Project Risk Management Methodology: A Case Study of an Electric Energy Organization

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A Project Risk Management Methodology Developed for an Electrical Portuguese Organization

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ABSTRACT

This paper resulted from an action-research undertaken on a Portuguese electric energy organization – EDP Distribution. The research aimed to develop, propose and implement a risk management methodology to integrate in the project management (PM) practices of an ongoing project. The methodology implemented allowed the project team to initiate systematized risk management practices through a simple structure, easy to apply, and with a degree of complexity compatible with the effort that the PM team could initially engage. It is expected that the proposed methodology signaled the initiation of the project risk management (PRM) process standardization in the EDP Distribution organization.

KEYWORDS

Action-Research, Organizational Risk Management, PMBoK®, Project Risk Management, Risk Management

INTRODUCTION

Project risk management (PRM) has the purpose to identify and prioritize risks that are likely to occur, providing guidance information for the risks response, and monitor and control the project risks, by increasing the probability and impact of occurrence of positive events (opportunities) and decreasing the probability and impact of occurrence of negative events (threats) of the project (Borge, 2002; PMI, 2013). It assures that most of the problems are discovered early enough so the recovery of their occurrence does not affect the project schedule or budgeting (Tamak & Bindal, 2013), improving the project control and lighten the decision-making process (Alhawari, Karadsheh, Talet, & Mansour, 2012; Leung, Rao Tummala, & Chuah, 1998; Marcelino-Sádaba, Pérez-Ezcurdia, Echeverría Lazcano, & Villanueva, 2013).

Over time some studies were published to determine the state of PRM in organizations. A study from Leung, Rao Tumala and Chuah (1998) reveals that risk management approaches are not widely accepted in PM, having as majors limitations: 1) time involvement required to use risk management approaches (due to the process of identification and assessing risks); 2) difficulty in obtaining input estimates and assessment of risk probabilities; 3) human/organizational resistance to change; 4) difficulty in understanding and interpreting outcomes of risk management processes; and 5) finding

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available risk management methods. Although these limitations detection was the result of a study undertaken sixteen years ago, it is perceived by the researchers experience that they are still valid.

Leung et al. (1998), using a survey from three industries, also concluded that formal risk management approaches can provide useful insights for project management and provide information that may improve the quality of investment decisions.

Elkington and Smallman (2000) conducted a study in a British utilities company to assess their project risk profiles. Based on the effects of risk, the authors developed a framework that might explain project success by 1) assessing the different kinds of project's risks to measure the amount of risk management undertaken by a project manager, creating questionnaire's sections to business risks, procurement risks, management risks and technical risks; 2) assessing how and when the project manager applied risk management processes during the project; and 3) determining the project managers' knowledge of risk management and their attitude towards it. In Elkington and Smallman (2000) study, a total of 10 of 20 questionnaires were responded completely by the invited project managers. They identified that the most successful projects undertook more risk management practices than the others. They also perceived that the earlier risk management is initiated, the more successful a project is. Therefore, they concluded that PRM is essential for the project's success.

Raz and Michael (2000), also through a survey, identified the tools and techniques most used by project managers, during the PRM process. Elkington and Smallman (2000) realized that the tools of the risk control group are perceived by project managers as low contributors for project success. These findings may be explained as a consequence of the management culture: project managers might be willing to invest time and effort in the earlier phases of risk management, which are carried out along with other project planning activities, and with the evolution of the project they become busier and are subject to resource constraints and time pressures, consequently neglecting the risk control phase, using the tools sporadically or not at all.

Ibbs and Kwak (2000), during a research conducted to assess PM maturity, found that the risk management was the area of PM with the lowest maturity qualification, with 2.95 from a 1 to 5 scale. This result shows that most organizations neglect this PM area, by applying little effort on risk management approaches. Elkington and Smallman (2000) also concluded, through interviews, that conducting risk management reactively is far less effective than conducting it proactively, and is much more effective to conduct a risk management assessment and develop contingency actions before the project start.

More recently, a worldwide study conducted by Fernandes, Ward and Araújo (2014) to ascertain the most useful PM practices, of a group of 68 tools and techniques, found that the project areas of knowledge of risk, scope, time and communication and integration assumed a high relevance among the most useful PM practices. Each one of these knowledge areas has at least three PM practices on the top 20 of the list of 68 assessed. For instance, under the risk management practices were identified: 'risk identification', 'risk response plan' and 'qualitative risk analysis'. With these results we can comprehend an evolution, on the point of view of the organizations, of the risk management approaches embedded on PM. However, a study about the PM maturity in Portuguese organizations presented by Silva, Tereso, Fernandes and Pinto (2014) shown that the six (6) risk management processes (risk identification, risk management planning, risk qualitative evaluation, risk quantitative evaluation, risk response plan and risk monitoring and control) obtained very low results, between 3 and 12 percent from a 0 to 100 scale, having the five worst results of all the PM processes evaluated. These results, regarding the maturity of the PRM processes, revealed the Portuguese organizations tendency to neglect PRM, in contrast to the results of the study of Fernandes, Ward and Araújo (2014).

