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RISK MANAGEMENT IN CONSTRUCTION SECTOR: NEW METHODOLOGY FOR PROCUREMENT IN SME´S

GESTIÓN DE RIESGO EN EL SECTOR DE LA CONSTRUCCIÓN: NUEVA METODOLOGÍA PARA LA OBTENCIÓN DE OBRAS EN PYMES

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I ABSTRACT

Construction industry is associated with complex projects with a great number of Risks. Within this sector, SME´s in Europe represent the majority of the companies in the sector and are responsible for sustaining the construction economy. Normally, managers of this kind of companies do not know about Project Management Methodologies and do not have time or resources to use them. The purpose of this final dissertation is the application of a New Risk Management Methodology to apply in SME´s within the Tendering Process with the intention to have more documentation to stablish a proper GO/NO-GO decision in the early stage of the project. The methodology is based in a broad comprehension of the literature review and a complete understanding of risk management in construction. The aim is to confer knowledge to improve quality and reduce time and costs during the Project Life Cycle. Three case studies provided by a SME of the construction industry were analysed and the methodology was applied. The results showed that applying Risk Management Practices with criteria can be helpful in the decision making and assessing when is possible to continue or not with the procurement of the project.

I.I KEY WORDS

Risk - Risk Management - Risk Management Process - Construction - Project Life Cycle - SME´s - Methodology - Tendering Process.

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1 INTRODUCTION

The construction sector is diverse and tremendously complex. Events in the last few years in many countries in Europe have change the behaviour of companies and clients within the construction industry. The decrease of the demand generates a competition between enterprises increasing the necessity to improve quality and reduce cost and time. This is the reason why Risk Management Practices became one of the most important topics of analysis for professionals in the last years. Risk interpretation and management is one of the most important features of Project Management (PM) in construction. PM cannot be performed with greater success without Risk Management (RM) (Cretu, et al., 2011).

Construction projects evolve with the course of its life cycle. They have a lot of stakeholders involved with different experiences and skills that may have uncommon interests and expectations, making the projects even more complex and dynamic. Most of these projects are always unique and unpredictable and risks appear from many different sources.

1.1 CONCEPT OF RISK

From the etymological point of view, the term risk comes from the Latin and Vulgar Latin (*resicum, riscum, riscus: cliff, récif, Felsklippe*). It is said that is the origin of the Italian words *risico*, *risco*, *rischio*, in Spanish *riesgo* and in French *risque*. While in English we have to look forward till the 18th century to found it in their vocabulary (Skjong, 2005). According with some dictionaries the Latin word comes from a Greek navigation term: *rhizikon, rhiza*, which was referred to “root, stone, cut of the firm land”. A metaphor to “difficulty to avoid in the sea” (Sandoval, 2016).

Nowadays there are different explanations and definitions of the term risk, and thus it is hard to decide which one is in every case true. Risk is a broad subject and its definition can differ and be difficult to apply in every sector. Each author provides his own understanding depending on experience, profession, project and field of industry.

It is necessary to distinguish between risk and uncertainty because both are perhaps the most used concepts covering RM. In many cases the definitions of these concepts are adapted for the use of a particular project (Gajewska & Ropel, 2011). Winch (2002) defines risk as a stage where there is a lack of information, but by looking at past experience, it is easier to predict the future. The same author defined uncertainty as a part of the information required in order to take a decision. The required information consists of the amount of available information and uncertainty. The level of uncertainty will decrease the further a project is proceeding throughout the lifecycle. Webb (2003) explained risk as a situation in which he possesses some objectives information about what the outcome might be, and uncertainties as situations with an outcome about which a person has no knowledge. Cooper, et al. (2005) said that risk is exposure to the consequences of uncertainty. Smith et al. (2006) indicated that Risks occur where there is some knowledge about the event while for uncertainties there might be not enough information about the occurrence of an event, but we know that it might occur. Cleden (2009) affirmed that risk is the statement of what may arise from that lack of knowledge. Risks are gaps in knowledge which constitute a threat to the project.

Uncertainty is the intangible measure of what we do not know. Uncertainty is what is left behind when all the risks have been identified. Darnall and Preston (2010) defined risk as a possibility of loss or injury. Schieg (2010) said that risk is usually defined as a positive or negative deviation of variables from its expected value. Most of the times understood it only as loos. Cretu, et al. (2011) defined uncertainty as "the quality or state of being uncertain". It is a state of not knowing. Luck of knowledge about current and future information and circumstances. Finally Winch (2010) considered uncertainty as the absence of information required for the decision that needs to be taken at a point in time.

Both terms are described as situations where the luck of information and knowledge are present. But the biggest difference is that uncertainty is not measurable. Always, when there is an uncertainty, a risk appears.

Risk is considered as a future phenomenon. Is not possible to find events that occur before they happens, hence is difficult to develop precise methodologies to deal with them. Nonetheless, Darnall and Preston (2010) stablished that there are some risks that there are more predictable and easy to identify than others that could result in additional cost and unexpected delays.

Most of the times people assumed that risk have negative consequences, and this is only because it represents an uncertain outcome. But the truth is that risks represent positive and negative results: negative risks as threats and positive ones as opportunities (Cretu, et al., 2011).

Risks have been evolved and their study becomes more important in the business practices and therefore in construction industry. There is even more evident the need to control every threat that can affect the normal operation of a company and generate losses economically, socially and in the environment of the image of the corporate governance (Mejía, 2013). But also, understand the positive consequences that the risk could have.

"Risk can be managed, minimised, shared, transferred or accepted. But it cannot be ignored". (Latham, 1994). The application of different methodologies or techniques to manage risks has to be formulated from the initial design phase of the project to its completion. If these risks are not understood and satisfactorily solved could be a problem of delays in time, cost overruns and quality that may affect the project. Mulcahy (2010) affirmed that the ignorance of risks causes between 8 and 20 % in additional cost of the project.

Despite this and that companies are taking RM in a proactive way, the reality shows that project managers still ignore risks and think that RM is only available for large projects so that they do not look to the causes of the risks (Mulcahy, 2010).

As it is showed, the concept of risk has a multi-dimensional approach. They are going to be with us and the lack of their predictability could suppose a damaging factor to the overall project, either in failing to obtain positive results, or making negative ones even worse.

That is why risk interpretation and management is every day more important and shifts constantly.

1.2 RESEARCH QUESTIONS

All of these factors lead to the formulation of the following research questions:

- Which is best way to identify, implement and manage risk in construction industry?
- How can we improve RM in terms of cost, time and quality in SMEs of the construction sector in Europe?
- Is there any difference between the public and the private sector while taking care of risks?

1.3 OBJECTIVES

The aim of this thesis is to create a new methodology for Project Risk Management. The idea is to find out which of the processes of the RM process is facing more problems in Construction and in particular in projects of SME´s in Europe and try to develop a new method or combination of methods that will help to create more quality value. It will help in the correct measurement of risks and reduce the probability of the risk occurrence. It should be a model that will help the company to increase the profitability in order to be more competitive and help contractors to avoid, reduce or retain risks.

The new methodology will aim to be generic. It has to by dynamic but at the same time strong and with the intention to represent real situations. A method that warrant the extraction of a large amount of information with the intention of facilitating the management and being able to automated into a high level. The intention with the application of this methodology is the time/ cost reduction and the increase in quality by reducing, increment the benefits and handle the main risks that will affect the Project Life Cycle (PLC).

1.4 FRAMEWORK

For that goal it is necessary to understand and support the following aspects:

- Understanding of the Risk Management Process (RMP) and the particular situation in the construction sector.
- Presentation of the PLC for construction projects and identified which is the critical phase in small and medium projects to apply the new methodology.
- Explanation of the new methodology. It has to be a combination of the methods analyzed before.
- Implementation of the methodology in a case study in the company. The case study will be provided by the Construction Company ORECO, SA which operates in Vigo (Spain).

The popularity of a method will vary depending on its complexity, the requirements or not of appropriate computer programs, the clarity and the quality of the results and the further used and verification during the project (Dziadosz & Rejment, 2015).

The first step is the identification of difficulties that SME´s face when new projects are given. It is important to understand the needs and the characteristics of the methodology. And then know their experience and problems in recent projects and the tools that they are using about management. This will provide the basis of the methodology.

As a result of the practical experience in a SME that operates in the construction sector, a case study will be analyse in order to find out if the methodology could help to avoid different issues related with RM that the company had faced or is facing during the life cycle of the construction project.

2 RISK MANAGEMENT PROCESS

RM is an integral part of PM, being an element of any project management methodology. It should not be an independent function from the rest of the PM disciplines (Pritchard, 2005). Some authors understand RM as a method of managing the events that have a potential to cause unwanted change (Pritchard, 2005). But as we could see above, risks not always provide us negative experiences. Others define RM as a systematic and proactive approach to take the control of the projects by decreasing or understanding uncertainties (Mulcahy, 2010). RM implicates the idea of minimize the consequences of negative events and increase the results of the positive events (threats and opportunities). It is necessary that these opportunities are included because things that go in a good direction give greater advantage over the things that go in a bad one. Understand which risk are more important than others will establish the success or not of the project. It is used in all kind of industries, from automobile to textile industries to the construction sector.

The international Organization for Standardization (ISO), in their standard ISO 31000 (ISO, 2009) define RM as the coordinated activities to direct and control an organization in terms of risk and identifies the next principles of RM:

- RM creates value
- RM is an integral part of the organizational processes
- RM is part of the decision making.
- RM explicitly addresses uncertainty.
- RM is systematic, structured and timely.
- RM is based on the best available information.
- RM is tailored.
- RM integrates human and cultural factors.
- RM is transparent and inclusive.
- RM is dynamic, iterative and responsive to change.
- RM is capable of continuous improvement and enhancement.

The Project Management Institute (2013) considered it as one of the nine Project Management Knowledge areas in the last and previous versions of the PMBOK Guide. Its philosophy in RM evolves towards the incorporation of new tools that reflect how times have changed regarding the incorporation of a greater number of risks in projects.

RM is part of our daily live, even if is it noticed or not. Most of the time, it is assess on an unconscious level, using habits to solve them. But theses habits are different from person to person. Not everyone manage risk in the same way, but most of the times common sense commands the way of managing the risks (Cretu, et al., 2011).

Not every project faces the same risks. Increasing the complexity of the project increases risk, and that is why not every project needs the same management approach. However, cost and schedule are the main goals that the organizations tend to pay more attention to. But the consequences of cost and schedule decisions, associated with technical risks, are based in uncertainties.

Using intuitive reasoning always helps as a starting point of decision process, but to manage more important risks effectively and achieve benefits it is necessary to look forward and apply a systematic process which implements the basic practices (Pritchard, 2005).

Every activity of a project present some risk. What changes from one activity to another is the amount of risk involved (Ehsan, et al., 2010). That is why it is possible to define Project Risk Management (PRM) as an integral process which aims to identify and respond to a potential risk associated with a project taking advantage of activities that can maximize the outcomes of the positive events and minimize the negative ones. As (Jardine, 2007) asserted, PRM includes quality and safety, cost management, time management, scope and change management, procurement and contracts, people management and external influences.

The problem these days is that the projects move on so fast, that there is no time or money to check or examine potential problems that are difficult to be resolved. (Pritchard, 2005). This way, RM and their risks become a secondary problem at the beginning of the project, and companies do not realise the importance of it until the opportunity is missed.

Within RM, one concept that is necessary to introduce is the RMP. As the main idea of RM is to decrease the possibility of impact of negative events and increase the likelihood of positive ones, the following processes should be consider (Project Management Institute, 2013).

- Risk planning
- Risk identification
- Risk Analysis (Qualitative and Quantitative)
- Risk response
- Risk monitoring and control

These steps are presented in a pyramid form where the planning is the basement and the monitoring and control at the peak. This approach seems to have sense from the process perspective, but according with Cretu, et al. (2011) if the size of each step is understood as the measurement of effort to perform them, each step becomes more difficult as the project move forward (See Figure 1 -2.1).

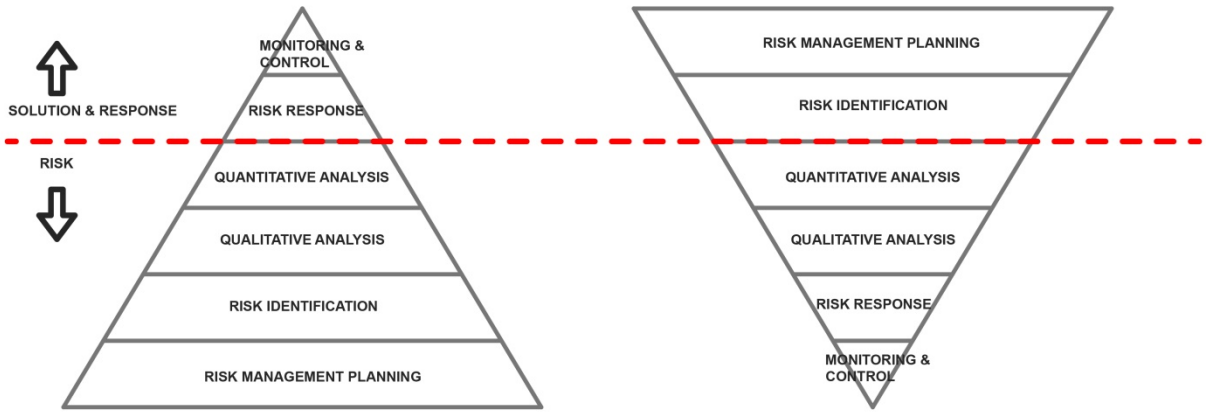


Figure 1 -2 Traditional vs Recommended Emphasis of RM (Cretu, et al., 2011).

