

Risk Management Framework for the Construction Industry According to the ISO 31000:2009 Standard

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Received 29 May 2012

Accepted 14 August 2012

Abstract

With stakeholders seeking for reducing the uncertainties in construction projects, the application of risk management has gained increased interest over the past decades, with a particular emphasis on the risk management process. However, very little attention has been given to the framework that supports the implementation of risk management processes within the construction sector. One of the most relevant particularities of the ISO 31000:2009 standard¹, on risk management - principles and guidelines, is the promotion of a risk management framework overseeing the implementation of risk management processes. The present paper proposes a risk management framework for the construction industry, taking into due consideration the specificities of construction-related companies and construction projects seeking to integrate risk management within their overall management system.

Keywords: construction sector, construction-related companies, construction projects, management framework, risk management.

1. Introduction

According to Carr², successful implementation of risk management in *organizations* involves, among other issues, the prevention of:

- a risk denial culture;
- a lack of organizational support;
- a deficient infrastructure supporting risk management.

Some *organizations*, when unprepared, tend to follow negative attitudes when facing risks. Those who normally point these risks out are often considered barriers and obstacles in the operation and development of the *organization*. This risk denial attitude inhibits a proactive approach and weakens management. On the contrary, the management of risk is based on the recognition that uncertainty exists in most every-day

decisions and on acknowledging that the effects of uncertainty on the *organizations'* objectives should be explicitly considered in their decision making processes and activities. This protects (from threats) and enhances (the opportunities) the *organizations* goals and objectives. This uncertainty can arise either from the natural randomness of phenomena and/or from the limitations of knowledge in understanding and representing reality, both of which affect the capability to predict the future.

The implementation of risk management requires an organizational support. Such implementation should not be grounded in political, marketing or other motivations of the kind. *Organizations* as a whole must be aware of the advantages and benefits of explicitly taking risks into account while performing their activities and also their decision making. This awareness will make it

possible to detect and understand threats and opportunities, allow risk-conscious decision making and accumulate experience along with knowledge regarding uncertainties that can affect *organizations*. Formal support from the *organization* top management is essential for a successful implementation of risk management, as it will enable the concepts and methods of risk management to be embedded at the various levels of the *organization*.

Complementarily, all aspects referred above should be effectively and efficiently framed, in order to prevent the development of independent and non-related risk management processes. Framing these aspects ensures that risk management processes articulate the specificities of the *organization*, and that such processes are continuously improving with company experience and project realization.

One of the most relevant differences between the ISO 31000:2009 standard¹ and the majority of the standards that reference risk management before its publication (with the exception of ONR 49000:2004³) is the consideration of a framework for risk management. This framework is to be embedded within the organization's overall strategic and operational policies and practices and includes a "set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing and continually improving risk management throughout the organization"¹. The foundations include a policy, objectives, mandate and commitment to manage risk. The organizational arrangements embrace plans, relationships, accountabilities, resources, processes and activities for managing risk¹.

This paper proposes a framework for the integration of risk management into the construction industry following the principles and guidelines of the ISO 31000:2009 standard¹. The proposed framework is generally applicable both at the company level and the project level. For convenience, the term *organization* is used to cover both levels, but distinctions between construction-related companies and construction projects are clearly identified.

2. A Framework for Managing Risk

2.1. General definition

A risk management framework links the management of risk with other management activities within the

organization. Therefore, such frameworks should be embedded in the overall strategy of the *organization*, as well as in its policies and practices. This is crucial for the success of risk management, as for the "effectiveness of the management framework providing the foundations and arrangements that will embed it throughout the organization at all levels"¹. In particular, the risk management framework should ensure¹:

- continual improvement;
- full accountability for risks;
- application of risk management in all decision making;
- clear and continual communications;
- full integration in the *organization* governance structure.

A framework for managing risk should emphasize continual improvement of management in general, and the management of risk in particular, by setting performance goals and by measuring, reviewing and adjusting processes, systems, resources, capabilities and competencies. This focus on continual improvement is the major distinction between purely bureaucratic management and effective management. To this end, the assessment of the risk management performance should be an integral part of the overall performance evaluation system of the *organization*, covering both departments and individuals. Selected performance parameters and indicators must represent the objectives of the organization and be compatible with the activities carried out at different levels.

Accountability for the risks, including the responsibility for their controls and treatment, must be set out in a comprehensive, fully defined and accepted way. To this end, the individuals with responsibilities should meet the required competencies and experience to identify, analyze and evaluate risk and detail risk treatment solutions. These individuals should have the resources needed to monitor risks, to check the controls, to implement treatment measures, and to report and communicate results of risk management. The *organization* should also delegate authority, grant the necessary time for risk management tasks and activities, as well as provide the required training for individuals to assume their responsibilities with success. All decision-making processes in the *organization*, regardless of the level of importance or relevance, must explicitly consider risks and the implementation of risk management. Records shall be maintained demonstrating risks have been discussed in key decision

making procedures, regardless if the discussion has been carried out in a free and non-structured fashion (e.g. in a meeting), or through the complete application of all steps of the risk management process referred in the ISO 31000:2009 standard¹.