This paper aimed to present the proposed PRM methodology that was developed and implemented to a pilot project of an electrical Portuguese organization – EDP Distribution, with no systematic PRM practices, during an action-research study. The preliminary results of this research study can be found on Peixoto, Tereso, Fernandes and Almeida (2014). EDP Distribution, the biggest electric energy organization responsible for the electricity distribution in Portugal, perceived the value of

PRM, and settled as a goal to define and implement a PRM methodology in a pilot project of the organization. The main objective of the distribution automation pilot project is to assess the risk management methodology developed and extend the methodology to all similar projects in the organization. However, this implies organization change, causing a series of events and reactions, such as organizational restructuring, modified work and decision processes, transition in work dynamics, and resistance from affected individuals (Lundy & Morin, 2013). Individual resistance is caused by: staff not prepared to change, or not understanding the need to change; everyone being already busy and; improvements in risk management practices requiring allocating even more time and energy into work (Loo, 2002).

The action research study undertaken had established the following specific objectives:

- Design a risk management methodology adapted to the project characteristics, which includes the risk management planning, identify risks, risk qualitative and quantitative assessment, plan the risk responses, and establish the risk monitoring and control processes.
- Provide all the necessary templates for the risk management processes.
- Develop the project risk register.
- Adapt the risk management methodology to future similar projects.

EDP Distribution has defined scope and quality as the most important project objectives, since the variation of the budget is not acceptable, and the schedule is not a major concern of the project. Therefore, the main concern about the project's risks is that they impact the project's scope and quality. The quality is connected to the smart grid infrastructure or functionalities, and if something happens in this particular area, the project success becomes more difficult to achieve. This pilot project implies a large use of new technical components, namely related to the automation equipment and the software platforms needed to manage and control the smart grid functionalities. Therefore, it is needed to assure that every task and implementation of the pilot project occurs with the expected quality to ensure the correct and successful functioning of the smart grid.

This paper has the following structure. After this introduction (first section), the second section presents the literature review on project risk management. The third section specifies the context of the Distribution Automation pilot project at Batalha. The fourth section describes the research methodology applied on this study. The fifth section briefly presents the new risk management approach conceptualization. Finally, the main results that emerged from this study as well as the conclusions and suggestions for future work are discussed in the sixth and seven sections respectively.

Literature Review

A definition for the term 'risk' is given by the PMBoK® (PMI, 2013): 'Risk is an uncertain event or condition that, if it occurs, has an effect on at least one project objective'. Thus there are differences between the term risk and uncertainty, being risk an event or condition with known probability and uncertainty one with unknown probability (Kolisch, 2010).

Knight (1921), Winch and Maytorena (2011) and Sanderson (2012) categorized risk and uncertainty in two subjective groups. Risk falls into two distinct categories, a priori probability (known knowns) and statistical probability (known unknowns), assuming that the future will be somewhat like the past (Sanderson, 2012). And uncertainty falls into the categories: subjective probability (unknown knowns) and socialized uncertainty (unknown unknowns), as shown in Table 1.

The risk and uncertainty categorization is related to the knowable data available to the decision maker about risk management. This knowledge limits the confidence degree embedded in every decision taken, as illustrated in Figure 1.

After understanding the differences between risk and uncertainty, the authors assumed the definition of 'risk' as considering not only the risks but also the uncertainties, such as the definition

Table 1. Assumptions about the categorizations of risk and uncertainty on the decision-making views on the nature of the future from (*Sanderson, 2012*)

Category		Description
Risk	*A priori* probability	The decision-maker is able to assign objective probabilities to a known range of future events through the 'known chances' of mathematic. For instance, the probability of throwing a six with a perfect die is 1 in 6.
	Statistical probability	The decision-maker is able to assign objective probabilities to a known range of future events on the basis of empirical/statistical data about such events in the past. For instance, the probability of having a fire in the building.
Uncertainty	Subjective probability	The decision maker faces a known range of possible future events with few data to assign objective probabilities to each possible event. Instead he uses the expectations grounded in historical practice to estimate subjective probability of future events, akin to scenario planning.
	Socialized uncertainty	The decision maker faces a situation where the nature and range of future events is unknown. The future is inherently unknowable because it is socially constructed and may bear little or no relation to the past or the present, resulting in decision-making that will change the future.

suggested by Project Management Institute (PMI), since there is an intrinsic relationship of the terms in PRM.