If the best planning is not applied or implement, then does not have any sense to make it and it is a waste of time. This could be basic, but as the author confirmed, traditional RM invested more effort in the analysis of the problems than in their solutions.

RMP established the context with the identification, analysis, evaluation, treatment, monitoring and communication of risks with the application of policies, processes and procedures related with management (Cooper, et al., 2005).

Not only the PMBOK has identified different phases in the RMP. Several authors consider, agreed or include more steps to the process.

According with Ehsan, et al. (2010) and Rodríguez (2012) RM includes four phases:

- Risk identification: the process of identify which risks are more prone to affect the project and characterize them.
- Risk quantification: evaluation of the outcomes of the project based on the interaction of these risks.
- Risk response development: The definition of all the activities related to the elimination of risks during the PLC.
- Risk response control: Response to the changes to eliminate risks during the project.

Smith et al. (2006) only focused in the main steps: identification, assessment & analysis, response and review, as it is shown in. Banaitis & Banaitiene (2012) also stablish 4 key steps: identification, assessment, mitigation and monitoring.

Zhang, et al. (2016) includes another phase apart from the others mention before: The communication phase, which seeks to establish who needs to know about RM. The process is shown as a wheel highlighting the continuity throughout the PLC. Communication is the center of the wheel and it is considered as the means to the information flow.

Every step should be included while dealing with risks effectively. They have serials of inputs and outputs that will help to manage the risks in every project dealing them with different methods and techniques.

For the purpose of this final dissertation the following phases are considered:

2.1 PLAN RISK MANAGEMENT

“If I had an hour to solve a problem and my life depended on the answer, I would spend the first 55 minutes figuring out the proper questions to ask. For if I knew the proper questions, I could solve the problem in less than five minutes” Albert Einstein.

The purpose of Plan Risk Management (PRM) is to engage managers to provide an organizational infrastructure to help them to deal with the identification of which risks are worth investment of time and money, try to eliminate or minimize risks, develop other strategies and stablish time and money reserves to deal with that risks that cannot be eliminated. It is a developed and organize infrastructure that support the other risk processes in a specific project (Pritchard, 2005).

PRM involves the process of setting how to proceed, when and which activities must be done during the PLC, who should be involved in these activities and how often should be done. PRM helps to complete the works faster, effectively and in an easier way (Mulcahy, 2010). It is important the communication with every stakeholder to get the support and ensure that the process will be performed during the whole PLC (Project Management Institute, 2013).

PMI (2013) and Mulcahy (2010) identified several inputs and outputs that are necessary for this process and are summarized in Figure 2 -2.2.

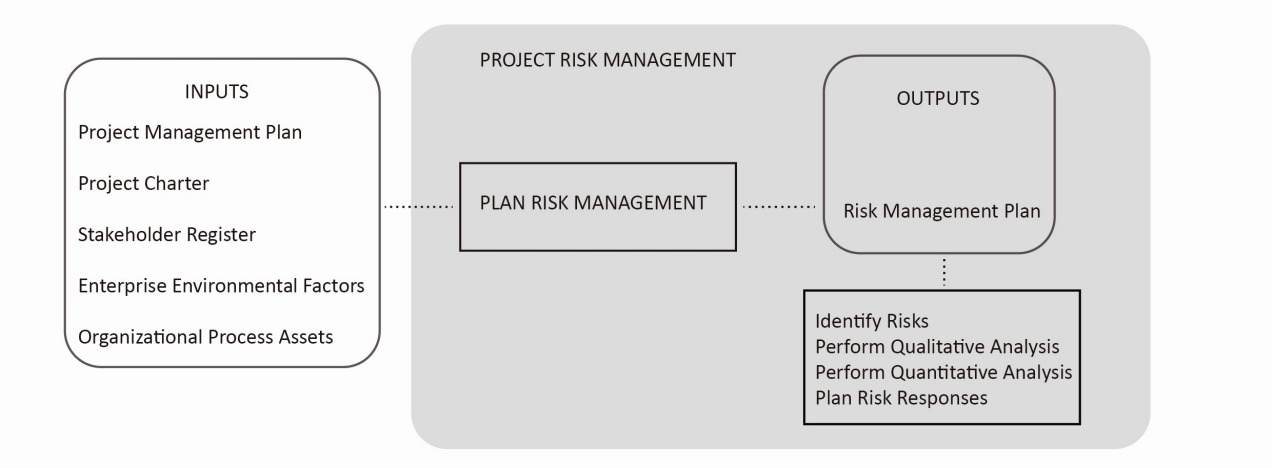


Figure 2 -2.1 Plan Risk Management.

The complexity of the project, the experience of the team and the importance of the process has to be according with the level and type of what is done. Rodríguez (2012) affirmed that PRM has a straight t relationship with the human factor, not only because is one of the sources that generates uncertainty, but they are those who will assess them and will propose corrective measures to them.

The following Table 1- 2.1 summarizes the different methodologies applied to develop a PRM.

RISK PLANNING	METHODS	REFERENCE methods
Predominant Use	Chart of responsibilities, time and budget	(Mulcahy, 2010)
	Planning Meetings	(Pritchard, 2005), (Project Management Institute, 2013)
	Risk Practice Methodology	(Pritchard, 2005)
	Project Templates	(Pritchard, 2005)
	Risk Modelling	(Pritchard, 2005)
	Strategic Risk Scoring Sheets	(Project Management Institute, 2013)
	Stakeholder Risk Profile Analysis	(Project Management Institute, 2013)
Secondary Use	Expert Interviews	(Pritchard, 2005), (Project Management Institute, 2013)
	Documentation Reviews	(Pritchard, 2005)
	Delphi Technique	(Pritchard, 2005)
	SWOT Analysis	(Pritchard, 2005)
	Check Lists	(Pritchard, 2005)
	Risk Breakdown Structure	(Pritchard, 2005)
	Root Cause Identification	(Pritchard, 2005)
	Risk Register Tables	(Pritchard, 2005)
	Estimating Relationships	(Pritchard, 2005)
	Rating Schemes	(Pritchard, 2005)
	Risk Factors	(Pritchard, 2005)
	Risk Response Matrix	(Pritchard, 2005)
	Performance Tracking	(Pritchard, 2005)
	Risk Reviews and Audits	(Pritchard, 2005)

Table 1 -2.1 Planning Risk Management Methodologies. Self-Produced.

2.2 RISK IDENTIFICATION

The interest in identify risks has existed since ancient times as a result of preventing unfavorable events (Mejía, 2013).

Risk Identification involves the process that identifies and records the list of threats and opportunities that may affect the project, understand these risks and clarifies the responsibilities of every risk using a combination of methods. It is an organized and complete approach to find the risks that are associated with a project. Everyone should be involved.

It is one the most important process but at the same time one of the less precise elements in RMP. Is no possible to manage risks without identify and understand them (Pritchard, 2005), however it is also impossible to coverage all risks (005). It is usually done by experience of older minds or by brainstorming sessions (Winch, 2010).

Some authors as Banaitis & Banaitiene (2012), Mejía (2013) and Carbone & Tippett (2004) considered this process as the first and most important step in RMP. It develops the basis for the next steps and ensures RM effectivity.

It is vital to identify risks in the early stages of the project, in that way future problems can be avoided through appropriate action plans. This does not mean that Risk identification should be only a process to develop at the beginning of the project. It has to be an iterative process throughout the life cycle of the project since is not possible to recognize every risk before the frst phase of the project and during the process more risks will emerge (Rodríguez, 2012; Office of Statewide Project Management Improvement (OSPMI), 2007).

Some authors understand this step in an informal way, saying that the identification of risks rely mostly on previous experiences (Winch, 2002).

Several inputs and outputs have been identified (Project Management Institute, 2013; Mulcahy, 2010)(Figure 3-2.2):

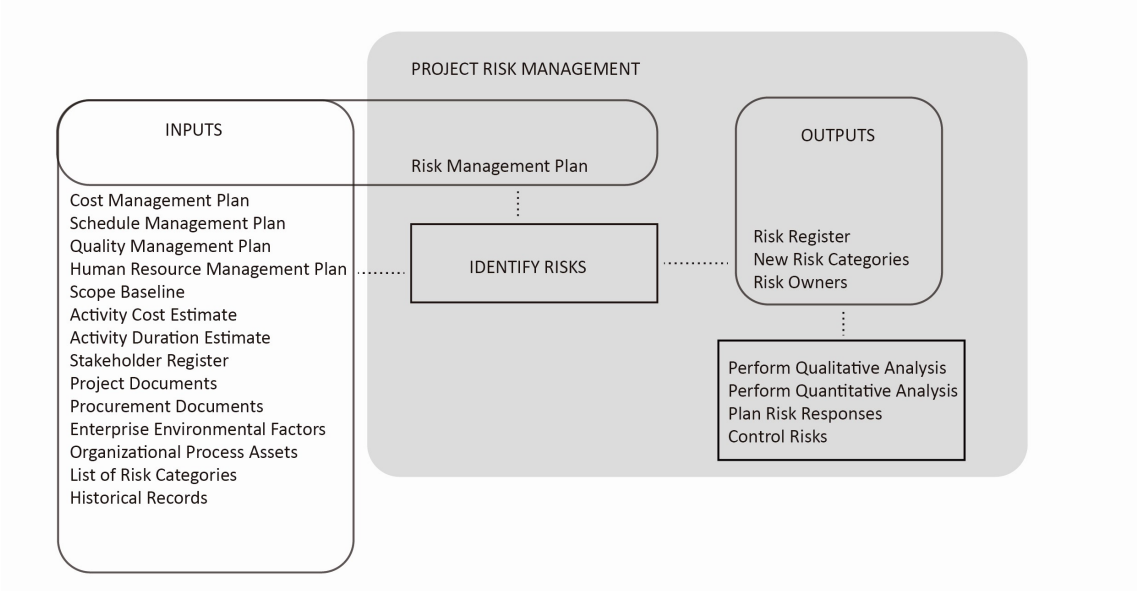


Figure 3 -2.2 Risk Identification.

As it is shown in Table 2 -2.2 different techniques can be applied to find the potential risks.

RISK IDENTIFICATION	METHODS	REFERENCE methods
Predominant Use	Sticky notes	(Mulcahy, 2010)
	Forms & Checklists	(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013)
	Prompt list	(Mulcahy, 2010)
	Historical records	(Mulcahy, 2010), (Gajewska & Ropel, 2011)
	Review other documentation	(Mulcahy, 2010), (Pritchard, 2005), (Gajewska & Ropel, 2011)
	Brainstorming	(Mulcahy, 2010), (Pritchard, 2005), (Winch, 2010), (Project Management Institute, 2013), (Mejía, 2013)
	Conduct a "Pre-Mortem"	(Mulcahy, 2010)
	Affinity Diagrams	(Mulcahy, 2010)
	Expert Interviews	(Mulcahy, 2010), (Pritchard, 2005), (Winch, 2010), (Project Management Institute, 2013), (Gajewska & Ropel, 2011), (Mejía, 2013)
	Nominal Group Technique	(Mulcahy, 2010)
	Delphi Technique	(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013), (Gajewska & Ropel, 2011), (Mejía, 2013)
	Cause and Effect Diagram	(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013), (Mejía, 2013)
	Failure Modes and Effects Analysis	(Mulcahy, 2010)
	SWOT Analysis	(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013)
	Force Field Analysis	(Mulcahy, 2010), (Pritchard, 2005)
	Influence Diagrams	(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013)
	Assumptions analysis	(Pritchard, 2005), (Project Management Institute, 2013)
	Analogy comparisons	(Pritchard, 2005)
	Crawford Slip Method	(Pritchard, 2005)
	Root Cause Identification	(Pritchard, 2005), (Project Management Institute, 2013)
	Top-level Risk Matrix	(Pritchard, 2005)
	Network Diagrams	(Pritchard, 2005)
	Flowcharts	(Pritchard, 2005), (Project Management Institute, 2013)
	Plan Evaluation	(Pritchard, 2005)
	Risk Breakdown Structure	(Pritchard, 2005), (Gajewska & Ropel, 2011)
	Sensitive Analysis	(Pritchard, 2005)
	Benchmarking	(Gajewska & Ropel, 2011)
	Questionnaires	(Gajewska & Ropel, 2011)
	Past Experience	(Gajewska & Ropel, 2011)
	Workshops	(Gajewska & Ropel, 2011)
	Visits to the location	(Gajewska & Ropel, 2011)
	Research assumptions and interfaces	(Gajewska & Ropel, 2011)
Secondary Use	Risk Register Tables	(Pritchard, 2005)
	Program Evaluation and Review Technique. PERT	(Pritchard, 2005)
	Planning Meetings	(Pritchard, 2005)

Table 2 -2.2 Planning Risk Management Methodologies. Self-Produced.