Risk management should be a central element in the management of construction-related companies and construction projects. There are three perspectives to establish the structural relation between the *organizations* management and risk management, namely⁴:

- the traditional option considers risk management as a component of the *organization* management, with top management delegating the responsibility for it (Fig. 1 a);
- another option is to consider risk management to be incorporated within the *organization* top management, so that risk management is not reduced to an administrative task (Fig. 1 b);
- another option is to consider risk management throughout all aspects of the *organization* management, including the possibility of delegating risk management task to external entities (Fig. 1 c).

The first perspective, somehow, isolates risk management as a separated additional task. The second perspective is more applicable for sectors such as insurance. For the construction industry, it is the authors' believe that risk management should be integrated according to the last perspective.

Globally, the ultimate goals of risk management can be summarized as follows¹:

- provide the *organization* an updated, accurate and comprehensive knowledge regarding the risk in their activities;

- ensure that the (level of) risk of the *organization* is consistent with the limits defined.

Fig. 2 presents the ISO 31000:2009 standard¹ risk management framework, including its relation with the risk management process. This model is being adopted by most of the national bodies developing or revising standards for risk management (e.g., BS 31100:2011⁵).

It is worth noting that the risk management framework proposed in the ISO 31000:2009 standard¹ follows the Deming's cycle (*Plan-Do-Check-Act*: PDCA). The nomenclature may vary depending on the context and the scope in which PDCA cycle is applied (e.g., the six sigma model uses definition, measurement, analysis and improvement and control), but the meaning remains substantially identical.

The risk management process is the operational component in the management of risk that enables the transposition of company goals into day to day project realization. This component has already been extensively discussed for projects in general⁸⁻¹¹ and for projects in particular sectors, including construction projects¹²⁻¹⁶. Also, most standards dealing with risk management (e.g., CAN/CSA-Q850-97:1997⁶; JIS Q 2001:2001⁷; AS/NZS 4360:2004¹⁷) that were developed before the publication of the ISO 31000:2009 standard¹ were focused mainly on the risk management process. However, little attention has been given to the framework needed to support the implementation of the process regularly and consistently. Therefore, the present paper is mostly focused on the risk management framework.

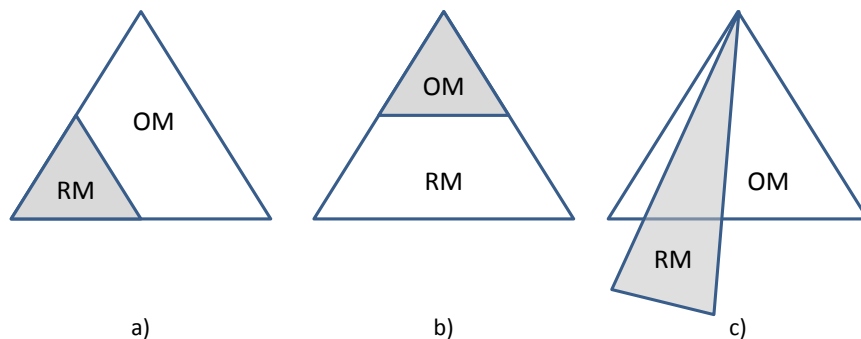


Fig. 1. Accommodation of Risk Management (RM) into the Organization Management (OM)

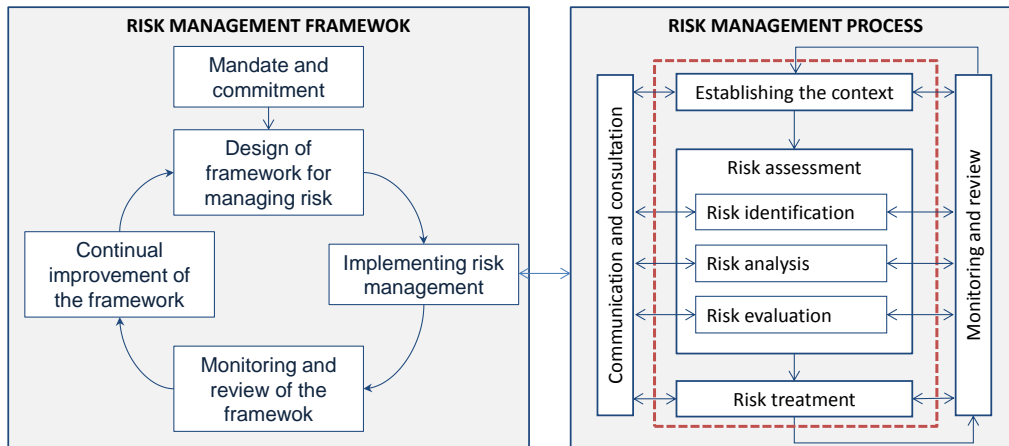


Fig. 2. Risk management framework¹

2.2. Mandate and commitment

In organizational terms, the mandate and commitment are the guidelines of the institutional strategy that the management is committed to implement, given the various interested parties. The mandate and the commitment reflect the legitimacy and the objectives of the *organization's* administration concerning the management of risk, while representing its stakeholders.