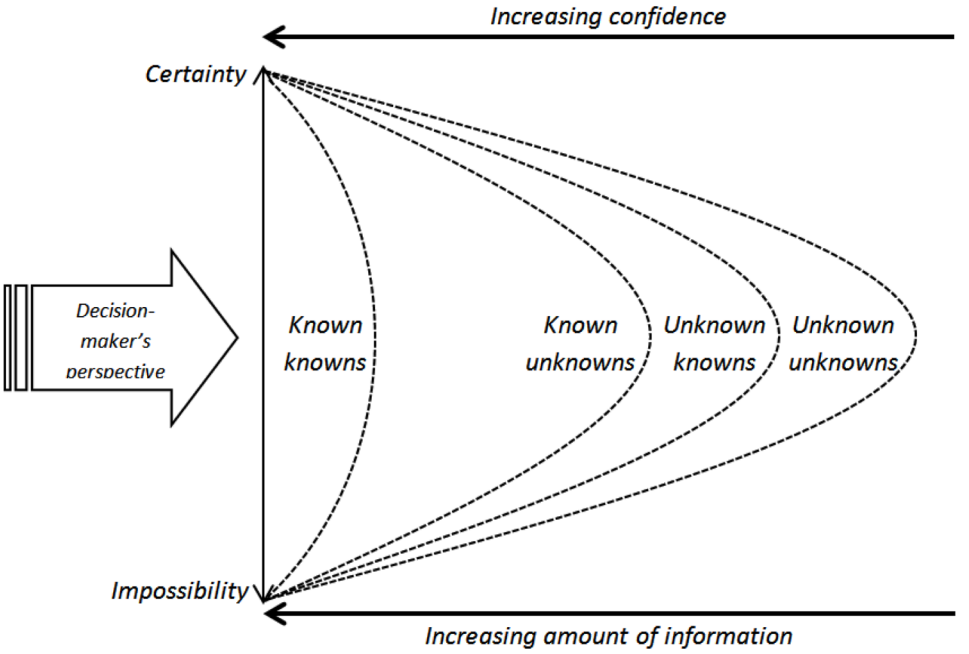
Thamhain (2013) considers that dealing with a broad spectrum of risk factors requires from project managers the capability of understanding the sources of uncertainty before attempt to manage them. This comprehends a wide-range approach with sophisticated leadership, integrating resources and shared vision of risk management throughout the organizational borders, time and space.

An effective project and organizational knowledge management contributes to reducing uncertainty in decision making (Alhawari et al., 2012), therefore it should be given greater attention to PRM (Ward & Chapman, 2003). Many projects failed due to lack of knowledge among the project team or lack of knowledge sharing during the project progress (Alhawari et al., 2012), providing a source of uncertainty to the project (Ward & Chapman, 2003). However it is necessary to understand that there is no perfect knowledge about the future state of an environment, and errors will always occur, even with the attempts of correction (Kutsch & Hall, 2010), in the form of residual risk of minor impact.

Project managers can employ experiences gained through their past projects to the present ones in the form of a standard of successful processes and procedures, not only in the general PM but also at different project stages, achieving the core element in PRM success (Perminova, Gustafsson, & Wikström, 2008). This practice at accumulating knowledge aids the management of uncertainty by providing basis for reflective processes that will help reduce uncertainty by transferring it into known risks and opportunities (Perminova et al., 2008).

Greiman (2013), during the management of the Big Dig project, learned that successful management of projects requires a well-strategized risk management approach through the establishment of clear project-developed risk plans and principles. The risk management framework, to enable robust and proactive oversight, must comprise (Greiman, 2013): 1) a mission that is based on mutual cooperation and shared values; 2) a formal risk management organization that involves the creation of multiple interdependent teams with shared principles; and 3) a defined strategy that focuses on continuous improvement, shared lessons learned, and the implementation of best practices.

Figure 1. Decision-maker's perspective (*Winch & Maytorena, 2011*)



Distribution Automation Pilot Project at Batalha

This study was undertaken in the EDP Distribution, a Portuguese electric energy organization, with the goal to implement a risk management methodology to an automation pilot project. The pilot project has the main objective to implement a smart grid system on the electric grid of a restricted area named Batalha. The smart grid system represents the next step to the energy sector. It is an information technology (IT) solution for electric energy efficiency. The smart grids solution accomplishes efficiency goals as allowing to reduce carbon dioxide emissions, allowing providers to charge variable rates according to supply and demand, and it is a self-healing grid (Amin, 2013; Colomo-Palacios, 2015).

This project represents a huge technological innovation for the local electric grid. Given the technological aspects and the expected quality, this project deals with great uncertainties and there is no historical data helping to know what could be expected with the project evolution and in particularly with the related risks.

This project has also some other particularities:

- It is a partnership between EDP Distribution and its main suppliers: the suppliers give the technological equipment and software, and the organization gives the means to execute the project.
- The PM is done by two project managers, one that manages all EDP Distribution activities, and another that manages all the project main suppliers' activities.
- Neither EDP Distribution nor the suppliers involved use standard or systematic risk management approaches.
- The implementation of the PRM methodology, which was initiated with the action research project described in this paper, was started after the pilot project's implementation phase took place.

Consequently, to develop the risk management methodology adapted to this particular pilot project, the researchers needed firstly to understand the project and the organization's PM practices, in order to achieve an effective risk management methodology.

Research Methodology

This paper results of an action-research methodology that was applied in EDP Distribution. The action-research approach has two parts, the research and the action, in order to set the practices improvement upon the learning by individuals and work groups. The research allows the researcher and other individuals involved acquiring better understanding of the problem and solution methods, and the action allows changing the organization or community, in order to solve the problem on hand.

This research methodology is concerned with the resolution of organizational issues by involving those who experience the issues directly and the researcher (Saunders, Lewis, & Thornhill, 2009), to facilitate the improvement of a practice through the direct application of research findings in a practical context (Mackenzie, Tan, Hoverman, & Baldwin, 2012).

This research strategy was chosen because the action-research approach allows the mutual interaction between researchers and the organization's collaborators in the development of actionable knowledge (Doherty & Dickmann, 2012) through the transfer and sharing of knowledge and social technologies (Baldissera, 2001). In this case, a mutual interaction between the researcher and the project team took place, in order to define of a suitable PRM, applicable to the reality of the pilot project under consideration.