2.3 RISK ANALYSIS

As Radu (2009) stated there are 3 methods to ascertain risks in a project: The qualitative, semi-quantitative and quantitative procedures.

Qualitative Risk Analysis

The qualitative approach uses criteria based on judgements to identify the outcomes. Qualitative Risk Analysis is the process which involves the initial look at the risks that have been identified and try to determine the risks that will be quantified later and will be addressed in the Plan risk response process. It is the first effort to classify risks according with probabilities and impacts. It introduces which risks can be quantitatively evaluated and which ones cannot, affording time and money to managers (Pritchard, 2005).

The main objectives of Qualitative Risk Analysis are the subjectively evaluation of the impact and probability of every risk, stablish which risks will be addressed in the response plan and make the go/no go decision (Mulcahy, 2010). The quality and reliability of the information pays an important role in this process.

Semi - quantitative Risk Analysis

The Semi – qualitative methodologies are used when relative risks appear. To analyse the probabilities of a risk to occur is not necessary mathematical data, but this methodologies provide a rigorous approach compared with qualitative assessments. They are useful when quantification of risks is hard to obtain and qualitative analysis are too subjective.

Quantitative Risk Analysis

Quantitative Risk Analysis tries to determine how much risks have the project and where, with the intention in focus time and effort in those risks that are more prone to occur or have a greater impact in the project. They provided numerically more information than the Qualitative analysis to make proper decisions (Mulcahy, 2010).

Between the objectives, the decision of which risks need a response, the objectively evaluation of the impact and probability of ever risk, determine the level of risk and the overall cost and time of the project and the identification of which risks will need a response planning are the most important (Pritchard, 2005).

This analysis should be performed after the Risk response plan to determine if the minimum amount of risk is acceptable within the cost and time necessities of the project. It is important to determine where to perform the Quantitative Analysis because will cost time and money. More sophisticated techniques and methods for construction projects are used. It is also important to combine different methods to assess the probability and impact of the risks.

Some authors as (Mulcahy, 2010) agreed in that this process is not the most important part of RM. Time spent in identify risks can have more benefits than quantitative analysis.

As in the previous steps, to perform qualitative and quantitative analysis is necessary the next inputs shown in the next Figure 4 -2.3:

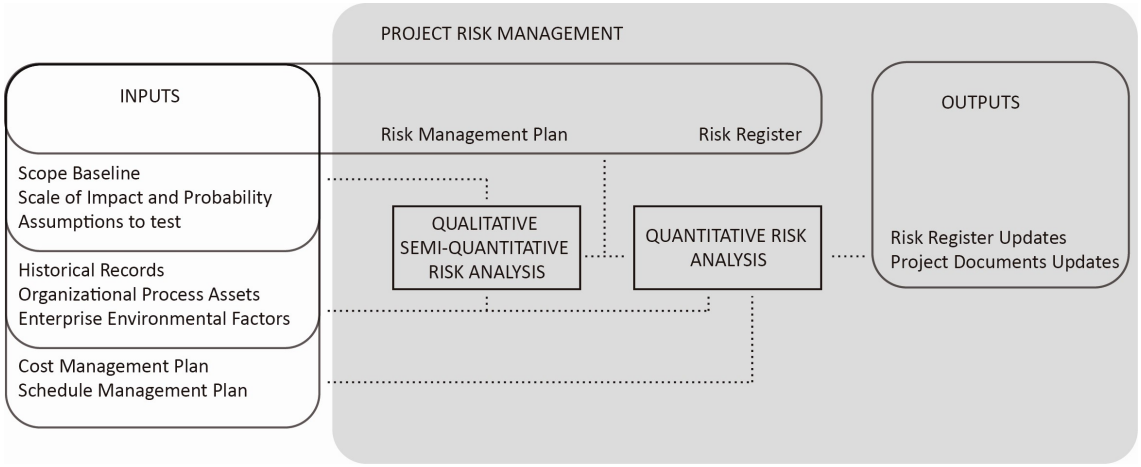


Figure 4 -2.3 Risk Analysis.

Different methods can be found within qualitative and quantitative analysis. The following Tables 3 -2.3 & 4 -2.3 show which ones are used as predominant and which ones are used as secondary.

QUALITATIVE & SEMI-QUANTITATIVE RISK ANALYSIS	METHODS	REFERENCE methods
Predominant Use	Data Quality Assessment Chart	(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013)
	Probability and Impact Matrix	(Mulcahy, 2010), (Winch, 2010), (Project Management Institute, 2013), 006
	Qualitative Risk Analysis Templates	(Mulcahy, 2010), (Project Management Institute, 2013), (Gajewska & Ropel, 2011)
	Use of Analogies	(Pritchard, 2005)
	Affinity Diagrams	(Pritchard, 2005)
	Urgency Assessments	(Pritchard, 2005), (Project Management Institute, 2013), (Gajewska & Ropel, 2011)
	Rating Schemes	(Pritchard, 2005), (Gajewska & Ropel, 2011)
	Risk Factors	(Pritchard, 2005)
Secondary Use	Expert Interviews	(Pritchard, 2005), (Project Management Institute, 2013)
	Planning Meetings	(Pritchard, 2005), (Project Management Institute, 2013)
	Risk Practice Methodology	(Pritchard, 2005)
	Analogy comparisons	(Pritchard, 2005)
	Delphi Technique	(Pritchard, 2005)
	Risk Breakdown Structure	(Pritchard, 2005)
	Root Cause Identification	(Pritchard, 2005)
	Risk Register Tables	(Pritchard, 2005)
	Project Templates	(Pritchard, 2005)
	Assumptions analysis	(Pritchard, 2005)
	Risk Modelling	(Pritchard, 2005)
	Sensitive Analysis	(Pritchard, 2005)

Table 3 -2.3 Qualitative and Semi-quantitative Risk Analysis Methodologies. Self-Produced.

Proper uses of qualitative methods are found when risks can be placed on descriptive scales from low to high level. Quantitative methods are based in numerical estimations.
Depending on the type of risk and project one or other method should be chosen. This will vary depending on past experience, expertise and if there is the availability of the right software and the proper formation to use them (Gajewska & Ropel, 2011).

QUANTITATIVE RISK ANALYSIS	METHODS	REFERENCE methods
Predominant Use	Expected Monetary Value	(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013)
	Monte Carlo Simulation	(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013), (Gajewska & Ropel, 2011)
	Decision Tree Analysis	(Mulcahy, 2010), (Pritchard, 2005), (Gajewska & Ropel, 2011)
	Failure Modes and Effects Analysis	(Mulcahy, 2010)
	Expert Interviews	(Pritchard, 2005), (Project Management Institute, 2013)
	Program Evaluation and Review Technique. PERT	(Pritchard, 2005)
	Sensitive Analysis	(Pritchard, 2005), (Project Management Institute, 2013), (Gajewska & Ropel, 2011)
	Risk Simulation Tools	(Pritchard, 2005)
	Watch Lists	(Pritchard, 2005)
	Estimating relationships	(Pritchard, 2005)
	Network Analysis	(Pritchard, 2005), (Project Management Institute, 2013)
	GERT and VERT Analysis	(Pritchard, 2005)
	Data Quality Assessment Chart	(Pritchard, 2005)
Secondary Use	Risk Practice Methodology	(Pritchard, 2005)
	Analogy comparisons	(Pritchard, 2005)
	Delphi Technique	(Pritchard, 2005)
	Assumptions analysis	(Pritchard, 2005)
	Rating Schemes	(Pritchard, 2005)

Table 4 -2.3 Quantitative Risk Analysis Methodologies. Self-Produced.

Quantitative methods seem more suitable for medium and large projects. The amount of time and resources required to perform this kind of methodology is remarkable. Also, it is needed trained personal and complex and expensive software to succeed and obtain reliable results. Quantitative analyses are limited in the assumptions made for the calculations. Quantitative models are as good as the algorithms used for them. But the limitation is that is difficult for them to adjust to the real world.

On the other hand, in small and medium size projects, where there is luck of time and limited resources, the application of simple techniques when a quick assessment is needed, is more effective (Heldman, 2005).

2.4 PLAN RISK RESPONSES

Plan Risk Responses will determine what actions are necessary to apply to reduce or increase the probability and impact of threats and opportunities of the overall risk of the project. Some authors consider it as the critical part of RM because determines what action or actions are taking to act against or in favor of those risks evaluated and identifies in the previous activities of identification, qualification and quantification (Pritchard, 2005).

It is a creative process and according with the literature reviewed the following strategies are the most common for this process (Cretu, et al., 2011; Mulcahy, 2010; Pritchard, 2005; Winch, 2010; Ehsan, et al., 2010; Rodríguez, 2012; Gajewska & Ropel, 2011).

- Avoidance: The process of trying to eliminate risks by looking at alternatives in the project. It is the best way to deal with risks. Communication is the most important part of risk avoidance. If the approach is not well documented or not well communicated then the risk can be reintroduced. Modifying the project scope is an example to do it. If the cost to avoid the risk is less than the expected impact then is a good solution. This is another reason about why RM should be incorporate in the early stages of the project.
- Transference: Change the responsibility and give it to a third party. It does not eliminate the risk. It used to benefit the costumer and the project in general if is well structured. The success depends on the ability of the other party to deal with the risk. Always has an extra cost.
- Mitigation: The process of taking different paths to reduce probability and impact of risks. Do not avoid the risk, but reduces the probability and impact. As soon as the risk is mitigated less cost will have.
- Acceptance: As simple as accept the risk. It is also known as retention and is the decision to recognize and support the consequences of a risk hen it occurs. This strategy will work with very small risks or risks that are unlikely to happen. It is necessary to understand the risks and their consequences and probabilities of occurrence. Even if is it accepted, has to be assumed and communicated. If risks have been accepted, then contingency plans should appear, normally in the budget or in the schedule. This strategy will work for threats and opportunities.
- Exploitation: It is the process that seeks the achievement of the opportunities to take full advantage of them. Enhancing the possibility that an opportunity will happen. It requires some investment but during the PLC cycle will be worth it.
- Share: Make a win-win situation by shearing the opportunity with other stakeholders. When one organization is not capable of handling the opportunity by itself, the process of sharing partnership can help to optimize the probability and impact of the opportunity.
- Enhancement: Is the process that allows increasing the probability and impact of an opportunity.

Other resources include Insure risks and Delay decisions in the group above (Winch, 2010). Depending on the classification of the risk source the decision of which option is optimal will vary: For probable disaster, mitigate or avoid; un-probable disaster, insure the risk. If not, mitigation better than acceptance. Transference is not an option for risks with large impact because the clients usually think in finances than the suppliers of construction sector.

Risks with lower impact can be managed with externalization. The best option is to allocate the risk to the actor that will be close to the source of the risk. Acceptance is valid when it is a case of “bad luck”. Another approach is to include an extra payment for excessive transaction costs.

Delay the decision is one of the most useful ways (Winch, 2010), until more information is available. It is favored when risks come from laws. That is another reason why clients prefer to obtain the design and execution from different services. Most of the uncertainties come from the design phase, but at the same time the cost of design is relatively lower comparing with the total cost of the project. If there is an option to postpone the decision of the high-cost activities through an extension in time of the design phase, then most of the risks can be mitigated or even eliminated. As it is obvious, this strategy cannot be used while handling critical situations.

Risks should be assigned to groups or individuals to let them take the responsibility of the implementation of planned risk responses. The strategies should be reviewed through the life cycle of the project (Mulcahy, 2010).

The next inputs and outputs are included and obtained in Risk Response process (Figure 5 -2.4):

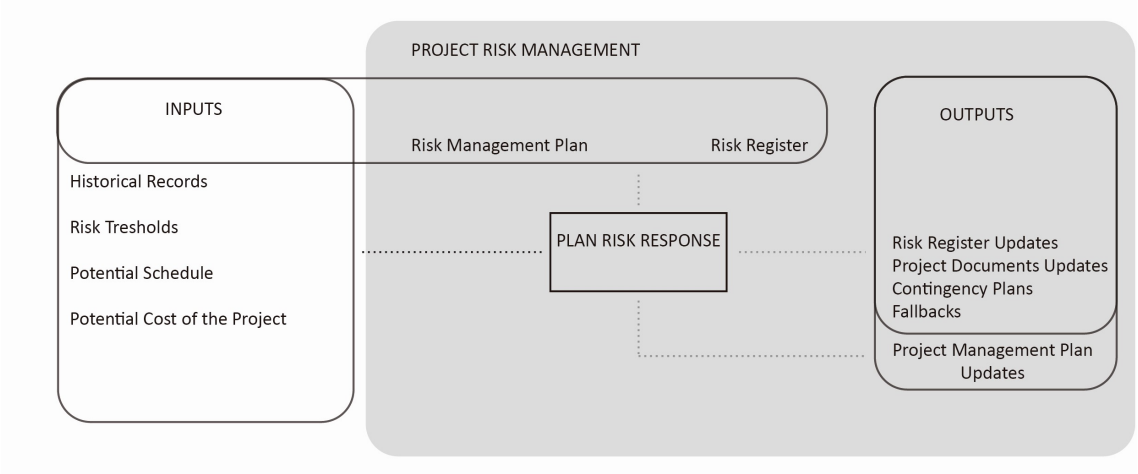


Figure 5 -2.4 Plan Risk Responses.