The management of the *organization* must initiate risk management and also ensure its efficiency. This requires a strong and sustained commitment, as well as a rigorous design of a strategic plan to obtain involvement at all organization levels. In this regard, the management should¹:

- define and endorse the risk management policy, ensuring that it is compatible and complementary to other *organization* policies (e.g., quality policy, environmental policy, health and safety policy, social responsibility policy);
- ensure alignment between *organization's* culture and risk management policy in order to facilitate implementation;
- define risk management performance indicators that are aligned with organizational performance indicators, making it easier to interpret results and allow benchmarking studies;
- align risk management objectives organizational objectives and strategies, ensuring compliancy with laws and regulations;
- assign accountabilities and responsibilities and empower individuals at appropriate levels of the *organization*, ensuring adequate competences;

- ensure that the necessary resources are allocated to risk management, providing the means for implementing the management of risks in operational terms;
- communicate the benefits of risk management to all stakeholders, capturing their support and acceptance for risk taking;
- ensure that the framework for managing risk continues to remain appropriate, adjusting to the changes in the surrounding environment and the *organization* dynamics.

2.3. Framework design

2.3.1. Understanding the organization and its context

Understanding the *organization* and its context includes the evaluation and understanding of "both the external and internal context of the organization¹". This contextualization is intended to define, with a certain degree of accuracy, the nature of the challenges faced by the *organization* and the objectives to be attained. It aims at identifying external and internal parameters that influence the pursuit of the *organization's* objectives and, therefore, must be taken into consideration while managing risks. The contextualization includes the definition of the external and internal context to which the *organization* is bounded and wherein risk management will be implemented (Fig. 3). Evaluating and understanding the external and internal contexts of the *organization* is the starting point for designing the risk management framework.

A correct contextualization ensures that the resources allocated to risk management processes are

directed towards core issues. The implementation of risk management in a company, a department or sector, or in a project, a portion of a project or a project activity, asks for different preponderance and relevance of the internal and external context parameters.

The definition of which internal or external parameters are relevant and what is their importance depends on the purpose and objectives set for the risk management. These parameters can be determined using the 6 W's model proposed by Chapman and Ward⁹. This model identifies 6 main questions, namely who (parties), why (motives), what (design), which way (activities), wherewithal (resources), and when (timing), to which the answers provide the basis for defining the internal and external contexts.

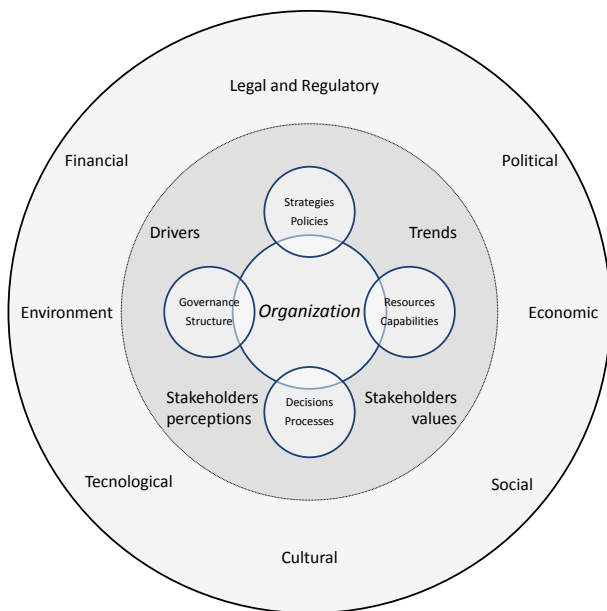


Fig. 3. Risk framework management contextualization^{1, 18, 19}.

2.3.2. Establishing risk management policy

The ISO 31000:2009 standard¹ defines risk management policy as a “statement of the overall intentions and direction of an *organization* related to risk management”. The risk management policy should set out the *organization's* attitude towards risk and its approach to risk management²⁰. Also, the objectives and the *organization's* commitment to risk management must be clearly specified, namely regarding¹:

- the *organization's* rationale for managing risk;

- links between the *organization's* objectives and policies and the risk management policy;
- accountabilities and responsibilities for managing risk;
- the way in which conflicting interests are dealt with;
- commitment to make the necessary resources available to assist those accountable and responsible for managing risk;
- the way in which risk management performance will be measured and reported;
- commitment to review and improve the risk management policy and framework periodically and in response to an event or change in circumstances.

Two of the points mentioned above are crucial for the risk management framework. One, the connection between the objectives and policies of the *organization* and the risk management policy in order to avoid incompatibilities and the repetition of tasks, since risk is a concern transversal to the *organization* activity. This connection will serve as a base model for the integration of risk management in the *organization*, and this will be detailed next. The other, the measurement and reporting of the risk management performance, must be adequately adjusted to the way that risk management processes are intended to be implemented, in order to standardize the monitoring and reviewing of *organization* management.