The study followed the common action research cycle: diagnosing, planning, taking action and evaluating (Baldissera, 2001). During each action research cycle, the following specific methods were used: 1) Observation: monitoring regular management and technical meetings and assessing the quality of the documentation produced by the methodology implemented, and 2) Focus Group: getting deeper insights, in order to enrich the data that was previously collected through observation and to contribute for their qualitative validation.

Project Risk Management Methodology

The theoretical foundation for this proposed risk management methodology was the PMBoK® (PMI, 2013) and the Practice Standard for Project Risk Management (PMI, 2009b) both from Project Management Institute (PMI), and follows the six risk management processes defined by PMBoK® (PMI, 2013): 1) plan risk management; 2) identify risks; 3) perform qualitative risk analysis; 4) perform quantitative risk analysis; 5) plan risk responses; and 6) control risks.

PM BoKs and standards were developed to provide projects knowledge and practices for management of individual and enterprise projects, and mature, assess and certificate professionals (Morris & Pinto, 2010). They offer an attempt to map out the knowledge elements of the PM competences, which influence industry views on competence, best practice, training and development (Morris, Crawford, Hodgson, Shepherd, & Thomas, 2006).

The PMBoK® is a body of knowledge (BoK) that is widely applied by PM professionals and practitioners around the world (Mesquida & Mas, 2014). The Practice Standard for Project Risk Management provides a benchmark of PRM aspects that are recognized as good practice on most projects most of the time, taking into account a variety of projects and organizations that require different approaches and the several specific ways of conducting risk management (PMI, 2009a).

Organizations have several benefits using an internationally-recognized BoK/standard to guide them in the development of the organization's PM and in this case a risk management methodology. These include: 1) the assurance that the organization is using what is considered to be 'best practice'; 2) demand from external customers that a recognized methodology is used; 3) assistance with external recruitment and the availability of suppliers of the methodology for training and support (McHugh & Hogan, 2011); and 4) removes to some extent the barriers to design/development of PM or risk

management methodologies as BoKs are recognized as 'best practices' (Haji-Kazemi & Bakhshehsi, 2009).

This proposed risk management methodology has a structure very similar with the PRM structure proposed by the PMBoK® (PMI, 2013), although there are some differences on the expected inputs, outputs and tools and techniques as will be explained.

Risk Management Plan

The PRM plan has the function to provide guidance to the project team and manager throughout the PRM. A document is defined, the Risk Management Plan, which gathers all the useful and relevant information for the project team to manage the project risks, namely, the PRM objectives and tolerances, the established tools, techniques and procedures to identify, evaluate, plan responses and monitor and control risks, and the defined templates to use.

This document establishes the use of other documents like a risk register, a report of lessons learned and best enforced practices, a risk breakdown structure (RBS), a documentation of risk response plans and a risk audit report. This document enables a good documentation of all identified project risks and the creation of a risk management history in the organization. Figure 2 presents the relation between all the documents that this proposed methodology requires.

The risk register collects all the information about the identified risks during the project's risk management. It must accompany all risk management processes by collecting and updating data of all identified project risks (PMI, 2009b).

The RBS is the hierarchical structuring of potential risk sources (Hillson, 2002; PMI, 2013), providing a source-oriented grouping of risks that organises and defines the total risk exposure of the project or business (Hillson, 2002). This framework aids the risk identification (Vargas, 2009) by using the RBS as a checklist to assure the coverage of all risk potential sources and also allows the categorization and prioritization of project risks by their sources (Hillson, 2002; Menezes, 2007).

The risk response plan is a document that collects all the information necessary to understand the risk triggers, the effects on the project if it occurs, the possible risk response plans to perform, and the secondary or residual risks that can result from the risk occurrence and/or the risk response plan. Every individual risk must have one record of risk response plan.

The risk audit is the document that gathers all the information about the individual risk occurrence and control, and about the risk management methodology. For instance, if during the risk monitoring and control some deficiency is found on the methodology proposed, it can be improved. Every individual risk with a risk response plan activated or in occurrence must have one risk audit record.

The lessons learned and best reinforced practices report allows the creation of a record of mistakes that were fixed in PM and should not be repeated, and good practices that should subsist for project success. This report should be updated every time a mistake in PM or PRM is found, and it should

Figure 2. Scheme of all the project risk management documentation

not be repeated. If some practice reveals to be useful, it should also be recorded to be repeated and passed through as a good experience.

All the PRM documentation is available along with all the other project documentation at an online organizational PM platform which allows easy access and update and whose availability is restricted to the project team assigned to the project.

Table 2 summarizes the inputs, tools and techniques and outputs established to the PRM plan.

Risk Identification and Qualitative Evaluation

Risk identification comprises the identification of the risks that may affect the project objectives and the documentation of their characteristics with the maximum extent practicable, recognizing the possibility of emergence of new risks as a result of decisions and actions taken and imposed externally to the project (PMI, 2009b), as well as, the evolution of the project horizon (Mojtahedi, Mousavi, & Makui, 2010; PMI, 2009b) through an iterative process during the project life cycle (Mojtahedi et al., 2010). An effective risk management relies on the identification of risks in the early phases, before the project concept has been finalized (Greiman, 2013).

Qualitative risk evaluation helps to prioritize identified risks (Greiman, 2013; PMI, 2009b) by estimating their probability and impact, and exposing the most significant risks (Mojtahedi et al., 2010). This prioritization can provide further action such as quantitative risk analysis or risk response plans (Mojtahedi et al., 2010).