The following Table 5 -2.4 shows a resume of all the activities and strategies that may help in this process.

RISK RESPONSE	METHODS	STRATEGIES	REFERENCE methods	REFERENCE strategies
Predominant Use	Brainstorming		(Cretu, et al., 2011)	
	Value Methodology		(Cretu, et al., 2011)	
	Expert Opinions	Avoidance	(Mulcahy, 2010), (Pritchard, 2005), PMBOK	(Cretu, et al., 2011), (Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013), (Ehsan, et al., 2010)
	Form for threats or opportunities	Transference	(Mulcahy, 2010)	(Cretu, et al., 2011), (Mulcahy, 2010), (Pritchard, 2005), (Winch, 2010), (Project Management Institute, 2013), (Ehsan, et al., 2010)
		Mitigation		(Cretu, et al., 2011), (Mulcahy, 2010), (Pritchard, 2005), (Winch, 2010), (Project Management Institute, 2013), (Ehsan, et al., 2010)
	Strategy Matrix	Acceptance	(Pritchard, 2005)	(Cretu, et al., 2011), (Mulcahy, 2010), (Pritchard, 2005), (Winch, 2010), (Project Management Institute, 2013), (Ehsan, et al., 2010)
		Exploitation		(Cretu, et al., 2011), (Cretu, et al., 2011), (Pritchard, 2005), (Project Management Institute, 2013)
		Share		(Cretu, et al., 2011), (Cretu, et al., 2011), (Pritchard, 2005), (Project Management Institute, 2013)
		Enhancement		(Cretu, et al., 2011), (Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013)
		Contingency Plans		(Mulcahy, 2010), (Pritchard, 2005), (Project Management Institute, 2013), (Ehsan, et al., 2010)
		Fallback Planning		(Mulcahy, 2010), (Pritchard, 2005)
		Triggers		
		Delay decisions		(Winch, 2010)
		Insure		(Winch, 2010)
		Risk Register		(Mulcahy, 2010)
	Reserve methods		(Mulcahy, 2010)	

RISK RESPONSE	METHODS	STRATEGIES	REFERENCE methods	REFERENCE strategies
Secondary Use	Planning Meetings		(Pritchard, 2005)	
	Analogy comparisons		(Pritchard, 2005)	
	Delphi Technique		(Pritchard, 2005)	
	Crawford Slip Method		(Pritchard, 2005)	
	SWOT Analysis		(Pritchard, 2005)	
	Root Cause Identification		(Pritchard, 2005)	
	Risk Register Tables		(Pritchard, 2005)	
	Network Analysis		(Pritchard, 2005)	
	Urgency Assessments		(Pritchard, 2005)	
	Sensitive Analysis		(Pritchard, 2005)	

Table 5 -2.4 Plan Risk Responses Methodologies. Self-Produced.

2.5 MONITORING AND CONTROL

Monitoring and control risks (MCR) is the process to observe, ensure compliance, measure, take corrective actions, evaluate the efficiency and refine the risk management plan. It covers the implementation, compliance and management of risk response plans; creation of workarounds; control the risks; update the risk register; performance of additional risk identification, analysis and response panning; communication with the rest of stakeholders; Lessons Learned (LL) and scope, schedule and cost evaluation for risk impacts (Mulcahy, 2010).

MCR is the phase of the project that consists on “doing” instead of “discussing” (Cretu, et al., 2011). It is an essential part of the RMP and continues during the life of the project.

Monitoring the risk include the identification of the owner of the risk, the responsible for monitoring the risk, the nature and frequency that the task manager will report to the project manager and establish a protocol according with these updates.

Controlling risks appears because every project changes during its life cycle. Cretu, et al. (2011) suggested 3 project milestones with the intention to do a workshop: concept development, preliminary design, and final design, while interim reviews have to be done between these milestones.

If the process is developed in a proper way, it gives information that will help with the decision making before the risk appears. The communication between the stakeholders to keep under control the levels of risk is necessary. The control of risks will help to adopt the emergency measures, new corrective measures or modifications to the contingency plans. As Rodríguez (2012) claimed, a recommendable practice is to deliver and manage the risk reports inside the company, to take profit from past experiences.

The next inputs and outputs are included and obtained in MCR process (Figure 6 -2.5):

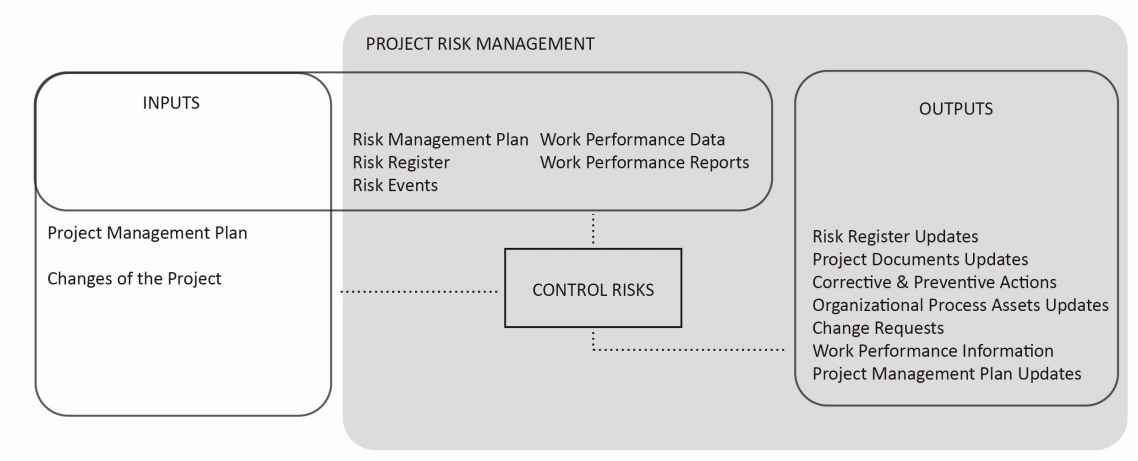


Figure 6 -2.5 Risk Monitoring and Control.

The next Table 6 -2.5, as it has been done so far, shows the main methods used in this phase:

RISK MONITORING AND CONTROL	METHODS	REFERENCE methods
Predominant Use	Risk monitor schedule	(Cretu, et al., 2011), (Gajewska & Ropel, 2011)
	Risk database	(Cretu, et al., 2011)
	Earned Value Analysis	(Pritchard, 2005), (Project Management Institute, 2013)
	Technical Performance Measurement	(Pritchard, 2005), (Project Management Institute, 2013)
	Checklists	(Pritchard, 2005)
	Risk Register Tables	(Pritchard, 2005)
	Urgency Assessments	(Pritchard, 2005)
	Performance Tracking	(Pritchard, 2005)
	Risk Reviews and Audits	(Pritchard, 2005), (Project Management Institute, 2013), (Gajewska & Ropel, 2011)
	Management by wandering around	(Winch, 2010)
	Informal Meetings	(Winch, 2010), (Project Management Institute, 2013), (Gajewska & Ropel, 2011)
	Spotting the weak trends	(Winch, 2010)
	Reserve Analysis	(Project Management Institute, 2013)
Secondary Use	Plan Evaluation	(Pritchard, 2005)
	Risk Breakdown Structure	(Pritchard, 2005)
	Project Templates	(Pritchard, 2005)

Table 6 -2.5 Monitor and Control Methodologies. Self-Produced.

No method is better than other, depends on the person or group of persons who are identifying the risks, and depends in the organization the final decision for how to proceed (Gajewska & Ropel, 2011).

2.6 LESSONS LEARN & DATA STORAGE

Lessons Learn (LL) is the learning profit that is obtained from the process of performing the project (Project Management Institute, 2013). Trevino & Anantatmula (2008) identify 5 essential activities in the practice of LL:

- Capturing important lessons
- Analyzing lessons
- Storing lessons
- Disseminating lessons
- Making effective use of these lessons

In order to provide a solid basement for the next projects it is crucial for companies to record any action and activity that take place in the project (Marcelino-Sádaba, et al., 2013).

Even if LL is shown in the last step of the wheel, it should not be a process that takes place at the end of the project, but during each life cycle phase. The learning process takes place during the life cycle in order not to forget important considerations during the activities of the project. The risk register is the method to effectively face this process. Creating a risk register will allocate every risk. It provides effective feedbacks for future projects and useful information. Advantages and disadvantages of the processes will come up and the project work will improve.

2.7 RISK COMMUNICATION

Communication is the process of shearing information and documents between all the participants in a project to achieve the project´s goals (Ceric, 2011). Within construction projects involves a multidisciplinary tasks with different interpretations and perspectives where the participants should collaborate, share, compare and integrate the information about the project and its objectives. It is a crucial part of a project (Ceric, 2012).

According with Cohrssen & Covello (1989) risk communication has to be dynamic, flexible and interact with the public at every step. It is a difficult task and will vary depending on several factors. That makes it different every time that a project has to be faced. The authors outlined that the following areas has to be taken into account:

- Information and education.
- Behavior change and protective actions.
- Warnings and emergency information.
- Problem solving and resolution of conflicts.

The transparency, credibility and the right to make mistakes should be the basis of RM (Marcelino-Sádaba, et al., 2013).

The result is a continuous process that is developed along the whole project and this is why it is represented in a circular way as it is shown in Figure 7 -2.7, where the communication is the heart of the process and the way for the project team to continuously evaluate the coherence of the project.

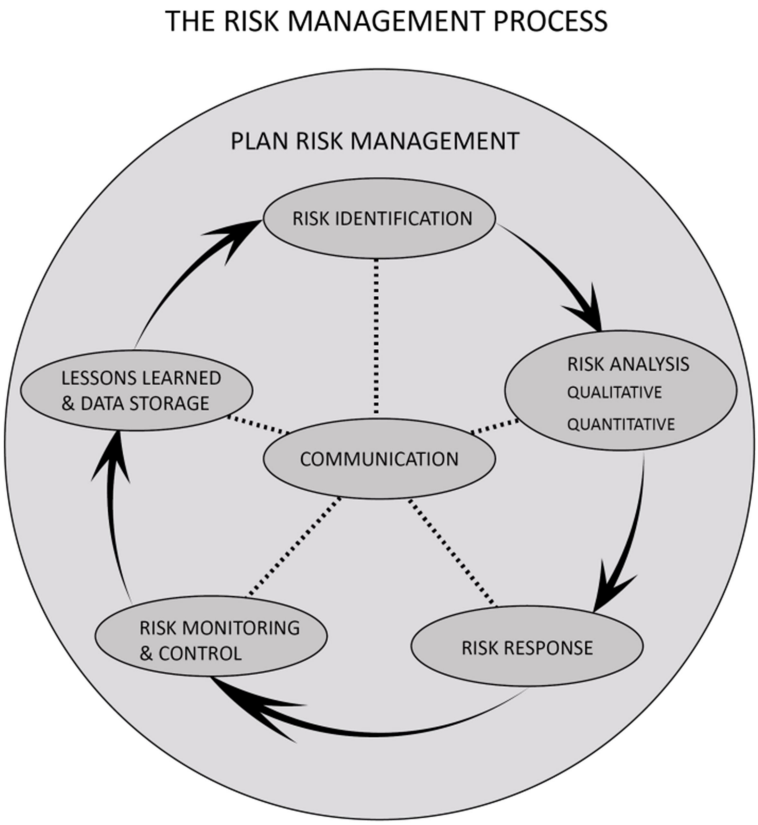


Figure 7 -2.7. The risk management process. Self-Produced

As it is possible to see, through all these phases, several benefits for the project can be found. But not only for the project itself, there are also benefits for the participants. Clear understanding and awareness of risks, more control of the whole project and an effective process of problem solving are main examples.

Despite the information analyzed before, not all are advantages while applying RM. A great amount of time can be waste if the risks are not assessed properly. A lot of resources can be derived to assess risks that are unlikely to occur, losing profitability on the entire project. Although nowadays inside the companies they know most of the benefits of RM, due to the luck of knowledge and many doubts whether these techniques really work, RM processes are rarely used (Banaitis & Banaitiene, 2012).

The level of risk of a construction project depends on the level of complexity that it presents. It used to happen, that as bigger as a project is (in time and area), more potential risk may face. The main important factors that can arouse the appearance of risks are related with financial, quality, time, design and environmental factors (Gould & Joyce, 2002).

As mentioned before, one thing is clear: every project has risks, and it is impossible to deal and eliminate them all. RM should be used as a tool to keep a balance between time, cost and quality with the intention to deal with as many risk as possible and ones that will affect the project the most.

