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Evaluating risk management practices in construction organizations

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Abstract

Construction organizations in developing countries, approach risk management in construction projects by using a set of practices that are normally insufficient, produce poor results often, and limit the success of project management. This paper describes the development of an instrument based on an organizational maturity model for evaluating the risk-management capability of construction organizations. This instrument has been applied to both, clients and contractors and is part of a general knowledge-based system. Outcomes of this research will allow a client or contractor first, to develop or improve its project risk management capability based on international and local best practices and second, to continuously improve the performance of this function along the realization of new projects. The novelty of this approach is that it addresses the risk management function from a knowledge-based perspective and that it will be based in a web application that will be available to every organization.

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Keywords: project management; risk management; maturity levels; evaluation; instrument

1. Introduction

Today every organization faces uncertain events that occur in different environments and with different characteristics and impacts. These uncertain events can generate more or less severe consequences for the organization (Aven, 2011). Uncertain events with negative impacts are called risks. The construction industry is no exception in being exposed to these uncertainties, which are complex and diverse risks (Zhao et al, 2013).

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Risk is a term that has long been studied in different areas. Hillson (2013) defines risk as the uncertainty that can be measured, and uncertainty is a risk that cannot be measured. To try to mitigate or eliminate the risk, we count on risk management, which is an integral part of project management. Risk management is a positive and proactive process intended to reduce the likelihood of unsatisfactory consequences to the project in its different stages, such as design, construction and operation (Mills, 2001; Rohaninejad & Bagherpour, 2013).

Risk management is an important area of project management then, since it allows anticipating the occurrence of events that could adversely affect a construction project and to define actions that could minimize their impacts. It is well known that one of the major roles undertaken by any project manager is to deal with contingencies or risks that occur continuously during the management of a project and this role is particularly complex and inefficient if risk management has not been performed or supported adequately since the start of the project. To make risk management an effective and efficient function, it is necessary to have a proper and systematic methodology and, more importantly, knowledge and experience of various types.

For many years, construction organizations in developing countries have approached risk management in construction projects and organizations by using a set of practices that are normally insufficient, producing poor results most of the time, and limiting the success of project management. This situation can be observed both in contractors and owners organizations as well. In general, it can be said that risk management in these organizations is inadequate, lacks a systematic and formal approach, and its performance is not measured.

One of the challenges being faced at this time then, is how to measure the capability of a construction organization to perform risk management effectively and how to help this organization to improve along time. This paper presents a partial report of a comprehensive research project on risk management in construction organizations and projects. One of the questions addressed by the research is: how can risk management practices be evaluated in organizations and companies involved in construction projects? It has been proposed then that risk maturity models may provide an appropriate framework for evaluating current risk management practices in construction organizations and identifying current gaps, because this kind of models are constructs that help to carry out the assessment of the risk-management capability of an organization and to obtain an understanding of its shortcomings.

This paper describes the process followed for the development of the risk-management evaluation model and instrument, and how this was validated using local experts' panels that took into account the local culture and idiosyncrasy. The process involved the following major activities: 1) the development of a model for risk management from best international practices and to compare it with real current domestic practices. This stage was mainly based on literature review both general and specific for construction projects, and addressed the state of the art of risk management, standards for risk management, and the identification of best practices and tools used in risk management, and 2) the development of an instrument based on an organizational maturity model, to evaluate the risk-management capability of construction organizations. The latter stage also included the identification and organization of a comprehensive set of best practices for helping companies to overcome identified gaps in their risk management practices. The final goal of the whole research project is to design and construct a web-based computer prototype of a risk-management support system. The idea is that the evaluation instrument be easily applied to any construction organization that wants to evaluate its risk-management capability through the interaction with the web-based questionnaire. In addition, this prototype would permit: (1) to store historical risk information and knowledge, (2) to guide companies and organizations in the development of the desired risk management capability, according to the established model, (3) to conduct the assessment and monitoring of the maturity of an organization's risk-management capability, (4) to have tutorials and being able to educate employees about risk-management depending on the hierarchical level and responsibility that every employee has in a company, and (5) to have a storage and retrieval system of best practices to help companies to improve their risk-management performance continuously.

Results of this research will allow a client or contractor to develop a risk management function based on best practices and second, to improve the performance of this function along the realization of new projects. The novelty of this approach is that it addresses the risk management function from a knowledge-based perspective, which does not exist in most of organizations and companies in our country. Also, an additional interesting contribution will be the best practices model that is being developed and that will be used as a benchmark for evaluation and

improvement. Finally, the instrument for evaluating current risk management capabilities by applying a maturity model will help to improve the performance of Chilean construction organizations, companies, and projects.