2.3.3. Integration into organizational processes

For its efficiency, effectiveness and, also, for the sake of simplicity, risk management should be integrated with management systems or practices that already are familiar to *organizations* within the construction industry.

Most construction-related companies have already adopted management processes addressing quality, environment, occupational safety and health, social responsibility, and others, along with the current practices of cost, time and scope management. Concerning the requirements laid down by standards or guidelines that *organizations* of the construction industry often use to develop environmental management systems (ISO 14001:2004 standard²¹) and Occupational Safety and Health (OHS) management systems (ILO-OSH 2001²² or OHSAS 18001:2007 standard²³), these already have risk management concepts explicitly embedded. Despite the fact that the

standard most commonly used by the *organizations* in the construction industry for implementing quality management systems (ISO 9001:2008 standard²⁴) does not make an explicit reference to risk management concepts, several of its requirements are indirectly related to risk management²⁵. Moreover, the international quality management standard that envisages the sustained success of organizations (ISO 9004:2009 standard²⁶) makes explicit use of harmonized risk terminology (ISO/IEC Guide 73:2009 standard²⁷) and it also explicitly states that "a quality management system is influenced by its organizational environment, changes in that environment, and the risks associated with that environment²⁵".

At a construction project level, it is worth mentioning that the ISO 10006:2003 standard²⁸ (an international quality management guideline applicable to projects) and the ISO/FDIS 21500 standard¹⁹ (an international project management guideline) incorporate a complete risk management process. The latter follows closely the Project Management Body of Knowledge (PMBOK) Guide model²⁹. In both cases, risk management is always depicted as a process transversal to all areas of interest in the project. For example, the ISO 10006 standard²⁸ establishes that "risk identification should consider not only risks in cost, time and product, but also risks in areas such as product quality, security, dependability, professional liability, information technology, safety, health and environment".

Hence, risk management is applicable to the activities of construction-related companies and constructions projects alike.

Fig. 4 depicts a general model for integrating risk management into the overall management framework (through the risk management framework) and the management processes (through the risk management process) of construction *organizations*. This model was conceived to be particularly suitable for the construction industry. However, its general conception is grounded in well established management standards, models and practices and this enables it to be adopted for other industries and economic sectors. It articulates top management, supporting management processes and procedures (including those pertaining to formally established management systems), functional areas or

departments in organizations and the inputs and outputs that are generated by the *organizations*.

Within this general model, the management framework is grounded in the PDCA methodology which is usually adopted by the top management of construction-related *organizations* (following quality management principles). The integration of different management processes can be operated through communication and consultation, on the one hand, and monitoring and review, on the other. One of the relevant features of the proposed general framework is that the risk management policy should not only influence the internal practices and processes of construction-related companies, but should also become part of the linked construction projects. In other words, the proposed general framework stresses the importance of risk management being embedded into construction project management plans and management manuals of construction-related companies.

The present paper is restricted to risk management and focuses in the risk management framework alone. Further details about integrated management system for the construction industry can be found in the works of Dias³⁰ and Almeida³¹.

2.3.4. *Accountability and resources*

At every level, from individuals (for personal or professional reasons) to the institutions (for social or commercial reasons), there are liabilities associated with the choices and decisions taken and/or the attitudes and actions adopted. Regarding risk management, "the *organization* should ensure that there is accountability, authority and appropriate competence for managing risk, including implementing and maintaining the risk management process and ensuring the adequacy, effectiveness and efficiency of any controls¹". This accountability for risk management has to be adequately supported by the necessary resources, both human and material, including time to perform the tasks and activities involved.

Following the guidelines which are laid down in the ISO 31000:2009 standard¹, the authors consider that it is particularly important for a construction-related company (see Fig. 5.a):

- to designate a risk administrator accountable for developing, applying, reviewing and updating the risk management manual as a result of implementing the risk management framework;
- to choose risk coordinators accountable for ensuring the uniformity of the operational context and the compatibility of the risk criteria throughout the company and its projects.

Also, for construction projects, the following key players concerning risk management should be identified (see Fig. 5.b):

- risk managers accountable for developing, applying, reviewing and updating the risk management plan as a result of implementing the risk management process;
- risk owners that have the accountability and authority to manage risks through the implementation of the risk treatment procedures/measures.

Regarding risk management, the link between the construction-related company and the construction

projects is established through the communication between risk managers and risk coordinators.

Managing risks in the construction industry is intimately related with the allocation of people with the appropriate skills, experience and competence, with the provision of the resources needed for each step of the risk management process, and also with the selection of methods and tools that are compatible with the specificities of this industry.

The degree of success in the development, implementation and maintenance of a risk management framework which is applicable to construction projects is directly related with the commitment and empowerment of the participating companies (e.g. designers and contractors), but above all with the commitment of the highest levels of the hierarchy of responsibility within every construction project, namely that of owners and their representatives.