RM needs a constant effort to keep the efficacy at every step of the project. Is not possible to predict what will happen, however with a great effort and honesty is it possible to minimize risks and uncertainties in construction projects, always having in mind that even the most perfect and well executed plan is able to fail.

During the early stages of the project, the level of uncertainty acquires its higher value. Thus, the vast effort for managing risks and uncertainty should occur in this phase. On the other hand, it is the moment where the project has lowest levels of reliable data. Many of the decisions taken in the early stage of the project may have consequences on how the risks will manage throughout the life cycle. Because of this, and construction projects are one shot play (there are not two similar works), managers should be more proactive in managing risks than decision-makers.

In construction industry, two kinds of professional trainings can be found (Mulcahy, 2010). The first one encourages the belief that there is only one way to solve a problem on a project; the second one encourages that qualitative methods are the way to solve the problems. Use to happen that the first group is composed by engineers and the second group by architects. But the truth is that to effectively manage risks, it is necessary the combination of maturity to admit that there is not enough information to give a final answer to the client, and the intellect to analyze the available information.

3 RISK MANAGEMENT IN CONSTRUCTION

As in many other scenarios, every construction project is not free of risks. At the moment that the projects come into existence are exposed to risks. Moreover risks and uncertainties in construction practices are higher than in other industries.

Experience and research have demonstrated that most of the construction projects show cost overrun and schedule delays. Clear examples of that can be found in the construction of the Opera of Sydney and the Elbphilharmonie in Hamburg:

The Sydney Opera House is the iconic symbol of Australia being recognized all over the world. But not everybody knows that the building, originally schedule in 4 years and a budget of 7 million AUS dollars, ended up in 14 years of construction process and 102 million AUS dollars. The unclear goals in the competition, giving more importance in quality factors than in time or cost, the luck of skills of the executive committee and the obstacles that the government create by preventing changes during the works contributed to the final delays and cost overrun.

The Elbphilharmonie on the Kaispeicher is now the new centre of cultural, social and daily life of Hamburg. But many problems within the construction process and a disastrous organization by the local council are translated in a project where the cost overruns and the delay in time exceed in more than 10 times the initial parameters. The project started in 2001 with an initial budget of 77 million euros and has ended up costing 789 million, 7 years later than the date of completion of the works (2010), becoming the twelfth most expensive building in history. Luck of expert knowledge, the unrealistic low initial budget, the organizational chaos and the failure to contemplate the risks that a project of these dimensions entails, have been the triggering events to reach such situation.

The building sector is not only facing these problems. An investigation about the cost of public works in Europe and North America based in 258 transport infrastructures projects conclude that 9 out of 10 projects are underestimated. In the case of rail projects the actual cost is on 45% average higher than estimated costs (Flyvbjerg, et al., 2002). They realised that the luck of proper risk analysis, the poorly defined scope at the initial phase and external pressures that these projects are facing, are the factors that affects cost overruns.

Clearly, as the construction sector becomes more sophisticated and the society more complex, it is required a suitable RM.

In construction, due to the fact that every project is unique, risks differ between them. The complexities of each project can change the initial conditions of it. That is the main reason because several authors considered RM as the most difficult area of the PM areas (Winch, 2002; Potts, 2008; Banaitis & Banaitiene, 2012). Winch (2010) affirmed that the project is the process of reduction uncertainty through time. Then RM should be the centre of PM.

3.1 FACTORS OF RISK IN CONSTRUCTION

There are several factors that may affect risk in construction (Ehsan, et al., 2010):

- Complexity: Depending on the difficulty and complexity of a project risks could be higher.
- Historical: A new project developed with new technologies and procedures that were not used before is more prone to have more risks than a project done many times in the past.
- Experience and expertise of the stuff: The luck of knowledge of the members of a construction site could be translated in delays on time, poor quality and changes of the estimated costs.
- Team size: Sometimes difficulties with communication could arise in the increase of problems.
- Management Stability: Share the same vision and direction.
- Availability of resources: As more accessible are the resources the probability of solving problems is higher.
- Compression of time: It is not a common case that construction projects finished before it is expected. But is true that more time gives more flexibility and this leads to avoid risks.

The same article also listed the common sources of risk in the construction sector:

- Changes in the scope and requirements of the project.
- Errors related to design.
- The inadequate definition of responsibilities.
- Lack of skills of the construction workers.
- Subcontractors.
- Luck of contractor experience.
- The uncertainty about the relationships between the participants of the project.
- New technologies.
- Luck of knowledge of the construction site environmental conditions.
- Force majeure.

For an effective construction RM, many suggestions on risk classification have been proposed in the literature review. Table 7 -3.1 shows a summary of them.

Construction risk categories	Factors of risk	Reference	
Technical risk	Incomplete design	(Ehsan, et al., 2010)	(Project Management Institute, 2013)
	Appropriateness of specifications		
	Uncertainty over the source and availability of materials		
	Design process	The US Department of Transportation (2006)	
	Environmental factors		
	Inaccurate assumptions on technical issues		
	Requirements in fact sheets		
Logistical/Operational Risks	Availability of sufficient transportation facilities	(Ehsan, et al., 2010)	
	Availability of resources (construction equipment, spare parts, fuel and labour)		
Management related risks	Uncertain productivity of resources	(Ehsan, et al., 2010)	
	Industrial relations problems		
	Poorly definition of purpose, objectives and needs of the projects		The US Department of Transportation (2006)
	Delays of contractor or consultants		
	Errors in schedules		
	Communication breakdowns		The US Department of Transportation (2006)
	Luck of coordination		
	Inadequate workers, availability of resource or inexperience		
	Abundance of projects		
	No control over staff		
Organisational risks	Loss of critical staff		
	Luck of time		
	Changes of objectives		
	Inconsistence of cost time and quality		
External risks	Contractual regulations	The US Department of Transportation (2006)	(Mulcahy, 2010)
	Force majeure		
	Social factors		
	Environmental factors		
Internal risks	Political issues, exchange rates, etc.	(CarreersinAudit, 2013)	(Tah & Carr, 2000)
	Non-compliance of information breaches	(Ehsan, et al., 2010)	(Project Management Institute, 2013)
Environmental and physical risks	Weather and seasonal implications	(Ehsan, et al., 2010)	
	Natural disasters		
	Geotechnical	(Guerra & Teixeira, s.f.)	
	Subsurface & phreatic level conditions		

Construction risk categories	Factors of risk	Reference	
Financial risks	Availability and fluctuation in foreign exchange	(Ehsan, et al., 2010)	
	Delays in payment		
	Inflation		(Guerra & Teixeira, s.f.)
	Local taxes		
	Funding	(Guerra & Teixeira, s.f.)	
Socio-political risks	Repatriation of funds	(Ehsan, et al., 2010)	
	Constraints on the availability and employment of expatriate staff		
	Customs and important restrictions and procedures		
	Difficulties in disposing of plant and equipment		
	Insistence on use of local firms and agents		
	Availability of soil	(Guerra & Teixeira, s.f.)	
	Environmental pressures		
	Regulations		
	Strikes & public disorders		
Security risks	Vandalism	(Guerra & Teixeira, s.f.)	
	Terrorism		
	Corruption		
	Assaults		
	Negligence		
	Intrusion		
Contractual and legal risks	Delays in dispute of resolutions	(Guerra & Teixeira, s.f.)	
	Delays in payments		
	Changes in the negotiation		
	Insolvencies		
Acceptable risk	Do not have a negative impact on a project	(Ehsan, et al., 2010)	
Unacceptable risk	Negative impact on a project		
Short term duration risk	Impacts that are visible immediately		
Long term duration risk	Impacts that are visible in the future		
Manageable risk	Risks that can be accommodate		
Unmanageable risk	Risks that cannot be accommodate		
Business risk	Risk of loss or gain		
Pure risk	Risk of loss exclusively		

Table 7 -3.1 Risk Classifications. Self-Produced

It is necessary to take care about all of these types of risk and identify the key risk factors in every category depending on the nature of each project.

3.2 MANAGING RISKS IN CONSTRUCTION

Ehsan, et al. (2010) established several advantages while managing the risk in the construction sector:

- Attainment of objectives
- Reliability of shareholders
- Capital cost reduction
- Decrease the uncertainty
- Increase of the value

Banaitis & Banaitiene (2012) provided other benefits like the identification and analysis of risks, the effective use of resources and improvement of the construction management process. Also with "quality", risk is the term that is used more often in construction. As it is shown in Figure 8 -3.2 despite the fact that the use of RM affects the cost of the project in the beginning step, this is offset by the advantages mentioned before. This will result in a reduction of costs in the period of realisation of the project as well as in a reduction of the operational time. The analysis of the risk potential of a project shows how the risk of the project affects to the risk situation of the company.

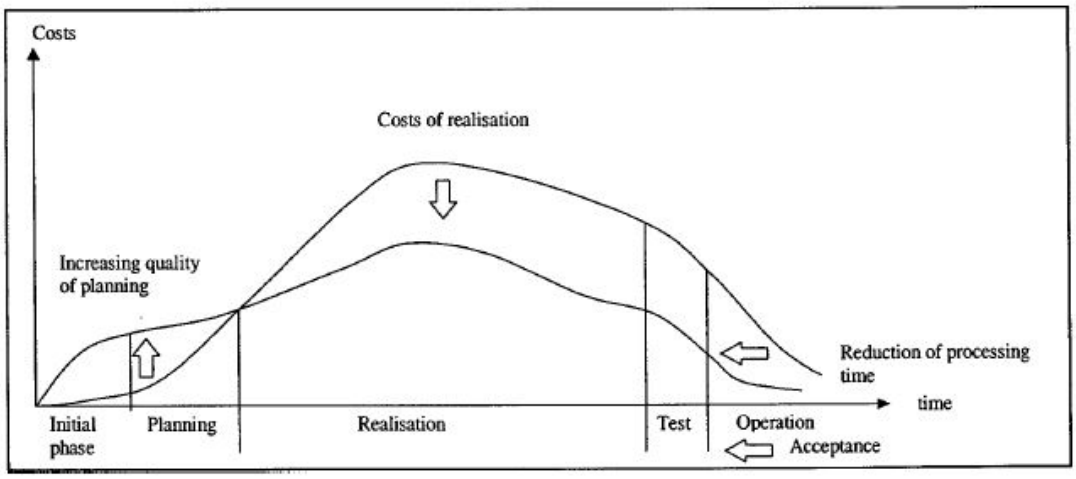


Figure 8 -3.2 Potential over the use of RM in construction projects **(Schieg, 2010)**.

Even though more construction companies are starting to be more conscious about the necessity of RM processes, they do not apply methodologies and techniques for RM. Many researches reveal that construction companies of the construction sector deal with project risks using their own judgement based on experience and intuition (Akintoye & Macleod, 1997; Ehsan, et al., 2010). The main reasons for this approach are based on the ignorance of the team members in managing RM techniques, doubts presented related to the utility of risk response methodologies and their difficulties to implement valid data. This contradicts the fact that the sector is trying to have more control of the projects alike become more cost and time efficient.

3.3 SME´s IN CONSTRUCTION

Small and Medium enterprises (SME´s) in Europe represent a significant part of its economy (Eurostat, 2017). The 99% of all businesses in the EU are created by these kinds of companies, employing over 90 million people. They provided 2/3 of the private sector employment and create around 85% of new jobs.

Particularly, construction industry provides 18 million jobs and makes a contribution of about 9% of the European Union (EU) GDP. Up to 95 % of the companies are micro-enterprises or SME´s (Figure 9- 3.3), being these ones the companies that more employ generate. Unlike large companies, SME´s tend to focus on specialized tasks and construction itself. On the other hand, great players are more committed to civil engineering and offer a wide variety of services.

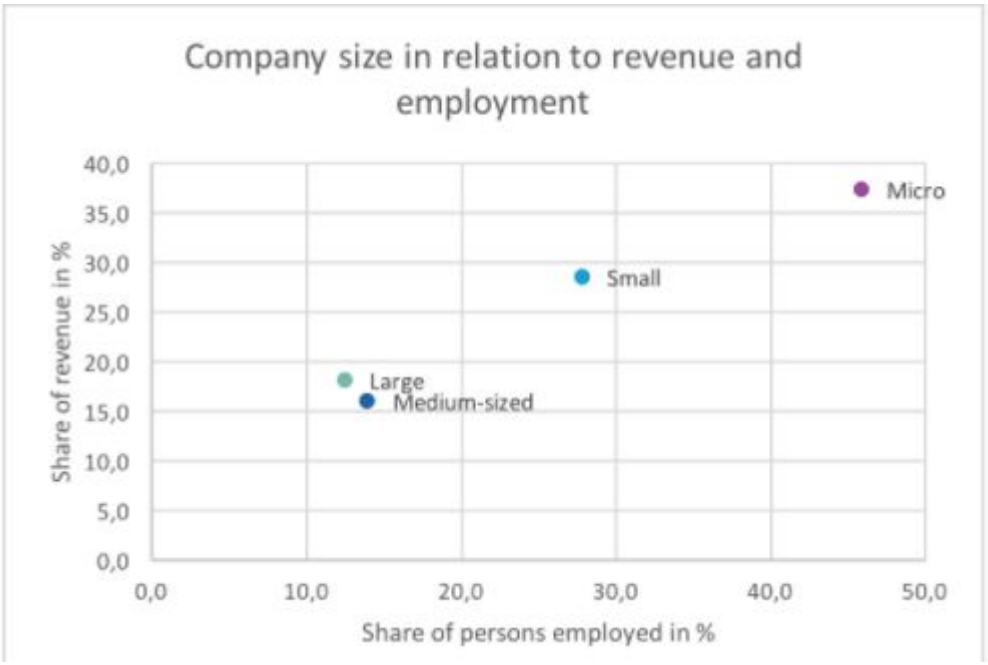


Figure 9 -3.3 Company size in relation to revenue and employment. https://buildingradar.com/es/construction-blog/la-industria-de-la-construccion-en-europa/

Because of the resource limitations to respond to different hazards that can cause huge amount of loss or insolvency, this kind of enterprises need to increase and perform the RM processes, unlike the large organizations that have more resources. These kinds of companies do not usually use some of the most recognized standards as the PMBOK mentioned before (Table 8 -3.3). This is due to several factors like the complexity compared with the size of the projects or the ignorance or luck of knowledge of the managers about the matter.