Carrying out both processes simultaneously provides a better understanding of the risks that are being identified. Table 3 summarizes the inputs, tools and techniques and outputs established to the risk identification and qualitative evaluation on the proposed risk management methodology.

The documental reviewing allows the understanding of the project reality, studying all the stakeholders involved, PM practices enforced and identifying the project's strengths and weaknesses. If there was a risk management history it would be possible to compare situations between past similar projects and current ones to acquire knowledge of the potential project risks behaviour.

Table 2. Summary of inputs, tools and techniques and outputs on risk management plan phase

Inputs	Tools and techniques	Outputs
Project documents (meeting records, project charter, WBS, contracts…)	Meeting with project manager	Risk register template
		RBS template
		Report of lessons learned and best enforced practices template
Project manager knowledge and experience	Definition of templates	Risk response plan template
		Risk audit template
		Project risk management plan

Table 3. Summary of inputs, tools and techniques and outputs on risk identification and risk qualitative evaluation phase

Inputs	Tools and techniques	Outputs
Project documents (meeting records, project charter, WBS, contracts…)	Documental reviewing	Risk register
	Brainstorming meetings	
	Recording the meetings	
Project manager knowledge and experience	Checklist	Risk breakdown structure (RBS)
	Risk breakdown structure (RBS)	
	Probability Impact Matrix	

Brainstorming meetings allows a free participation of all elements without criticisms or judgements, but for being successful the process of collecting ideas must be kept organized. These meetings require preparation both for the moderator as for the participants, using for instance an agenda. This agenda should explain the meeting's subjects and purpose, and be presented to the meeting's participants beforehand so they can prepare themselves and come up with ideas to share and doubts to clarify.

The use of the RBS as a checklist allows the coverage of all risk sources during the risk identification, which facilitates the process of identification. The RBS also provides a classification of the identified risks by their sources, which allows the project team to provide more attention to some risk sources that are more usual in the project than others.

The probability impact matrix (PxI matrix) matches the risk occurrence probability and risk impact at project objectives allowing the classification of the risk as of low, moderate and high importance for the project (PMI, 2013). The risk probability of occurrence is assessed through a subjective ordinal scale. And the risk impact is estimated through a relative value of impact. Table 4 shows the adopted PxI matrix for the project and constrains to evaluate the importance of the risk to the project.

All information gathered during the identification and qualitative evaluation of the project risks is collected into the risk register. The RBS collects the distribution of the risks on the project risk sources and the work breakdown structure (WBS) codes that identify the risk activities on the project. This risk distribution enables the project team to recognize easily the risk sources that can represent more danger to the project.

Risk Quantitative Evaluation

The risk quantitative evaluation assesses numerically the effect of identified risks on global project objectives (PMI, 2009b). It evaluates risks and their interactions to assess the range of possible project outcomes (Greiman, 2013). This quantitative evaluation takes focus on the highest-priority of identified risks on qualitative evaluation (Greiman, 2013; PMI, 2013).

For the studied project, it was defined that risk quantitative evaluation only is mandatory if the risk is classified in the PxI matrix above 0.14 and if the risk owner is a representative of EDP Distribution (this project is a partnership so it has some work packages which are the partner's responsibility).

Table 5 shows the inputs, tools and techniques and outputs established to perform risk quantitative evaluation on the proposed risk management methodology.

The decision tree analysis uses the tree scheme to illustrate the structure of the several different situations that may arise in decision-making on dealing with risks. This tool is used along with the expected monetary value (EMV) and a multicriteria analysis.

Table 4. Probability impact matrix adopted for the project

	Impact				
Probability of occurrence	VL	L	M	H	VH
VH	0,05	0,09	0,18	0,36	0,72
H	0,04	0,07	0,14	0,28	0,56
M	0,03	0,05	0,10	0,20	0,40
L	0,02	0,03	0,06	0,12	0,24
VL	0,01	0,01	0,02	0,04	0,08
Constrains					
	Between	0	And	0,5	Low
	Between	0,5	And	0,15	Moderate
	Between	0,15	And	1	High

Table 5. Summary of inputs, tools and techniques and outputs on risk quantitative evaluation phase

Inputs	Tools and techniques	Outputs
Risk register	Decision tree analysis	Risk register
	Expected monetary value (EMV)	
Project manager knowledge and experience	Multi-criteria analysis	

The EMV allows to determine the expected cost associated to all alternative risk response plans to consider and facilitates choosing the one that fits better the project objectives and reduces or even avoids risk.

The multicriteria analysis allows the combination of a set of criteria that will condition the decision making, taking into account their different weights (Dias, 2012; EVALSED, 2013). This analysis will provide orientation in what kind of decision to take against the risk and the more adequate type of response.

Figure 3 illustrates an example of the use of the decision tree technique during the conduction of quantitative analysis of the project risk - the mismatch of customer/final client expectations for a sub product functionality - which got a qualitative evaluation of 0.15, and the risk owner was EDP Distribution.