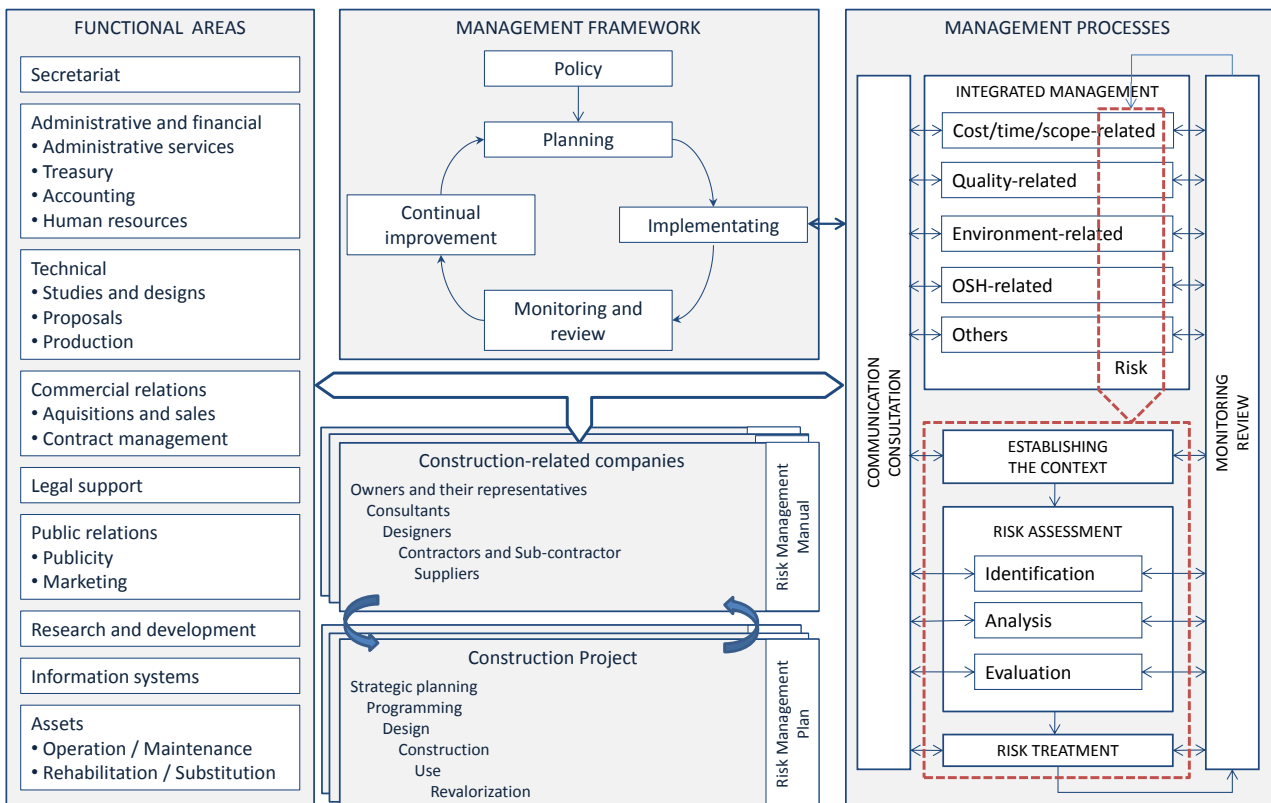


Fig. 4. Integration of risk management into construction organizations

Within construction projects, a risk manager with the adequate capability is paramount for the implementation of a successful risk management plan. Also, a risk owner is the person with the obligation to manage risks (or the state of its management) relating the area of the construction project over which it is accountable and exercises authority. Risk owners are allies of the risk manager in the sense that their expertise and knowledge support the application of the risk management process, especially regarding the risk assessment (risk identification, risk analysis and risk evaluation) and risk treatment stages, to all activities of the construction project, within or outside their particular area of influence.

Fig. 5 suggests a risk management organogram for a construction-related company (Fig. 5 a) and for a construction project (Fig. 5 b). In the former, there can coexist several risk coordinators depending on the company dimension and internal structure (e.g., different risk coordinator for different construction project types or different project locations). The risk coordinators integrate the risk commission. Regarding the later, the level 1 risk owners are usually those directing large processes of the construction project (e.g. financing, design, construction, etc.) and level 2 risk owners are usually hierarchically attached to level 1 risk owners. The risk team is formed by all level 1 risk owners.

Risk-related accountability may be allocated to different participants. Tables 1 and 2 provide examples of how this allocation may be accomplished for different risk management tasks, respectively, in a construction-related company and in a construction project. Namely, for a construction project, the authors suggest that:

- the *construction project manager* should be accountable for approving and verifying risk management activities and related documents;
- the *risk manager* should be accountable for the updates of the risk management plan and its associated documents, for validating the risk-related activities of risk owners, for supporting the risk management team and for reporting the risk and the state of its management;

- the *risk management team* should be accountable for supporting the construction project manager regarding risk-related activities, for assisting risk reporting activities and for issuing risk-related recommendations;