Aspect	Large company (>250 workers)	Medium company (between 50 and 250 workers)	Small company (between 10 and 50 workers)	Micro-company (<10 workers)
Taking strategic decisions	General management/Project Manager Director	General Management	General Management	Business owner
Taking tactical decisions	Project Manager Director	Functional management	General Management	Business owner
Making operational decisions	Project Manager	Project coordinator	Functional director	Functional director
Training in project management	Important	Average	Scarce	Non existent
Types of projects	Technological innovation	Innovation/R & Dri	Product development/Implanting management systems	Adapting to the market or regulation
Degree of uncertainty in the projects	Significant-average	Medium	Scarce	Scarce
Technological complexity	High	Medium	Medium-low	Low
Project size (absolute)	Large	Medium	Small	Small
Project size (relative)	Medium	High	High	High
Number of simultaneous projects	Significant	Medium	Low	One
Availability of human resources	Average	Average	Scarce	Scarce
Availability of technical resources	High	Average	Low	Low
Existence of management systems/methodologies	Project management/Innovation management	Quality / NPD management	Quality	None

Table 8 -3.3 Project and organization according to their size. **(Perez & Marcelino, 2012)**

In order to achieve a high level of RM practices it is necessary to develop an appropriate RM framework which addresses the requirements, resources, and preferences of the SME´s in construction sector (Sommerville, et al., 2015) and also decrease costs while managing risk.

3.4 PROJECT LIFE CYCLE

The PLC may help in the identification of which phase is needed to pay more attention of the project in order to proceed with the methodology. It is the series of sequential phases that a project goes through from the initial point to the end (Project Management Institute, 2013). These phases can be divided by objectives, deliverables, milestones or financial availability. It provides the basic framework from the project to be managed.

According with the PMI 4 phases are identified: Starting the project. Organizing and preparing, Carrying out the work and Closing the project.

The following Figure 10 -3.4 shows the relation between cost and time during the different phases of the life cycle of a project. At the beginning cost and staffing levels are low, they increase and reach a peak when the work is carry out and drastically decreases while the closure is approaching. As it is logical, this cannot be applied at all projects. Some of them may need significant cost at the starting phase for instance.

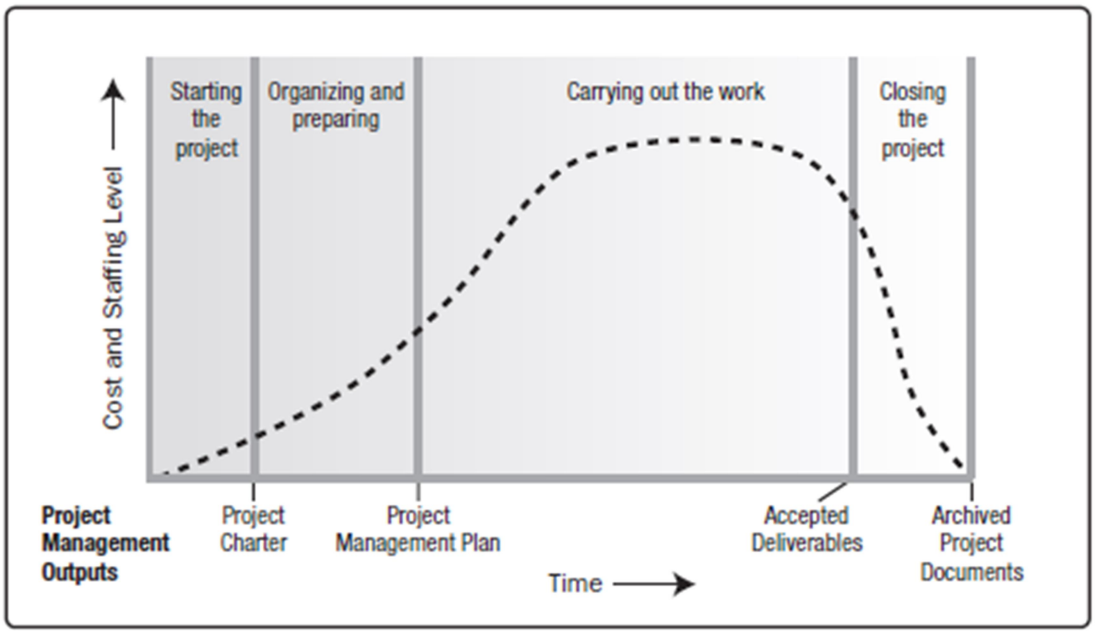


Figure 10 -3.4 Relation between costs and time during the PLC. (Project Management Institute, 2013)

On the other hand, risk and uncertainty are higher at the beginning of the project and decrease as soon as the decisions are reached, while the cost of any change or correcting errors flows in the opposite direction as It is shown if Figure 11 -3.4.

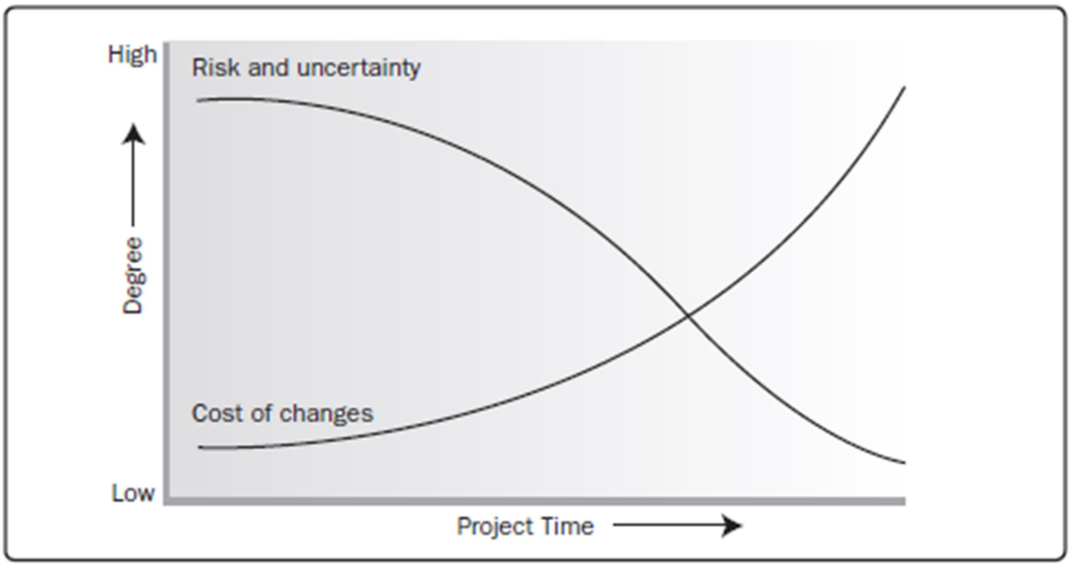


Figure 11 -3.4 Relation between cost and Risk & Uncertainty during the PLC. (Project Management Institute, 2013)

Knowing the production processes of the company also helps to understand in which part the main problems erases.

As Boquera (2015) stated, there are different types of production processes:

- Continuous process
- Chain process
- Batch process
- Process by project

Inside construction industry the ones that are more usual are the processes by project. This kind of processes are developed in a different way depending on the product, they have a specific end and in most of the cases are developed in a specific place where the product is needed. The main characteristics are temporality and uniqueness.

3.4.1 PROJECT PHASES

Every project consists in a large number of activities or actions interrelated with each other. Once there are completed they lead to the completion of the project.

Every product in construction is different from the previous one. They are developed only once in most of the cases and it is difficult to know the price and the final design until the end of the process. This is due to several factors as the difficulty of mechanizing the productive processes, the realization of the activities in different places every time and in distinct circumstances, the heterogeneity of the productive processes and because the activities begin and ends many times.

SME´s in the construction sector can be involved in many different activities during the life cycle of a project.

- Design face: Financing, Drafting, Project writing, Subscription of secures, Control
- Tendering process: Economical study, Technical study, Bids
- Construction phase: Economical control, Quality control, Environmental control
- Waste Management: Control
- Maintenance: Maintenance, Updating, Improvement

The activities are developed throughout the project process in the following way:

The promoter (private or public) identifies a problem, need or an opportunity and makes the decision solve the problem or take advantage of the opportunity. After an initial planning, the realization of a technical project designed by skilled technicians has to be done.
The promoter is also responsible for finding the means of financing and managing the entire process. Sometimes, when he does not have the capability to do it, hires PM specialists to do it.
He is also the one that contract the execution of the technical project to a constructor and the site management to the appropriate technicians. The constructor will need materials and other inputs (machinery, workforce, tools, etc.) that will receive from its suppliers. Part of the execution process is entrusted to other subcontractors or specialized companies.

Both the constructor and the technicians in charge of the technical project and the site management need the help of specialized auxiliary services.

Once the construction is finished, the process ends with the use and/or exploitation of the work executed.

The variety of construction companies arise as they perform one or more activities mentioned before as well as through the aggrupation and combination of the different stakeholders.

From the point of view of a SME´s of the construction sector is it possible to distinguish the following phases:

- The promotor, after finding a necessity or opportunity, commissions the implementation of a technical project to qualified technicians.
- The promotor also asks to several construction companies for a bid to develop the construction works expressed in the technical project. The constructions companies are in charge to carry out technical and economical study for this project. It is possible to differentiate between private or public promotors. If it is private, the construction companies are chosen freely. If the public administration is in charge, there are specific normative for the construction companies that tend to present the bids.
- After the presentation of the bids, the technical and economic negotiation takes place. The contract is the key piece that will condition the economical result of the works.
- Preparation, execution and finalization are the following steps for the whole process of the construction project.

It could be mentioned two different phases related with the maintenance and the waste management, but there are not going to be of interest for the purpose of this master thesis. The Tendering Process is the phase where more attention will be paid.

3.4.2 TENDERING PROCESS

Many definitions of tendering can be found in different sources. Patil, et al. (2016) defined it as a process of preparing and submitting a conforming offer for acceptance to carry out a particular work for a price, transforming the estimation in a bid.

Hassan (2015) stated that a proper tendering process embraces two main objectives:

- The promoter can obtain realistic and competitive prices for the project
- The contractor completely understands the requirements of the works that it is hired for.

In traditional path the process starts at the end of the design phase and the promoter, before hiring a contractor, asks for help to a professional team or consultant. This way includes the following types tendering process:

- Open tendering: Anyone is able to submit a tender in equal conditions and opportunities. This is a method commonly use in small projects. Due to a high competition, this method attracts the most economical offers. Nevertheless the costs of administration are high and sometimes the most economical bid comes from contractors without the capacities, thus could increase the risks of the project to be completed.
- Restricted tendering: In this procedure every business could ask to participate, but only the preselected ones will be able to submit the tenders. There is a limit of 37 days to request participation, counted from the publication of the contract. Then the public authorities are the ones that select at least 5 candidates. The candidates have 40 days to submit the tender.

- Negotiated tendering: it is recommended for contracts with a great value of specialization. The engagement with the project is possible in an early stage, but the competiveness is lower.
- Competitive dialogue: Public authorities must invite a minimum of 3 candidates to define the technical, economic and legal aspects. It is used for complex contracts where the Public authority is not able to define the project specification at the beginning.
- Electronic auctions: It is an iterative process where after a first evaluation of the offers, and the establishment of a date, time and number of bidding rounds, an electronic device allows the classification of the bids through automatic evaluation methods.
- Selective tendering: This process may give some clients more reliance about the fact that the requirements will be satisfy. Tenderers are selected from a list of contractors that previously have proved that are qualify for specific works. Promoters only submit tenders by invitation. Selective tendering might be appropriate for complex contracts but can exclude those companies that are trying to grow in a new market.
- Serial tendering: This process is like a hybrid of the open tendering but with negotiation. It is used when there are phases with similar work, normally for an arranged period of time: Minor works, maintenance or repetitive projects. The advantages of this kind of tendering process are cost reduction and the encouragement to the suppliers to provide low rates in order to secure a continuous programme of work. Still, it could be exclusive and therefore without competition.
- Framework tendering: Clients can invite tenders from services and good suppliers when required to carry out the works over a period of time. In that way one or more suppliers are selected and the client is able to select the appropriate one for the work. With this process, time consuming of the pre-qualification process is avoided and the costs are also lower.
- Single-stage and two-stage tendering: The contractor is involved in the first design of the project. In that way the details and agreement on the price to the design and construction of the project is fixed. The risk of the contractor is lower and gives benefit to the promoter in time cost and precision.