2. Research background

The presence of uncertainty in everyday life as well as in organizations has become an important issue at present and to achieve its appropriate management has become a challenge. Due to the dynamic and complex environment that exists around organizations, uncertainty becomes an important issue that must be taken into account for the realization of any project (Rohaninejad and Bagherpour, 2013). There is a connection between uncertainty and risk as indicated by Hillson (2004). Risk is a measure of the probability and severity of adverse effects (Hubbard, 2009; Aven, 2011) affecting project objectives (Baloi and Price, 2003; Nielsen, 2006). Risk may be a multifaceted concept (Wang and Yuan, 2011), which currently is a concern for any organization. In the construction industry risks are inevitable and they are present throughout the life cycle of the project and the organization should manage them proactively (Tah et al, 2001a; Goh et al, 2013; Zhao et al, 2013). On the other hand, not always risks are associated with negative results, being also possible the presence of a positive opportunity or risk. These opportunities, when taken, can mean time and money savings and the creation of value for the project (PMI, 2008; Hillson, 2013). Despite this, people tend to see only the downside of risks (Baloi and Price, 2003).

To manage, identify, assess and monitor risks that arise within an organization or project, there exists the process of risk management which has its origin in the U.S. in the '30s, when securing businesses from their initial stages was sought (Zheng et al, 2009). In the '70s, this process became an integral part of project management (Del Caño and De la Cruz, 2002; Arikan et al, 2009). Risk management must accept that risk is inherent in any project (Hubbard, 2009) and that one of the greatest difficulties is to determine which are risks and how they should be prioritized (Anderson, 2009). This is a key process and that is why project managers recognize that risk management is essential to carry out a good project management (Baloi and Price, 2003; Goh et. al., 2013).

Different models of the risk management process have been proposed in the literature by different researchers and different bodies of knowledge (Goh et. al., 2013). The intended output of risk management is to identify, assess and control risks using methods to reduce them to an acceptable degree and have a successful project (Rohaninejad and Bagherpour, 2013).

2.1. Risk management

In the past four decades, research on risk management has grown considerably in the construction industry (Chapman & Ward, 2011; Lehtiranta, 2011) due to the fact that construction projects are permanently exposed to risks and are perceived as projects with greater inherent risk due to the involvement of many stakeholders. It is possible to analyze project risks from two different perspectives. From the point of view of the client, who is key to decision-making in the project, and from the point of view of the contractor, who traditionally increases costs to hedge risks, but given that the margin utility is getting lower, is facing a practice that has become unprofitable (Baloi and Price, 2003). These two groups have different behaviors against the risks of the project and different possibilities of transferring risks to the party best able to manage them (Wang et al, 2011).

Currently the practice of risk management is reactive, semi-permanent, casual and unstructured within the construction industry, resulting in a lack of capacity to manage risks appropriately. The main barriers that were found for the implementation of an effective risk management system are the lack of formality of the system and the lack of integrative mechanisms of risk management among the parties involved in the project (Choudhry and Iqbal, 2013). In addition, risk management is not applied with the same rigor as other topics of the project management process (Fan et al, 2008).

The system used for risk management in projects has been mainly based on a qualitative analysis, but this technique does not allow to record risks, issues, and actions taken to resolve them as well as lessons learned so that they can be used for development of new projects (Tah et al, 2001a; Hubbard, 2009).

It is known that over time and in different countries, the construction industry tends to use a limited number of risk management techniques, which are not appropriate for every situation. Among the techniques used to identify the risks are the brainstorming, checklist; sensitivity analysis and risk register (Goh et. al., 2013), also indicating that qualitative methods for risk assessment are much more used than quantitative or semi-quantitative methods.

The aforementioned deficiencies have an impact on the project development. In construction projects, risks can seriously affect its main objectives: time, cost, scope and quality, which can mean an additional cost and hence a low rate of return on the investment for the customer and a loss of profit for the contractor, in addition to other consequences. Despite this, risk communication is imprecise, incomplete, and inconsistent throughout the value chain of construction projects (Tah and Carr, 2001a; Aven, 2011). In addition, project participants have not a common understanding of project risks and their consequences, which precludes an implementation of effective and early warning measures and strategies to mitigate adequately the problems resulting from a decision-making in any part of the chain (Tah and Carr, 2001b).