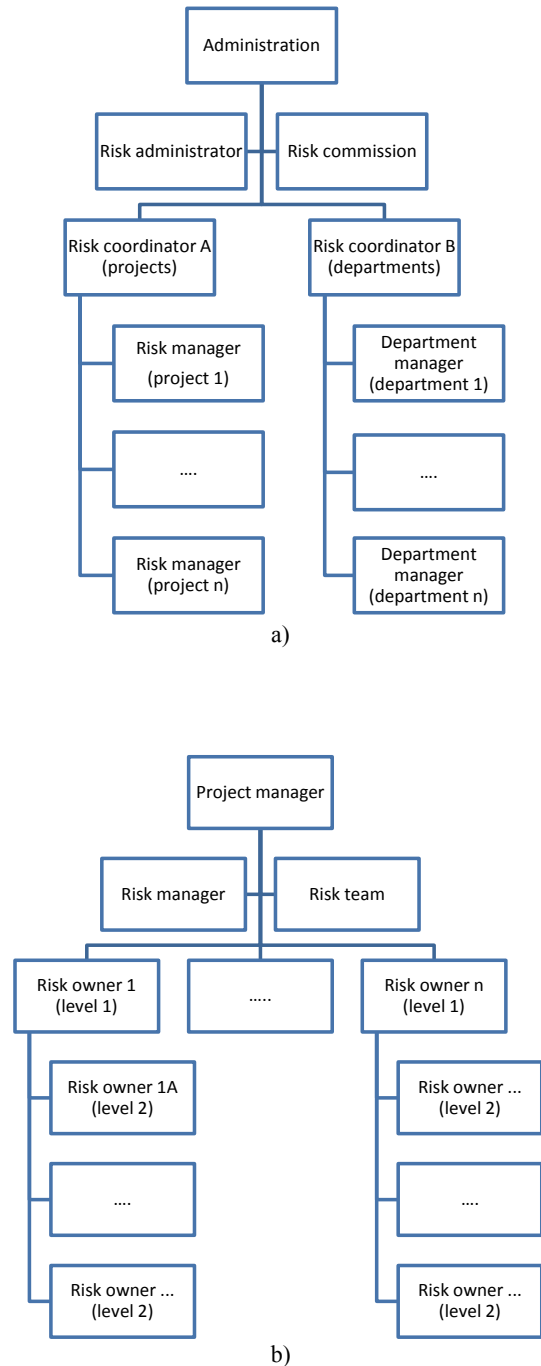


Fig. 5. Risk management organogram for a) a construction-related company and b) a construction project.

Table 1. Suggested allocation of risk-related accountability in construction-related companies.

Risk management components		Administration	Risk administrator	Risk coordinators
Risk management manual		A	E	P
	External context	A	E	P
Establishing the context	Internal context	A	E	P
	Operational context	A	V	E
	Risk criteria	A	V	E
Risk treatment strategies/protocols		A	E	P
Monitoring and review		A	E	P

A – Approval; V – Validation; E – Execution; P – Participation

Table 2. Suggested allocation of risk-related accountability in construction projects.

Risk management components		Project manager	Risk manager	Risk owners
Risk management plan		A	E	P
Risk identification	Detection	A	V	E
	Recognition and description	A	E	P
Risk analysis		A	V	E
Risk evaluation		A	E	P
Risk treatment procedures/measures		A	V	E
Monitoring and review		A	E	P

A – Approval; V – Validation; E – Execution; P – Participation

- the *risk owners* should be accountable for the execution of risk management activities and risk-related documentation (including for the activities and documentation generated by hierarchically dependent risk owners), for reporting threats and opportunities and for validating and implementing risk treatments activities.

2.3.5. Communication and consultation

In order to be effective, management generally requires a continuous flow of information to keep track of the dynamics affecting the *organizations*. According to the ISO 31000:2009 standard¹, the communication and consultation is a "continual and iterative processes that an *organization* [public, private or community enterprise, association, group or individual] conducts to provide, share or obtain information and to engage in dialogue with stakeholders regarding the management of risk". In the case of risk management, the communication and consultation of subjective aspects can be as relevant as that of objectives issues, in order to

correctly characterize the full spectrum of the positions, values and interests of the various stakeholders, both internal and external.

This is clearly a core issue for implementing risk management, for stakeholders in the construction industry range from authorities and official bodies, to owners and their representatives, banks and insurance companies, conformity assessment bodies, designers, contractors, subcontractors and suppliers, and, finally but definitely not the least, end-users¹⁶. Moreover, these are stakeholders that can strongly affect, be affected by, or perceive themselves to be affected by a risk management decision or activity.

In fact, risk perception is significantly influenced by risk information and by the manner by which it is conveyed³²⁻³⁶. As such, communication and consultation must ensure that relevant information is conveyed in a manner appropriate to its receptors, so as to avoid irrational reactions that may lead to losses or, which amounts to the same, to the impossibility of attaining expected benefits. For this reasons, Faber³⁷ highlights

the importance of communication, and refers to it as a special means of risk treatment. Cooper et al.¹⁰ also stress the importance of communication and consultation for the purposes of justifying the allocation of resource needed to implement risk management solutions or alternatives, ensuring that key stakeholders are satisfied with risk management and recording the performance of risk management.