For this particular risk, the goals defined were the maximization of the customer satisfaction and the minimization of the cost of technical changes. A 1-10 scale was used to represent the customer satisfaction. The cost in euros was converted to this common scale, using equation (1), a minimization linear function.

$$y\left(x\right) = \frac{\text{Max} - x}{\text{Max} - \text{Min}} \times 10 \tag{1}$$

Then a global score for each alternative was evaluated using equation (2).

$$\text{Global Score} = 60\% \times \text{Costumer Satisfaction} + 40\% \times \text{Cost} \tag{2}$$

The Expected Monetary Value (EMV) was 8.56 and the best solution, considering the objectives, was to make minor technical changes. This solution corresponds to a cost of 20 000€.

This kind of analysis allows the organization to decide what to do if risks occur and evaluate how much the organization might need to spend to respond to the risks. Nevertheless, we have to be careful because the values used are estimates that should be further analyzed if the risk really occurs. A sensibility analysis might also help on this analysis.

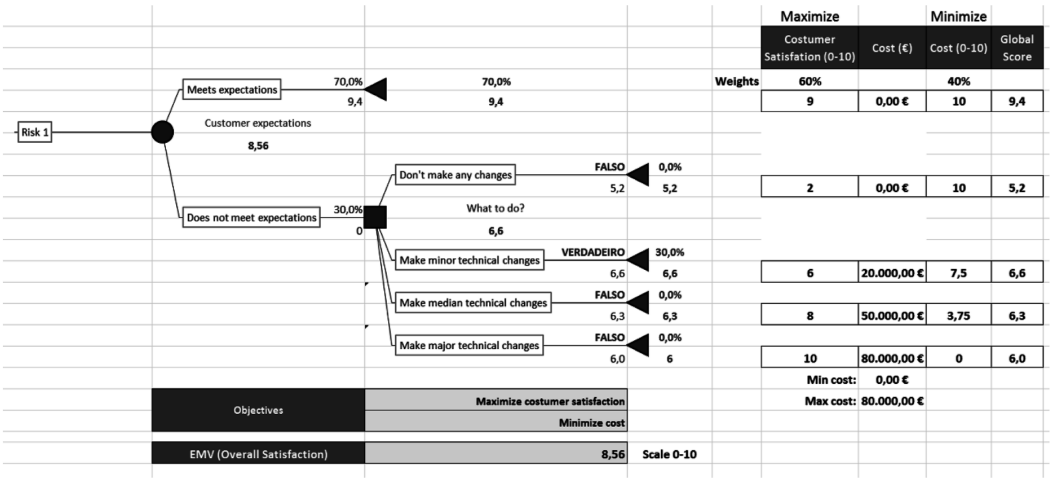
All information and calculations are gathered and updated in the project risk register.

Risk Response Plan

The risk response planning phase has the role of developing options and defining suitable actions to deal with threats, reducing them, and opportunities, exploring them, having in account the priority of individual and global risks to the project (PMI, 2013).

Table 6 shows the inputs, tools and techniques and outputs established to perform risk response plan in the proposed risk management methodology.

Figure 3. Pilot project's risk decision tree for risk 1



For risk response planning it was defined that the risk owner or the project team would fill in a document that collects information about: 1) the assumptions that involve the risk, such as risk causes; 2) potential risk effects on scope, quality, schedule and costs; 3) identification of risk responsibility; 4) description of the actions to be taken as risk response; 4) communication moments along the risk responses; and 5) identification of secondary or residual risks that may arise as consequence of a risk response to the primary risk.

The PxI matrix used on risk qualitative evaluation can help the project team to perceive the type of response plan that must be considered as more adequate and the type of monitoring to do (see Table 7).

Nevertheless this does not exclude the possibility of a risk to have more than one response plan that can be necessary if the first response plan does not work or did not run on time.

It was also defined that the risk response actions should be incorporated to the project WBS in order to guarantee the integration of risk management on project activities and to promote the PM team knowledge of the risk response plans. All the risk management activities on the WBS are pointed at the project RBS.

The information gathered during this phase is updated to the risk register and the risk response plan for every individual risk identified.

Risk Monitoring and Control

The risk monitoring and control has the purpose of implementing the risk response plans, control the identified risks, monitor residual risks, identify new risks, and assess the effectiveness of the risk management processes implemented on the project (PMI, 2013).

Table 8 shows the inputs, tools and techniques and outputs established to perform risk monitoring and control on the proposed risk management methodology.

The risk audit allows to perceive and assess the PRM methodology rules that are being well applied by the project team and if the methodology is adequate for controlling the project and, if not, what improvements to suggest (PMI, 2009b).

The purpose of the control meetings was to update the project risks status, the risks or trigger situations that occurred, the effectiveness of risk response plans activated and additional actions necessary, the closed risks and their impact on the project plan, and lessons learned acquired along the process (PMI, 2009b).

Table 6. Summary of inputs, tools and techniques and outputs on risk response plan phase

Inputs	Tools and techniques	Outputs
Risk register	Meetings and feedback via e-mail	Risk register
		Risk response plans
Project manager knowledge and experience		Project WBS updating

Table 7. Relation between the project risk impact and the adequate risk response and monitoring

	Project impact	Monitoring	Response
	High	Urgent attention	Avoid
	Moderate	Periodic risk revision	Reduce/Mitigate
	Low	Control	Mitigate/Accept

Table 8. Summary of inputs, tools and techniques and outputs on risk monitoring and control phase

Inputs	Tools and techniques	Outputs
Risk register	Risk audit	Risk register
Project manager knowledge and experience	Control meetings	Risk audit report
Risk response plans	Risk reassessment	Lessons learned and best enforced practices report

The risk reassessment assures the cycle of the risk management processes, which grants the effective control of project risks (PMI, 2009b) by identifying new risks and updating risk status (PMI, 2013).