It shall be mentioned the education of the promoter that will decide the final award of the bid is crucial. The understanding that not only the cheapest bid will be the best is a basic need and a cultural change, extremely important nowadays.

Understanding all of the risks that will appear in a project till its finalisation before making the decision on the price of the bid and the support to the contractor to understand the project nature will help to complete the project under time and budget.

4 PROPOSED METHODOLOGY FOR RISK MANAGEMENT IN PROCUREMENT FOR SME´S

4.1 GENERAL DESCRIPTION

According with the literature review the initial and final phase of the projects are the ones that focused the most part of the attention. Another important fact is that from the beginning, the election of projects is not the best. Since the crisis hit few years ago, the need for projects to be developed by the company increased drastically. But not all of them are properly chosen, and this fact could lead to the appearance of more risks.

SME´s with the intention of presenting a bid for a private and especially for a public tenders have to deal with risks. Risks must be identify and evaluate in order to determine if the project is worth it or not to be developed. This decision has to be made with scarce information and short time. Experience and managing skills of the project managers in charge are relevant. For those with fewer aptitudes, time or money a qualitative analysis of the risks may be helpful (González, 2014).

The purpose of this methodology is to facilitate small and medium construction companies the decision-making based on a risk analysis during the tendering process of a project to help them to make the right decision at the moment of the bid elaboration and presentation.

The intention is to be used both, by experts in the field and those who have recently begun their professional path in the construction industry. The idea is to create a proposal that will be use over an over different projects. This will create a larger database every moment that the methodology is used so that project after project it will be faster and more practical the evaluation of the tendering process.

Some considerations that the methodology has to approach:

- It has to provide a detailed overview of each project in order to identify risks.
- It has to be simple to use.
- It has to provide fast documentation and simple tools to use and understand.
- It has to be flexible for all type of construction projects that the company is working with.
- The participation and access to information through the communication between the parties is a fundamental key.
- Extreme importance has to be taken to the lessons learn to increase quality and do not fall into the same mistakes over an over

Figure 12 -4.1 shows the overall view of the methodology proposed based in all the literature review and dispose the following steps:

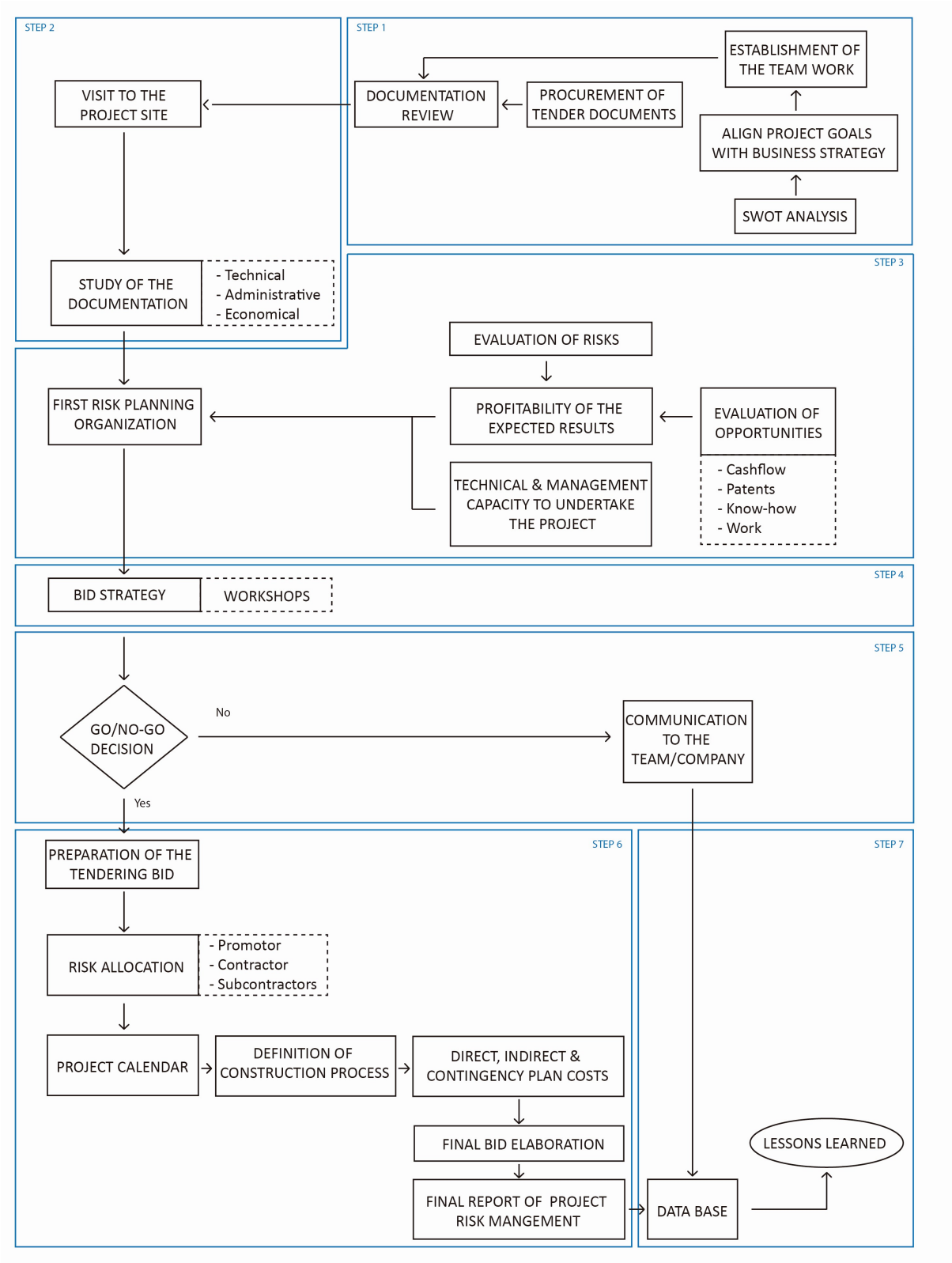


Figure 12 -4.1. New Risk Management Methodology for Tendering Processes. Self-Produced.

4.2 STEP 1: ALIGNMENT OF PROJECT & BUSINESS GOALS AND ESTABLISHMENT OF THE WORK TEAM

After the procurement of the tender documents a first review of the documents should be done. For that it is necessary to stablish the work team that will be in charge of the overall process. Corporate strategic management of the company and individual project RM should be linked in order to guarantee that the objectives could be achieved. It is important to understand which is the technical and management capacity of each member of the team and the entire company to undertake the specific project. A very useful tool to define the objectives of the company, to enhance strengths and opportunities and to decrease weaknesses is to perform a SWOT analysis (Marcelino-Sádaba, et al., 2013). The general objective of the project as well as the specific objectives related with the strategic objectives of the company should be detected. It is also essential to define deliveries for each step that will help to define later where the mistakes were in order to correct them.

4.3 STEP 2: STUDY OF THE DOCUMENTATION

With the company objectives clear and the project team selected a proper study of the tendering documents is needed. It should be both administrative-economical and technical study supported by the proper data base achieved from other projects. It is necessary to schedule an initial visit to the work site to have a clear idea of where the project will be place and visual documentation of the worksite to facilitate the mentioned study. The study of the documentation should be finalised with a report identifying the key aspects of the project in every area.

4.4 STEP 3: PLANNING ORGANIZATION

When this study is done, a first planning in the risk organization is necessary. It is important to know the management and technical capacity of the company and the profitability of the expected results. A proper evaluation of the opportunities that risks generate could lead to the success of the project. There are new challenges that not only the big companies should face. Taking into consideration the new trends that the society is facing nowadays, different problems could be seen as interesting opportunities to grow as a company.

Stimulating demand, training, innovation and energy efficiency and climate change are some of them. Sustainability and Energy efficiency are two topics that have already been written and will continue to be written as crucial factors for the correct development of the planet. Companies that apply sustainable and efficient methodologies not only improve the company image but also seem to be more attractive to clients with a new mentality and who value this fact as an increase of profitability. Also the EU provides economical aids for those companies or promotors that promote and try to innovate with the intention of improving the environment. Horizon 2020 or LIFE (Program for the Environment and Climate Action) are two examples of it. Also, opportunity as a work to be done has to be taken into consideration since companies need projects in order to gain money and value to survive.

How to put in value the patents and how to improve the experience that the company has to develop the activities that can develop with a greater level of expertise (know-how) are crucial to take advantage of the opportunities.

Besides, it is necessary to take into consideration possible improvements with the cash flows. Avoiding late payments, stablishing an adequate credit with the banks, assure long-term financing for the purchase of those fixed assets, understand the planning process for tax impact in the activities and strategies of the company and apply the retention to subcontractors that correspond with the retention to the owner are examples of it.

To identify and analyse risks several methods or combination of methods mentioned in the previous chapters can be helpful. The next Table 9 -4.4 shows possible risks during the tendering process.

<table>
<tr><th colspan="4">TENDERING PROCESS</th></tr>
<tr><th>RISK CATEGORY</th><th colspan="3">FACTOR OF RISK</th></tr>
<tr><td rowspan="2">TECHNICAL RISKS & OPPORTUNITIES</td><td colspan="2">Luck of information
Incongruity between plans and reality
Incomplete design
Modifications in the project due to the client
Modifications in the project due to external factors
Modifications in the project due to the ignorance of the conditions of the project site</td><td>NEGATIVE</td></tr>
<tr><td colspan="2">Possibility of creating new patents</td><td>POSITIVE</td></tr>
<tr><td rowspan="3">LOGISTICAL and PHISICAL RISKS & OPPORTUNITIES</td><td rowspan="2">INTERNAL</td><td>Inconsistence of cost time and quality
Capacity of the company surpassed by the volume of work
Use of different programs or obsolete programs
Operational Accidents</td><td rowspan="2">NEGATIVE</td></tr>
<tr><td rowspan="2">EXTERNAL</td><td>Force Majeure
Suppliers
Specific delays, labour or material availability</td></tr>
<tr><td>Location of the plot
Transportation</td><td>POSITIVE/NEGATIVE</td></tr>
<tr><td rowspan="2">MANAGEMENT RISKS & OPPORTUNITIES</td><td colspan="2">Wrong actions due to the incorrect communication or luck of information
Changes in the scope and objectives
Inexperience of the team work and/or project manager
Modification or lose of project files by the team
Changes or rotation in the company personnel in charge of the project
Contractor do not participate in the design phase</td><td>NEGATIVE</td></tr>
<tr><td colspan="2">Integrating PM methodologies</td><td>POSITIVE/NEGATIVE</td></tr>
</table>

ENVIROMENTAL RISKS & OPPORTUNITIES	Geological, Geotechnical and/or Hydrogeological Instability Interference with existing public service networks Environmental impacts not foreseen in the environmental impact assessment Environmental liabilities Location of the project in protected areas	NEGATIVE
	Climate considerations	POSITIVE/NEGATIVE
	Sustainability and Energy Efficiency aids by the government Reuse and recycling of work materials	POSITIVE
FINANTIAL RISKS & OPPORTUNITIES	Variation of labour costs Variation of material costs	NEGATIVE
	Know - How initiatives Work itself Cashflow initiatives	POSITIVE
SOCIO-POLITICAL RISKS & OPPORTUNITIES	Strikes, termination of contracts or organizational breakdowns Tax modification because the implementation of a new government Insistence on use of local firms and agents Change of regulations Presence of press, neighbours and municipal entities Delays in obtaining licenses	NEGATIVE
CONTRACTUAL AND LEGAL RISKS & OPPORTUNITIES	Promotor Insolvency Other contractors by the promotor Not finding the right contractor Need to perform new procedures or permits	NEGATIVE
SECURITY RISKS & OPPORTUNITIES	Lose of information due to technical problems, electric damage or lose of database Impacts of accidents Stolen material in the company and in the plot Corruption Terrorism	NEGATIVE
HUMAN ERRORS	In general	NEGATIVE

Table 9 -4.4 Risks in Tendering Process. Self-Produced.

To proper analyse risks qualitative methods will be applied. A probability and impact matrix will be the method to follow. The % of probability of each risk to happen will be evaluated and after that the same process for the impact of the same risk in the project.

4.5 STEP 4: STRATEGY OF THE BID

With all of this in mind, the following step is the definition of the strategy of the bid. The decision of how to focus, plan and execute RM is necessary. Most of the risks and their characteristics analysed before must be understood by all of the stakeholders.