Biocca³⁸ has concluded that communication is particularly relevant for managing environmental and health and safety risks. The same author considers that communication is both a technique, a right and a condition. Communication techniques must be adapted according to the scenarios in which they are used. Successful communication and consultation depends on the capability of effectively and clearly transmitting or grasping an idea. From the *organization* point of view, an effective communication strategy must take into account the characteristics of the interlocutors, the legitimacy of the content and trustworthiness of the communication process. However, communication is a bi-directional process in which the challenge lies more in the ability to formulate or grasp the message correctly than in the ability to convey it. All interested parties have the right to be informed and should be given the possibility to express opinions that may influence the decision making. Communication contributes to create a condition conducive to highly consensual decisions, and to ensure that all interested parties are duly informed about particular aspects and assumptions supporting the decision and know and understand the different points of view.

The mechanisms and protocols for communicating and consulting within construction-related companies must support and encourage the responsibility and duties in managing risk. Also, those should include tools and rules to obtain and consolidate the relevant information regarding risk management from different sources.

Communication and consultation within construction projects should take place during all stages of the implementation of a risk management process. It is convenient that a communication and consultation program is available at the earliest stages of the construction project. This program should cover all stages of the construction project (strategic planning, programming, design, construction, use and revalorization – see Fig. 2) and should undertake a

consultative team approach involving multiple stakeholders, which allows:

- to establish the context of risk management appropriately;
- the understanding and consideration of the interests of various stakeholders;
- taking into account different views when defining risk criteria and in evaluating risks;
- the identification of risks;
- the merging of different areas of expertise for risk analyzes;
- the execution, validation and approval of risk treatment plans;
- enhanced change management during the risk management process;

The communication and consultation program helps establishing more detailed and context specific communication and consultation plans. These plans should address issues relating to the risk itself, its causes, its consequences (if known), and the measures being taken to treat it¹. The goals of the communication and consultation plans may vary, depending on the stage and on the type of stakeholders that are covered by it. Communication and consultation should in all cases facilitate truthful, relevant, accurate and understandable exchanges of information, taking into account confidential and personal integrity aspects¹.

Construction projects gather stakeholders with varying perceptions and attitude towards risk. This schema of communication and consultation allows stakeholders' perceptions to be identified, recorded, and it is important for supporting future applications of the risk management processes¹⁰.

2.4. Implementation

The implementation of risk management in the construction industry can be envisaged at two complementary levels: i) construction-related companies' level, and ii) construction projects level.

Regarding the first level, it is the authors believe that the construction-related companies will have to adhere to risk management principles in order to cope with risk-related demands of interdependent markets such as those of property, finance and insurance – markets that seek some kind of demonstration that the risk of the activities and the deliverables of the construction industry is being properly managed. This adherence does not necessarily imply the development and implementation of a “risk management system”

within the construction-related company. Instead, construction-related companies should integrate risk management into their existing overall management system, by adapting components of the ISO 31000:2009 standard¹ to their specific needs. Construction-related companies should, therefore, implement risk management by¹:

- defining the appropriate timing and strategy for adapting risk management components;
- developing and applying a risk management policy and process to existing organizational processes;
- complying with legal and regulatory requirements;
- ensuring that decision making, including the development and setting of objectives, is aligned with the outcomes of risk management processes;
- holding information and training sessions;
- communicating and consulting with stakeholders to ensure that its risk management components remain appropriate.

Regarding the second level, a successful risk management is dependent of the degree of commitment of construction project owners and their representatives. This is because they are in a privileged position to enable risk management to be relevantly, effectively and efficiently embedded into the construction project from its early stages. Construction projects owners should, hence, ensure that a risk management plan is designed and implemented throughout the various phases of the construction projects they oversee, in order to establish the approach, the management components and the resources to be applied to manage risk.

The authors suggest that risk management plans should include all information needed to support the implementation of risk management at the construction project level. These plans should be customized according with the specific context and particular objectives of each construction project, and should detail the applicable rules for establishing the context of the risk management process and for other core risk management activities such as risk identification, risk assessment, risk treatment, communication and consultation and monitoring and review. Fig. 6 situates risk management plans within the hierarchy of risk documentation that is generated throughout the execution of a construction project.

The risk register summarizes the construction project risk information regarding risk assessment (risk identification, risk analysis and risk evaluation) and risk treatment. It provides a ranked list of risk and may

include prioritized actions or tasks that can then become the basis for risk treatment plans³⁹. The purpose of the risk treatment plans is to stipulate how the chosen treatment options will be implemented for each risk or set of risks¹.



Fig. 6. Risk management documentation.

Risk reports facilitate the exchanges of information between stakeholders about the risk of the construction project and the state of its management. These reports should take into account confidential and integrity aspects. These report may describe¹:

- the objectives and the scope of the risk management process;
- a description of relevant parts of the construction project;
- a summary of the external and internal context of the construction project;
- risk criteria and their justification, limitations, assumptions and justification of hypotheses;
- risk assessment methodologies;
- risk identification results;
- data, assumptions and their sources and validation;
- risk analysis results and their evaluation;
- sensitivity and uncertainty analysis;
- critical assumptions and other factors which need to be monitored;
- discussion of results;
- conclusions and recommendations;
- references.