Alongside this, in many occasions the identification of risks is done only during the preparation of the program and budget, but they are not monitored appropriately during project implementation (Nielsen, 2004). Other barriers that impact risk management are the lack of a common language (Aven, 2010; Xanbo et al, 2012; Goh et al, 2013), insufficient resources to carry out the risk management process and the lack of formalization of this process in construction projects (Tah and Carr, 2001b).

2.2. Maturity of risk management

During the past decade, interest grew on researching and applying maturity models to assess the process of risk management in different fields. These models help organizations to understand the abilities that the organization has on risk management and to contrast them with a reference framework. This framework is defined by best practices in terms of maturity (Hillson, 1997; Jia et al, 2011).

Maturity is assessed through models that measure the capability of the risk management process inside of an organization. In this paper, the focus of the evaluation is on construction companies. Several models have been proposed like the maturity model of Hillson (1997). This model presents a formal approach to the risk management, assessing maturity in four levels, where each of these levels confirms the fulfillment of previous levels and focuses mainly in evaluating attributes as: culture, process, experience and application of risk management. Another maturity model available is the Capability Maturity Model Integration CMMI (2009). This model was developed originally for the computer industry and raises the key features for maturity models and process capability additionally providing best practices associated generically and specifically with five levels of evaluation.

The Hillson's model served as a reference for the development of other maturity models proposed by different authors. One of these models, based on the Hillson's model, is that proposed by the International Council on Systems Engineering INCOSE (2002), which proposes the Risk Management Maturity Model, RMMM. The modification shown by this model is basically the extension of the initial definitions of the four maturity levels proposed by Hillson. This model manages to define elements of risk management within each of the attributes to evaluate, as well as their characteristics according to each of the four maturity levels proposed. Some adaptations have been proposed also by Heijden (2006) and Wolbers (2009) in an attempt to complement some weaknesses of the RMMM. These models have been applied in practice and comparisons carried out between applications and environments.

In another contribution, Yeo and Ren (2004) developed a maturity model of five levels, where a gradual advancement in the features to be met by the organization is proposed. The first three levels of maturity were developed to ensure that the organization has established a structured process for managing risks to enable risk control and appropriate procedures to address them. As to the next two levels of maturity (4 and 5), they were designed in order to make the process of risk management able to address emerging risks.

The Risk Management Maturity Model RM3 proposed by Zou et al., (2010) was developed based on the maturity models proposed by Hillson, and Ren and Yeo. This model seeks to assess the maturity of construction companies in attributes such as: risk management capability, risk management and the organizational culture, the ability to

identify risks, the ability to analyze risks and their development, and the standardized application of the risk management process. These attributes are evaluated in four levels of maturity. This model has a drawback in that it focuses on only one part of the process of risk management leaving aside important stages of the process such as risks response and risks control.

The application of maturity models for risk management still has deficiencies in the construction industry (Zhao et al., 2013). In the construction industry organizations, it is necessary to have a clear idea of their actual performance in risk management to define their objectives and a specific system for risk management according to their abilities (Zou et al., 2010).

Furthermore, Serpell and Howard (2012) developed a model based on the CMMI maturity model, where four specific levels for each of these attributes are evaluated, gaps are identified, and a diagnosis and monitoring is done to each of them. Also, proposals of best practices are presented although generically and without identifying skills or practices that should be developed to move from one level to the superior level.

Under all these proposals of maturity models, it can be said that the installation of a maturity model in an organization is a starting point to begin to make a good risk-management function within an established culture, a suitable system and the practice of risk management in both the organization and their projects. This will allow the company to start establishing best practices for continuous improvement in risk management.

3. Research methodology

The research has been carried out with financial support from a government agency. The research methodology has involved five stages so far, as follows:

1) A comprehensive literature review to understand how risk management is carried out internationally, both in general and at the construction industry in particular.
2) The construction of a preliminary risk management model from the literature review. The main factors and sub-factors that affect risk management, as reported in the literature, were grouped using an affinity analysis.
3) Validation of the risk management model through the participation of two experts' panels of four experts each. The process consisted in the presentation of the model constructed initially to the first panel of experts who provided their opinions and recommendation to improve the model. Once corrected the model by the research team, the resulting output was sent to the second panel of experts who approved the model or presented some additional comments and observations that were incorporated by the research team. Then the model was presented to the experts for a last review and approval. A risk management model of five main factors and 14 sub-factors was created as shown in figure 1.
4) Construction of the instrument for risk management maturity assessment. Organizational maturity models were used to define the maturity model to be applied in this research. Each of the main factors is to be evaluated using a scale of four levels with a description of the situation that represents the conditions associated with each level.
5) Validation of the instrument for assessing the maturity of risk management was carried out following the same approach explained for the risk management model.