For the studied project, the monitoring and control phases were accomplished through control meetings, each two to three weeks, to perform risk audit and risk reassessment.

During the project risk monitoring and control, the information was collected into the risk register, risk audit report and lessons learned and best enforced practices report.

On the risk register it is collected the main information of the risk status and if the risk response plan was activated. The risk status is assessed in five stages: 1) 'irrelevant' if the risk is far from the horizon of project activities; 2) 'controlled' if it's time of occurrence is being watched and tracked, implying the activating or not of the response plan; 3) 'requires attention' if is perceived that the risk presents symptoms and can get out of control any time, with or without the response plan activated; 4) 'critical' if the risk is already out of control and there is no response plan to activate; and 5) 'exceeded' if the risk is closed even if it occurred or not. This assessment allows controlling the evolution of the risk over time and creates ways to anticipate its behaviour before the actual risk occurrence.

The risk audit report is a document that collects relevant information about the risk during its occurrence like: causes and triggers that lead to risk occurrence, response plans in action, observations about the response plans, communications made, results of the risk response plans, lessons learned and best enforced practices. Every individual risk that had occurred has one risk audit report document.

The report of lessons learned and best enforced practices gathers information from all project risks, in a single document, facilitating future access.

Risk Management Results of the Distribution Automation Pilot Project at Batalha

The implementation of the PRM methodology allowed to identified twenty one risks, five of them were secondary risks. Only one opportunity (positive risk) was recognized.

Most of the identified risks were mainly qualified as moderate and high importance to the project, which implies that the majority of the identified risks can, indeed, jeopardized project success. Table 9 presents the identified risks distribution in the PxI matrix adopted for the project.

By looking to Table 7 and recalling Table 6 it is perceived that the project team will need to apply mainly avoidance and mitigation response plans to deal with the risks of the project. As consequence the risk monitoring and control will require more attention. Nine risks were identified on the darkest zone of the PxI matrix during the qualitative evaluation of the risks. These risks are of higher importance for the project objectives and so it is necessary to guarantee more attention to them so they can be avoided or reduced to residual risks with minor impact on the project. Consequently, these risks required avoidance response plans in every situation that was possible to use this type of response.

Eleven risks were located on the middle zone of the PxI matrix. These risks have moderate importance for the project therefore require periodic supervising and mitigation response plans. The risk management team also decided to use avoidance response plans to these risks.

Only one risk was located at the light colour zone of the matrix, representing low importance to project objectives. This risk requires normal monitoring and control.

Through the project's RBS it was possible to recognize as main risk sources the technological and organizational factors, with an incidence of 8 and 4 risks, respectively. These identified sources were of internal nature. Project external risk sources were local factors and legislation, both with two risks. The identification of these sources of risk aids the PM team to focus their attention on them, preventing the occurrence of unexpected risks due to these critical factors. But, it is important not to neglect other factors.

Of all risks identified, only three were evaluated quantitatively, due to the restrictions established for this type of evaluation. Technological, organizational and commercial factors were the sources of these three risks.

Table 10 presents a summary of the risk response plans established for the project risks and the monitoring and control of the identified risks. Table 10 shows that PM team established, in some cases, more than one risk response, to prevent the possibility of a delay on the first risk response or an unexpected result. Therefore fifteen avoidance or exploration plans, ten mitigation plans, two transference plans, and eleven acceptance plans were established.

On the risk monitoring and control (Table 10) three risks were assessed as irrelevant, which means that they were not in the horizon of the project, non-requiring special attention. Ten risks were controlled, which implies that these risks could interfere with project activities that were ongoing, or were to start soon, requiring some attention. Four of the controlled risks had already risk response plans

Table 9. The PxI matrix with the identification of project risks by their ID numbers

	Impact				
Probability of occurrence	VL	L	M	H	VH
VH			A1.1		A14
H			A3, A4, O15	A14.1	
M			A7.2, A8, A9, A11, A12, A16, A7	A2, A7.1, A10, A13	A6
L		A9.1		A5	A1
VL					

activated. Five risks were assessed as requiring attention and as so these risks had some probability of getting out of control of the project manager. Of these five risks, two had response plans activated and three risks were exceeded, which means that the risk situations were solved.

CONCLUSION

The PRM methodology presented in this paper resulted from an effective action-research process that involved actively the collaboration between the organization PM team and the researchers. During the risk management methodology evaluation processes, the active project team participation allowed the researchers to be more effective in the adjustments of the risk management methodology to the specific project.

This risk management methodology was developed based on PMBoK® (PMI, 2013) and the Practice Standard for Project Risk Management (PMI, 2009b). The risk management methodology was developed for the context of the Distribution Automation pilot project at Batalha. The pilot project under study is about the implementation of a smart grid system, an information technology (IT) solution for electric energy efficiency. The project product will result in a solution to accomplish efficiency goals as allowing reducing carbon dioxide emissions, allowing providers to charge variable rates according to supply and demand, and it is a self-healing grid (Amin, 2013; Colomo-Palacios, 2015). One of the reasons why the majority of the identified risks were classified as medium and high may be the fact that this is a pilot project and there is no historical data available. There is also a great level of technical knowledge required for a smart grid, which was never done before. Therefore, the implementation of a project risk management methodology is particularly important for this kind of projects. Nevertheless, the methodology could be adapted and used on other similar projects of EDP Distribution.