2.5. Monitoring and review

Alike other elements of overall management, risk management culminates with concrete proposals for amendment of policies, strategies, processes, projects, operations or activities. However, there are no guarantees that these proposals will be correctly implemented, that they remain adequate or that they

contribute to the achievement of the organization objectives. Hence, it is crucial to undertake monitoring and review activities. The ISO 31000:2009 standard¹ defines monitoring as "continual checking, supervising, critically observing or determining the status in order to identify change from the performance level required or expected and review as the activity undertaken to determine the suitability, adequacy and effectiveness of the subject matter to achieve established objectives".

Monitoring and review can be applied at different levels (e.g. construction-related company level, construction project level) and may envisage different object (e.g., framework - risk management manual, process - risk management plan).

At the construction-related company level, monitoring should cover the status of risk and its management and check if the level of performance complies or deviates from what is established in the risk management manual. On the other hand, review should determine the appropriateness, adequacy and effectiveness of the risk management manual to achieve the objectives laid down in the risk management policy. Review should also promote the necessary changes, if necessary, towards continual improvement.

At the construction project level, monitoring and review should be covered within the risk management plan and be a planned part of the risk management process. The risk manager should be accountable for both activities. The risk manager should collect and register the information generated by the risk owners, and report in an adequate manner to the project manager and to the risk team, which on their turn should provide feedback to the risk manager. Reporting should cover issues such as the effectiveness and efficiency of existing controls, lessons from successes and failures, the need for changes in risk criteria or other aspects of the context, the need to revise risk treatments and priorities and new emerging risk. Measurement of the adequacy of the risk management plan regarding the overall performance of the construction project should be encouraged (e.g. using proactive and reactive risk management key-performance indicators) and these results should also be used as an input for continual improvement of risk management activities.

Monitoring and review is crucial to overcome two major difficulties⁴⁰:

- risk management is, by its nature, orientated to the future (if a risk does not occur, it can be difficult, if

not impossible, to show that was the result of the management's actions);

- risk management, like many other forms of management, involves delegation of many management functions to the *organizations* being managed (if the *organizations* use different models or codes to appreciate risks, the interpretation and comparison of results may become impractical).

The former, since it is natural to risk management, is extremely difficult to eliminate or mitigate, and it might only be possible to draw indirect observations in the long range through trend analysis or similar approaches that must be incorporated in monitoring and review procedures.

The later can be significantly mitigated through the implementation of an efficient and effective monitoring and review procedure at a construction-related company level. These procedures must be extended to the construction project level. This has to be promoted by the owner and their representatives during project's inception.

2.6. Continual improvement

The suggested framework includes monitoring and reviewing activities that, alongside with communication and consultation, provide a solid ground for enhancing a risk management culture within the construction industry. The authors suggest that risk managers should be alert to identify and report opportunities for continual improvement of risk management components in order to mature its applicability to the construction industry, both at the construction-related company level and at the construction project level.

3. Final Remarks

The risk management process is a core operational component of risk management, which has already been extensively discussed for projects in general and for construction projects in particular. In fact, there were already many standards on the risk management process before the publication of the ISO 31000:2009 standard¹. However, very little attention has yet been given to the framework needed to support the implementation of risk management processes within the construction industry.

According to Hillson⁴¹, organizations can be ranked into four increasing levels of risk maturity: i) naive; ii) novice; iii) normalized; and iv) natural. The

implementation of a fully operational risk management framework is part of the requirements towards a natural risk *organization*, with a risk-aware culture and a proactive approach to the management of risk in all aspects of its activities. The present paper envisages promoting higher risk maturity levels for the construction industry by proposing a risk management framework applicable to the specificities of construction-related companies and projects. The framework proposal is grounded in the ISO 31000:2009 standard¹ internationally accepted principles and guidelines.

Unlike most sectors, the construction projects involve companies with different core businesses and motivations (e.g., property investors, engineering companies) interacting with varying degrees of involvement throughout successive stages (e.g., design; build; operate). However, it is the authors' belief that, from a project stand point, the successful implementation of risk management should be started and guided by the owner and their representatives, in order to capture the full spectrum of interested parties involved and focus the product performance on the end user demands. Following this, the designers, the contractors and others, should then implement the risk management based on the owner's guidelines, in order to ensure that the objectives of the end users are met.

Acknowledgements

The authors gratefully acknowledge the support ICIST Research Institute, from IST. Vitor Sousa and Nuno Almeida were financially supported by FCT, the Portuguese National Science Foundation, through their PhD grants SFRH/BD/35925/2007 and SFRH/BD/39923/2007, respectively. Vitor Sousa thanks the Fulbright Commission for the award of a Fulbright/FLAD grant supporting his research at UC Davis. Nuno Almeida acknowledges the Calouste Gulbenkian Foundation grant supporting his research at Ryerson University and at Florida International University.

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