding: time in the company, work area, and hierarchical level.

## **5 MAIN RESULTS**

### **5.1 The six drivers of innovation**

We identified six determinants of firm innovation from our literature search. These are: culture and human resource management, organizational structure, knowledge management, research and development, technology and partnering (Bowonder et al, 2010; Wan et al, 2005, Manley et al, 2008; Miozzo and Dewick, 2002, Holmen et al, 2005, Gadde and Dubois, 2010; Kyläheiko et al, 2010; Yam et al, 2010, Raymond and St-Pierre, 2009; Sun and Du, 2010; Becheikh et al, 2006; Chen and Huang, 2009, Liao et al,

2008; Jiménez-Jiménez and Sanz-Valle, 2010; Yitmen, 2005; Zhang et al, 2009; correa et al 2007, Blasquez, 2005; and others). Based on the literature review, each factor could be defined, including its scope in the research and its relationship with innovation.

- Culture and human resource management will be focused on the following dimensions: the attitude of professionals and company executives facing change, the perception of employees regarding the senior management commitment within the company referred to innovation, the conduction of training professionals and executives in the company, and the promotion level of teamwork coming from the company. In order to have motivated employees to innovate, there must be a culture supporting and rewarding innovation, it is suggested to use multi-skilled teams, conduct training and formation programs and to be able to convey commitment. Employees must believe that innovation is a value and innovation activities should be supported by the ideologies of the organization and by generating adequate teams work. A key issue is the commitment, as the belief that innovation is important for the success of the company, is positively related to greater innovation in itself.

- Organizational structure will be focused on the following scale dimensions: how to make decisions in the company, i.e., as the organizational structure allows or no autonomy in decision-making. Decentralized and informal organizational structures, facilitates innovation, because the flexibility and openness of this kind of organizational structure helps to promote the generation of new ideas. Thus, we have characterized as an innovative organization companies that can reduce the hierarchy, allowing greater lateral communication and greater autonomy of lower level employees. On the other hand, concentration of power in centralized organizations would be a major obstacle in adoption of innovations. Decentralization of authority in decision-making is a basis to achieve an adequate infrastructure to proceed smoothly towards innovation. Finally, we can say that greater decentralization of decision-making authority is positively related to greater innovation in the company.

- Knowledge management includes both internal and external knowledge. Regarding internal knowledge consider the following aspects: presence of organizational learning and their level of development, ability to extract learned lessons from projects (both good and bad practices) and the ability to store and transfer the learned lessons into the organization. As for external knowledge to the company, the ability to follow best practices outside the company will be included, i.e., see what has worked for other companies and/or industries, find out why it has worked, and determine if it is possible apply it to the company. Organizations have within themselves the ability to improve their own level of innovation. Ensuring that the learning of the projects is transmitted to business processes requires the maintenance of a formal system of transfer learning as a "continuous process" in the business. This implies greater internal communication, which is positively related to greater innovation of the company, as it helps the spread of ideas and learned lessons within an organization, increasing the quantity and diversity. On the other hand, it is important not to create the wheel again, as it means a waste of resources and efforts. For this it is important to follow up the best practice outside the company, see what has worked and why it has worked. It should not be limited to creative advances within the company, applying external ideas creates a range of internal options, ensuring that options have not been no limited. And being watching of external knowledge will allow watching changes also. Managing a business in an uncertain world requires being alert to changes and innovation to adapt itself. Both internal and external knowledge

implies greater internal communication, which encourages a positive innovation in the enterprise, helps the spread of ideas and lessons learned within the organization, increasing the quantity and diversity.

- Research and development (R&D) will be focused on how to conduct R&D and why it is done. These can be for: a professional's own initiative or executive of the company, the characteristics of one or a few projects require or the principal's request, by necessity of competitiveness with other companies and also can outsource R&D processes, where the company after identifying the need for R&D in some respect very specific and highly complex, processes are outsourced to specialized researchers. You can find cases where one or more ways and reasons exist within an organization. Exploring new ideas facing a real need, owning and investing special funds for innovation, are an important basis for the development of an adequate infrastructure to proceed smoothly towards innovation. A greater amount of resources of the organization set up to invest in research and development is positively related to greater innovation in the company. There are studies that suggest that companies that invest more in R&D are more innovative.

- Technology will be focused on the use or application of technology in the processes and/or construction methods, considering whether it occupies only proven technology (safe) or whether it uses innovative technology, such as frequency of use. Technology can be generated internally or can be obtained from outside. The value of creating internally is essentially using it and the value of capture is to exploit new opportunities. Strong barriers to the use of technology are both existing attitudes and beliefs about technology, as the current level of knowledge and skills, so that developing the use of technology positively encourages innovation in company.

- Partnering will be focused on alliances and partnerships that the company can make with both other external companies (suppliers, customers and/or business peers), and with universities, and in over the level of development of partnerships or alliances made. A current lack of cooperation has been seen as a major cause of a low level of innovation in the construction industry. Participation in partnerships and alliances, corporate and projects level help to synergize knowledge, complementary skills, share resources and risks. Companies participating in the partnership with organizations and universities, are more likely to be innovative than firms that do not align with these strategies.