4. Preliminary research outcomes

Besides the definition and validation of the risk management model as shown in figure 1 above, the research has advanced in the development of the instrument that will be used for the evaluation of the maturity of construction organizations, by assessing each of the sub-factors of each main factor. To accomplish this goal, a maturity model had to be developed mainly from the literature review. A comparison of the different proposals found in the literature is shown in table 1. The analysis of these proposals convinced the research team to use the Hillson model (Hillson, 1997) as the base framework for the maturity model to be applied in this case, but with an adaptation

regarding the evaluation levels. The number of levels selected for evaluation was decided to be four as follows (generic description):

- Level 1: the organization has a very low development of the sub-factor evaluated. If the sub-factor exists or is applied to some degree, this is done sporadically and only because a professional decides to do so out of his or her own interest, but it is not an institutional procedure.
- Level 2: The organization has a basic and incipient development of the sub-factor evaluated. If this is carried out or applied, it is generally in an informal manner and not only depends on personal choices, but a greater participation and institutional interest are appreciated.
- Level 3: The organization contains the sub-factor evaluated, but this development is still incomplete. The sub-factor is held or applied in a formal and institutional manner, but still in an infrequent way, with limited implementation in some projects.
- Level 4: The organization develops the sub-factor evaluated constantly worrying about its improvement. The sub-factor is applied in a formal, institutional, and regular way to all projects of the organization and its participants.

Figure 1 Risk management model

An example of the application of the maturity model to the sub-factor Diffusion is shown next to illustrate the specific use of this approach. The sub-factor Diffusion refers to the fact that the organization should spread the information about risk management to all the key participants of its project, raising awareness of its benefits.

- Level 1: In this organization, no information on risk management of any kind is disseminated.
- Level 2: In this organization, some information about risk management is disseminated to the participants of a project.
- Level 3: In this organization partial information about risk management is spread to all project participants.
- Level 4: In this organization, complete information about risk management is spread to all project participants.

The instrument (questionnaire) for the evaluation of risk management maturity in construction organizations is finished and validated. It has been applied to three construction companies as part of a pilot study that will allow the

calibration of the instrument. The application of the pilot is realized through Internet. This pilot has been designed not only to measure the level of maturity of the organization, but also to measure the clarity of the wording and the content of each situation.

Table 1 Comparison of some risk maturity models found in the literature

Maturity Model	Advantages	Disadvantages
Hillson, Risk Maturity Model (1997)	First approach to generate a framework for assessing the maturity of risk management.	Too general in the definitions of the levels and characteristics of the attributes measured.
Capability Maturity Model Integration, (CMMI 2009)	It has the support of many organizations that have used it and generated worldwide acceptance. It is a generic model adaptable to multiple contexts and organizations.	Does not provide any measuring procedure associated with the model.
International Council on Systems Engineering (INCOSE) Risk Management Maturity Model (RMMM 2002) and Shoults (2003)	It partially completes the Hillson's model.	It is still very general. It does not propose an instrument for evaluation.
Heijden (2006) Wolbers (2009), based on the RMMM	Complements the INCOSE model, adding the attribute "Structure" as the fifth attribute to be evaluated in the model.	Wolbers proposes a measuring tool based on a questionnaire. However the instrument is not well calibrated and does not reflect what is the situation of the organization accurately.
Yeo y Ren, Risk Management Capability Maturity Model (RMCMM 2004 and 2009)	This model proposes to evaluate attributes both at the organizational level as well as at the risk management process. It addresses the concepts of security and robustness that a maturity model should have.	No procedure is presented for the evaluation of the risk management maturity.
Crawford (2002)	It is based solely on the risk management process established by the PMI in the PMBOK, which allows having a more detailed analysis in the process.	Does not consider factors that are external to the process, which may be equally or more important, such as organizational culture, resource allocation, leadership, and other factors.
Zou, Chen & Chan, Risk Management Maturity Model RM3, (2010)	It is based on attributes for construction companies and is focused on evaluating attributes like the risk management capability, the organizational culture in relation to risks, the ability to identify and analyze risks and the ability of developing a standardized risk management process.	Its focus is only on one part of the risk management process and neglects important steps such as the risk response and control.
Howard and Serpell (2012)	Consider different characteristics for each attribute to evaluate it. They include the identification of existing gaps, and the diagnosis and monitoring of each of the attributes to be evaluated.	They only establish general practices without identifying what is needed to go from one level to the next one.