The methodology implemented allowed the project team to initiate systematized risk management practices through a simple structure, easy to apply, and with a degree of complexity compatible with the effort that the PM team could initially engage. The Distribution Automation pilot project at Batalha is ongoing by the time of production of this paper, so the effect of this PRM methodology on the project success is not known. However, it is possible to affirm that during the research and implementation of this methodology, the project team adopted these practices with great openness, and that this methodology allowed the identification of some risks that otherwise would only be identified near or after occurrence, what would limit the time available to work on risk response plans. Therefore, it can be concluded that risk management aids the project team to be prepared to risk occurrences, to minimize the negative risks and to exploit the positive ones.

Research Limitations

As expected, during the implementation of the risk management methodology in the pilot project, some difficulties were found, due to the introduction of a new practice in the PM work. These difficulties were related to: 1) the practice novelty; 2) timing of the research study; 3) resistance to change; 4) time available; and 5) perception of the risk management value.

The proposed methodology was a novelty imposed to the project team. The organization did not have this practice as a systematic process of PM, therefore it was necessary to assure that the project team would understand the value of the risk management plan implementation and the need to commit to it. Consequently, it was necessary to inform and clarify doubts that have been raised during the process. The ‘perceived easy of use’ and ‘perceived usefulness’ were the key embedding factors for the embeddedness of the proposed risk management methodology within the project team management practices (Fernandes et al., 2014).

This research project was started after the beginning of the pilot project. This led the project team to pile up the proposed risk activities with other project activities, regarding the project studied and other projects of the organization. If the risk management plan had been established along with the

Table 10. Summary table with the identification of the risk response plans established for the project risks and risk status at project risk monitoring and control

	Risk response planning					Monitoring and control		
ID	PxI matrix	Avoid/ Explore	Mitigate/ Improve	Transfer/ Share	Accept	Status	Response activated	Response plan
A1		X		X		Exceeded	Yes	Avoid
A1.1		X			X	Requires Attention	Yes	Mitigate
A2			X		X	Requires Attention	No	
A3		X	X		X	Controlled	Yes	Avoid
A4		X	X		X	Requires Attention	Yes	Avoid and Mitigate
A5		X			X	Controlled	No	
A6		X	X			Requires Attention	No	
A7		X	X			Controlled	Yes	Mitigate
A7.1		X				Controlled	No	
A7.2			X		X	Controlled	No	
A8			X			Exceeded	No	
A9		X				Controlled	No	
A9.1		X			X	Controlled	Yes	Mitigate
A10					X	Controlled	Yes	Accept
A11					X	Irrelevant	No	
A12		X	X	X		Irrelevant	No	
A13		X			X	Controlled	No	
A14		X			X	Controlled	No	
A14.1		X	X			Requires Attention	No	
O15		X				Irrelevant	No	
A16			X			Exceeded	Yes	Mitigate
Total		15	10	2	11			

project plan, when the project was defined and characterized, this introduction could be more easily accepted and would have prevented the stacking of the activities to happen.

The resistance to change was tangible during the collection of information with the project team. This process took more time than expected and consequently delayed the process of implementation of the risk management plan. For instance, the feedback by e-mail took much more time than expected, and it was almost impossible to schedule a meeting because of the lack of time of the team members. Lundy and Morin (2013) appoints the uncertainties about the unknown, the novelty, the routine distraction, the culture change and the loss of status/control/power/security as some reasons for resistance to change in PM. Leung et al. (1998) sees the training and education on the risk management concept as a tool to lessen the resistance to change and to familiarize the project team and other organizational personnel with the benefits of this approach.

The project team needed to accomplish several activities of the project under study and other organizational projects, and as this methodology had not been programmed in the project activities, it was difficult for them to find time to undertake the risk management activities imposed by the proposed methodology.

There were some difficulties related to the identification of opportunities, since only one opportunity was identified during the risk management plan implementation. Therefore, it is necessary

to develop a greater openness to the perception of risk by the project team in order to face risk as threat and also as an opportunity.

It was realized that during the risk control meetings, the project team became more familiarized with the risk management practices contributing to the systematic implementation of the proposed methodology and to the establishment of confidence in risk management. It is expected that this proposed methodology evolves gradually towards a robust organizational risk management methodology.

Future Work

In order to implement improvements, it will be necessary additional information of the project team in order to understand the organizational needs and to leverage a systematic PRM practice, by acquiring know-how and stimulating them to participate on the process of risk management and contribute with improvement ideas.

For future work, it would be interesting to study the effect of the implemented risk management plan, and assess if the risk management plan affected, in some way, the project success. For example, by collecting the opinion of the project team about the effect of the risk management plan on the project.

The implementation of the risk management practices at organizational level contributes positively to the organizational PM maturity level, making the organization more competitive and efficient (Ibbs & Kwak, 2000). It is essential to perceive that remembering our mistakes will keep us from repeating them, which is valid for all aspects of our life and even more for the organizations facing an increasingly competitive and demanding market.

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