## **5.2 Findings of the development of the evaluation system and in his implementation in the case studies**

The proposed evaluation system contains three major parts: (1) a maturity model of the innovation management, (2) data collection methods for assessment and (3) a generating proposals engine of best practices.

The model created considers five maturity levels, which are determined by the state of the six driving factors of innovation, where the achievement of each level of the model allows the development of an infrastructure for innovation management suitable for the next level allowing an incremental and durable improvement (Chrissis et al, 2009). Its architecture of five levels is based on staged representation of CMMI, being a systematic and structured approach to improvement. To achieve the description of each factor by maturity level, we rely on a combination of models of innovation, technological



innovation and risk. The models used were selected to complete the full and comprehensive description of all factors under the single framework of innovation.

The methodology for developing the data collection methods resulted in the development of a questionnaire and a focus group with professionals and executives of the company are going to be developed. The conduction of the last one is not to do statistic calculations, because it is a sample of nonprobability, which means this tool is not meant to generalize, but to deepen the scope of the analysis. The questionnaire, associated with the maturity model, aims to determine the status of each driving factor, and thus the maturity of innovation management. It is able to contextualize the factors through situational descriptions of these, for each maturity level, allowing the questionnaire to obtain the data sought. The application of this questionnaire was widely accepted by professionals and business executives from companies involved in the research, for the following reasons: (1) to provide situational descriptions made the application of the questionnaire take a reasonable and acceptable time for them, (2) were given particular cases where some respondents did not know the name of the factor, but the situational description of these enabled them to recognize the concept of the factor within the company, and (3) the same description allowed to see different situations of the same variable, allowing them to have different perspectives on them and thus better differentiate the situation of the company.

Once the questionnaire was applied, we proceeded to give each company its results, through a focus group applied to a number of professionals and executives of the company. Aimed to deepen and explore, through group dynamics, the status and perception of each company facing its result. The development of the focus groups was greatly appreciated by the companies studied, because: (1) it allowed professionals to understand what represented the maturity level obtained, i.e., they themselves were able to self-evaluate, accept and comprehend the gaps they had for each driving factor, from the given assessment, (2) to understand their shortcomings, further contextualize the factors within the company, allowing to establish relations of cooperation and interdependence between the factors, understanding that improved innovation management comes from the proportional development of the factors and not just concentrate on developing one of them, (3) within the dynamics of looking for where innovation has a greater impact within a construction company, they realized that the answer is not given in a particular area, but as applied innovation add value to the final product of the company, then it will impact too, and (4) all of them agreed that the strongest barrier to innovation is the culture and human capital management.

The generating proposals engine of best practices is a matrix containing for each factor, the best practices associated with the driving factor and the objectives to be met according to the maturity level where the factor is and the level where it has to move on. According to preliminary comments, not yet conclusive, the way they deliver the best practices (best practice associated with each factor and objectives must be fulfilled) would allow the company to choose the practice which is most aligned to the company strategy, i.e. to generate business value, In this way, the goal to keep doing what is expected could be reached and now adding continuous innovation.

Finally, the application of the evaluation system overall obtained a very good acceptance by the companies studied, with satisfactory results. Furthermore, within the procedure for applying the evaluation system was considered a validation stage within the company, to ensure consistency of results, which was also well received by companies. Its application supported the analysis of the results, because it allowed exacerbation of the points of conflict on the real situation of the factors in each company, i.e. what areas could be distinguished within the company having different perceptions on the status of a factor.

## **6 DISCUSSION AND CONCLUSION**

First, we reaffirm the existence of six determinants of innovation, culture and human capital management, organizational structure, knowledge management, research and development, technology and partnering, and the positive relationship between them and the innovation. With this, we test the hypothesis H2.

Second, we present the evaluation system, consisting of the maturity model, methods of data collection and the generator of best practices. Regarding the maturity model and based on the results of the implementation of the evaluation system into three construction companies, we can conclude that it really is able to measure with reliability and validity, the maturity of innovation management in construction companies, from the reading of six determinants. Thus, we can also affirm the reliability and validity of the questionnaire used as an instrument for measuring the maturity. At the same time, we must say that the results of focus groups cannot be generalized, but we can conclude (1) that contributed to expand the scope of the investigation, because it helped us to delve deeper into the situation of the companies studied, (2) explain to the companies why they gave certain situations in their evaluations and (3) helped to each company to really understand their situation by themselves, allowing each company to develop a climate conducive to receive the proposal of best practice We believe that the latter point may be essential to the successful implementation of best practices. Also, from the focus group, we were able to explore and delve into what might be the biggest barrier to innovation, the discovering was in conjunction with the companies, resulting the culture and human capital management. With this we check the hypothesis H3.

Third, considering all the above, we have sufficient evidence for the hypothesis testing H1, highlighting the importance of combining data collection methods, both qualitative and quantitative, for greater scope in research and to improve understanding and the analytical capacity.

In this investigation we have not considered the impact of firm size, since according to the literature review, it not turned out to be one of the determinants of innovation.

Based on the concerns of the companies studied, we propose as future research: (1) a system of monitoring and control of the best practices, applying for this the principles of the Balanced Scorecard, (2) an expert system based on the evaluation system proposed and adding the ability to learning, and (3) investigating how to ensure the success of the best practices.

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