5. Summary of results obtained from the pilot study

The risk-management model and the associated maturity evaluation instrument were applied to three construction companies as part of a pilot stage. The characteristics of companies are shown in table 2. Companies under the

guidance of researchers selected the persons that answered the evaluation instrument, including at least, the General Manager, Departmental Managers, and professionals both at the central office and at the site.

Table 2 Characteristics of construction companies that participated in the pilot study

Company	Type	Main construction specialties	Number of participants in the study
A	Contractor	Housing buildings, Commercial and General building, Industrial construction	7
B	Contractor	Building, Infrastructure construction, Industrial construction	11
C	Contractor	Infrastructure construction, Mining construction, Energy construction projects	12

The global maturity levels obtained from the perceptions and answers of participants of each of the companies are shown in table 3.

Table 3 General maturity levels of companies on the scale 1 to 4

Company	Maturity Level
A	1.7
B	2.1
C	2.2
Average	2.0

Figure 2 displays the results of each of the companies for each main factor of the risk-management model and the average of the three companies.

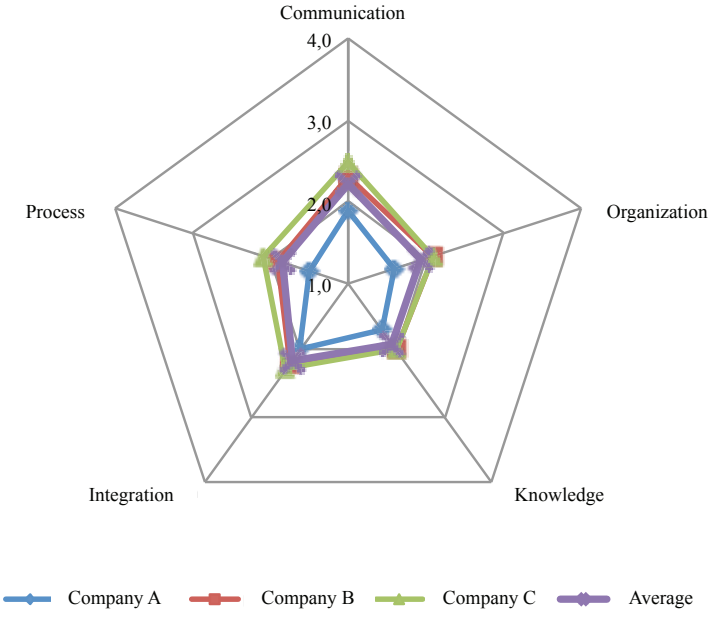

Figure 2 Maturity levels of companies for each factor

6. Discussion

Results obtained during the pilot study show that the maturity levels of the three construction companies are low and that there is an opportunity for significant improvements. The average is just 2.0 in a scale from 1 to 4. Using the characterization of each level, it means that: the organization has a basic and incipient development of risk-management. If this is carried out or applied, it is generally in an informal manner but not only depends on personal choices; an increasing participation and interest are appreciated from the organization.

As shown in figure 2, the most deficient factor according to the average of the three companies was Knowledge, followed by Organization and Process. The fact that Knowledge is so low, shows that people at work have a scarce knowledge about risk-management and that construction organizations do not collect and store the knowledge that is obtained from experience, i.e., they don't have appropriate knowledge-management in this area.

The pilot study also allowed the research team to test the evaluation instrument in a real domain. According to the comments received from the companies, the instrument was appropriated and the results agreed with the current conditions of risk-management in their companies. This information was confirmed by way of interview carried out after the application of the instrument and the report of results to companies. In addition, the Cronbach alpha test was applied to the evaluations showing good results.

7. Conclusions

Risk management in both construction business and construction projects should be part of the organizational culture. This would allow its development and implementation and to become a standard for planning and implementation of projects. Important part of this is to generate an effective management of knowledge to have a system, which can keep the lessons learned so that they can be spread and reused in future projects. Having the proper channels of communication between project parties for risk management is also imperative as well as training on this topic.

During the realization of this research it has been observed that the lack of knowledge about risk management within the domestic construction industry has became a barrier that has prevented the participation of some companies that have been not willing to contribute to the study. However, it is expected that this attitude will change once the findings of the research are spread out to the construction community. Also, companies will realize that the evaluation system will help them to identify the gaps in their risk management performance and make use of available best practices to improve. This information is intended then to support companies to be in constant assessment of their risk management maturity level and to implement those activities that would help them achieve the level of maturity they aspire to reach.

Much remains to be done in this area, which becomes increasingly more critical to the performance and success of construction projects especially where risks consequences are so relevant.

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