The creation of workshops where all of the parties at this stage of the project are involved will help with the proper definition and assessment of all of the risks. It is important to distinguish the different participants, the inputs and outputs and define the activities to be done. The duration of every workshop must not exceed several hours in order to make it effective and efficient. An example of a possible workshop can be the following showed in Figure 13 -4.5:

Figure 13 -4.5 Workshop model sample. Self-Produced.

The inputs come from the previous steps and the goal is to provide several outputs that will facilitate the final decision. Depending on the nature of the project, the participants involved and the activities proposed in the workshop, the results will be simple or more difficult to analyse.

At this point the information obtained is enough to make the decision to continue or not with the whole process.

4.6 STEP 5: GO/NO-GO DECISION

The GO/NO-GO decision is the process where opportunities are separated in those that will be sought and the ones that will not. It is one of the most important processes in construction (Construction Work Zone, 2015). It is not smart for a company to come after every single opportunity that comes along. The decision making has to be related with the attitude of the company, with its competences and the risk associated with the project. For that the definition of the framework for the project selection has to be done (step 1).

The GO/NO-GO decision should be made to participate or not in the tender. If there is no option to go forward with the project it is necessary to file the case, communicate the decision to the rest of the company members and make a document for the LL. The communication to the rest of the team is crucial. Transparency and clarity are key factors to be all in the same page of the project. If the decision is positive, the process continues with the preparation of the tendering bid. Depending on the kind of tendering process that the project is involved, different documentation may be needed.

4.7 STEP 6: PREPARATION OF THE TENDERING BID

When risk and hazards are identified and assessed, they have to be assign to one or more specific stakeholders involved in the project (Bunni, 2005). For that, the figure of the contract erases. Because of the legal characteristics, the construction contracts involve the participation of lawyers. Notwithstanding, technical experts in construction have a great responsibility on the final results, since they are the ones in charge of establishing a correct definition of the project that will be contracted and its management (Huidobro, et al., 2009). If there is a dispute between two parties and the risks are not allocated in that contract, the judge is in charge to allocate those risks. Usually, this allocation is based in shearing the risks between the parties involved.

For the elaboration of the final bid, it is necessary a clear study and a schedule of the project, the final definition of the constructive process and the estimation of the direct costs, indirect costs and the contingency plan costs with the intention to know the total cost of the project. The administration of the company should also review the total cost estimation and include the profits for the company as well as the taxes to be applied. Finally the bid is presented to the promotor.

4.8 STEP 7: DATA STORAGE & LESSONS LEARNED

According with Hari, et al. (2004), construction industry, and above all SME´s of the sector, has been managing their knowledge in an informal way the past years. Most of these enterprises think only in terms of tangible cash flow, without the implementation or access to re-use processes adopted in the daily practice. Capturing the knowledge will help the companies managing change, solving problems, to implement the innovation, making the LL effective and with the success of the overall plan. All of this will reduce the risks in each project.

All of these considerations are part of an integral and difficult procedure inside the Knowledge management practices that are not part of this final dissertation but they could be an interesting path to follow nowadays with the intention to help SME´s in their organizational growth.

4.9 LIMITATIONS

The implementation of the methodology will have to face a series of limitations imposed by the nature of the project and the information that the company will obtain from other sources:

- Time: Sometimes the time needed to present the economical bid in the tendering process is not enough. Depending on the type of the tendering process some differences arise (Bæk ,2017; Europa.eu, 2017 & FIDIC 2017) :
    - Public tender: After 52 days from the advertising of the tender
    - Restricted tender: 37 days to apply for Prequalification. 40 days for the tender and 7 days for action in between
    - Stand BY: From 112 to 168 calendar days
    - Stand Still: By mail 10 days and by post 15 days.
    - Contracts: After the letter of acceptance 28 calendar days
    - Commencement Day: After the letter of acceptance 42 calendar days
    - Detailed Time Schedule: Has to be prepared 28 calendar days after the commencement day by the contractor

  To this factor is also important the fact that several projects could be implemented at the same time at the company and the registration does not necessarily occur from the day after the call for the process. In that case time is even fewer.

  The preparation of the bids require time, and in SME´s of companies the number of employees is limited. This is important due to the fact that carrying out the risk assessment is not an indispensable task within the requirements to be presented in the proposal, and most of the times the employees are occupied with the mandatory tasks to present.

- Luck of information or limited data about the project: Occasionally, some of the expedients that contain the memory of the project, structure calculations, budget and technical planning have several errors or mistakes.

Contractors nowadays follow an informal process to develop a previous evaluation of the project during the tendering process. They assess costs and measurements from the most important work packages inside the total budget of the project. However they are not considering unforeseen situations that could be originated during the execution of the works.

As it is mentioned in previous chapters, regardless the intention and care that it is given when performing an economical study, it is still an estimation under conditions of uncertainty. The reasons for these uncertainties during the tendering process can be many: problems with prices, differences with actual and budgeted resources, variations with the estimations of time, changes in the project among others. The causes for these changes can be diverse: wrong assumptions, changes in the legal bases of the project, more knowledge about it, etc.

5 CASES STUDIES

To determine how this methodology could be applied in practice, different projects from the same company were analysed. The intention is to understand better the previous contents in a project organization and test whether the proposal would help SME´s to achieve the objectives previously mentioned and to assess the risk that currently escape to the consideration in this kind of companies. The analysis of the methodology will be focused on the risk analysis, evaluation and bid strategy with the intention to establish the GO/NO-GO decision. Greater importance will be given to the part prior the decision, where risks are properly identify and analysed.

5.1 DATA COLLECTION

To collect the appropriate data for the study, Oreco S.A. provided 3 projects executed after 2015. There are public and private projects which have reached different phases of the construction process:

- Rehabilitation and extension of the primary school Alonso Daniel Rodriguez Castelao (Public).
- Conditioning of the space for the enlargement of the university room of the UNED in premises of the Auditorium and Conference Hall of Vigo (Public).
- Supermarket reform (Private)

5.2 CASE STUDY 1: REHABILITATION AND EXTENSION OF THE PRIMARY SCHOOL ALONSO DANIEL RODRIGUEZ CASTELAO (VIGO-PONTEVEDRA)

5.2.1 PROJECT DESCRIPTION

In order to comply with the requirements of the Consejería de Cultura, Educación y Ordenación Universitaria, it is proposed to rehabilitate and expand the existing building (phase 2) by the incorporation of a new floor and the modification and rearrangement of different spaces of the original plans. This is the second modification after the almost completion of the Phase 1 planned for the end of July 2017. Plans and pictures can be found in Appendix B.

The original idea of the existing building is maintained, which only will be affected in its height. The distribution of the new spaces and the modified ones are carried out in the same way as in the lower floors, without modifying the typology of the educational building: large central corridor with all rooms open to it. Table 10 -5.2.1 shows the general data of this project.

REHABILITATION AND EXTENSION OF THE PRIMARY SCHOOL ALONSO DANIEL RODRIGUEZ CASTELAO	
CONSTRUCTION COMPANY	Oreco S.A.
CLIENT	Consellería de Cultura, Educación y Ordenación Universitaria (Public)
DESIGNER	Santiago Ezquieta Llamas
LOCATION	Pedra Seixa Nº 35_Navia - Vigo (Pontevedra) - Spain
TOTAL AREA	8.203 m^2
TIME LIMIT	9 months
WORK INITIATION DATE	17/07/2017
WORK FINALIZATION DATE	13/04/2017
TYPE OF TENDER	Open Tender
INITIAL BUDGET	1.612.831,51 €

Table 10 -5.2.1 Case Study 1 General Data. Self-Produced.

5.2.2 APPLICATION OF THE PROPOSED METHODOLOGY

To proper analyses how to approach the procurement of the project the methodology proposed in the previous chapter was applied.
A SWOT analysis was performed with the intention of analyzing the main objectives to achieve by the company and try to establish the appropriate work team for this project (Table 11 - 5.2.2).

STRENGHTS	WEAKNESSES
40 years of experience in this kind of works Committed and qualified staff Environmental quality certification (ISO 14001) Quality certification (ISO 9001) National and international location Relatively stable jobs	Use of programs without BIM methodologies Luck of knowledge in sustainable construction Luck of knowledge in Project Management techniques No cooperation with research institutes
OPPORTUNITIES	**THREATS**
Grow as a company To be known in the public sector Procurement of contracts with public entities Educate new people in the company More experience for employees To have more work to do	Recent financial crisis Possibility of not winning the tender Price inflation Companies with more economical and technical resources Climate conditions of the area

Table 11 -5.2.2 Case Study 1 SWOT Analysis. Self-Produced.

Following the SWOT analysis, the establishment of the work team will be based in the next aspects:

- Work experience in the field.
- Workload at the start of the process.
- Work experience in the company.

At least one Project Manager or Architect of the company will be part of the team, along with a site manager.

The study of the whole project is needed. It is necessary to understand the technical aspects provided by the designer, establish a first approach of how to combine these technical aspects with the workflow of the company as well as analyze the economic aspects and administrative documents required. Every plan, measurement and initial budget were investigated in order to find out if the data provided was correct. After this process the following conclusions were made:

- Some of the measurements provided by the public entities were confused or incorrect
- Incoherence between budget and measurements
- Health and Safety Study with some inconsistences
- The objectives of the company are different from the objectives of the client

Risks were identify and categorized taking into account Table 9 -4.4 of Chapter 4.4, the complete understanding of the project and using brainstorming with the project manager of the company. The followings were the risks identified during the first planning organization and incorporated to the next Table 12 -5.2.2 where are designate with a code and analyze with a probability and impact matrix (Appendix A).

REHABILITATION AND EXTENSION OF THE PRIMARY SCHOOL ALONSO DANIEL RODRIGUEZ CASTELAO							
RISK IDENTIFICATION				QUALITATIVE ANALYSIS			
Risk Code	Category	Risk	Threat (T)/Opportunity (O)	Probability (P)	Impact (I)	PxI	Risk ranking
P01-TR01	Technical	Incongruity between plans and reality	T	0,1	0,1	0,01	12
P01-TR02	Technical	Incomplete design	T	0,1	0,1	0,01	12
P01-LR03	Logistical	Inconsistence of cost, time and quality	T	0,9	0,8	0,72	1
P01-LR04	Logistical	Capacity of the company surpassed by the volume of work	T	0,3	0,2	0,06	8
P01-LR05	Logistical	Use of different programs or obsolete programs	T	0,5	0,4	0,2	3
P01-LR06	Logistical	Operational Accidents	T	0,3	0,8	0,24	2
P01-LR07	Logistical	Force Majeure	T	0,1	0,2	0,02	11
P01-LR08	Logistical	Suppliers	T	0,7	0,1	0,07	7
P01-LR09	Logistical	Specific delays, labour or material availability	T	0,3	0,1	0,03	10
P01-LR10	Logistical	Location of the plot	O	0,5	0,1	0,05	13
P01-LR11	Logistical	Transportation	O	0,5	0,1	0,05	13
P01-MR12	Management	Wrong actions due to the incorrect communication or luck of information	T	0,3	0,8	0,24	2
P01-MR13	Management	Inexperience of the team work and/or project	T	0,1	0,8	0,08	6
P01-MR14	Management	Modification or lose of project files by the team	T	0,1	0,4	0,04	9
P01-MR15	Management	Changes or rotation in the company personnel in charge of the project	T	0,3	0,4	0,12	5
P01-MR16	Management	Contractor do not participate in the design phase	T	0,9	0,2	0,18	4
P01-ER17	Environmental	Interference with existing public service	T	0,1	0,4	0,04	9
P01-ER18	Environmental	Environmental impacts not foreseen in the environmental impact assessment	T	0,1	0,8	0,08	6
P01-ER19	Environmental	Environmental liabilities	T	0,1	0,8	0,08	6
P01-ER20	Environmental	Climate considerations	O	0,7	0,4	0,28	14
P01-FR21	Financial	Variation of labour costs	T	0,1	0,4	0,04	9
P01-FR22	Financial	Variation of material costs	T	0,1	0,4	0,04	9
P01-FR23	Financial	Work itself	O	0,9	0,4	0,36	15
P01-PR24	Socio-Political	Strikes, termination of contracts or organizational breakdowns	T	0,3	0,8	0,24	2
P01-PR25	Socio-Political	Presence of press, neighbours and municipal entities	T	0,1	0,4	0,04	9
P01-PR26	Socio-Political	Delays in obtaining licenses	T	0,1	0,4	0,04	9
P01-CR27	Contractual	Need to perform new procedures or permits	T	0,1	0,2	0,02	11
P01-SR28	Security	Lose of information due to technical problems, electric damage or lose of database	T	0,1	0,8	0,08	6
P01-SR29	Security	Impacts of accidents	T	0,1	0,8	0,08	6
P01-SR30	Security	Stolen material in the company and in the plot	T	0,3	0,4	0,12	5
P01-SR31	Security	Corruption	T	0,1	0,8	0,08	6
P01-SR32	Security	Terrorism	T	0,1	0,8	0,08	6
P01-HR33	Human errors	In general	T	0,3	0,4	0,12	5

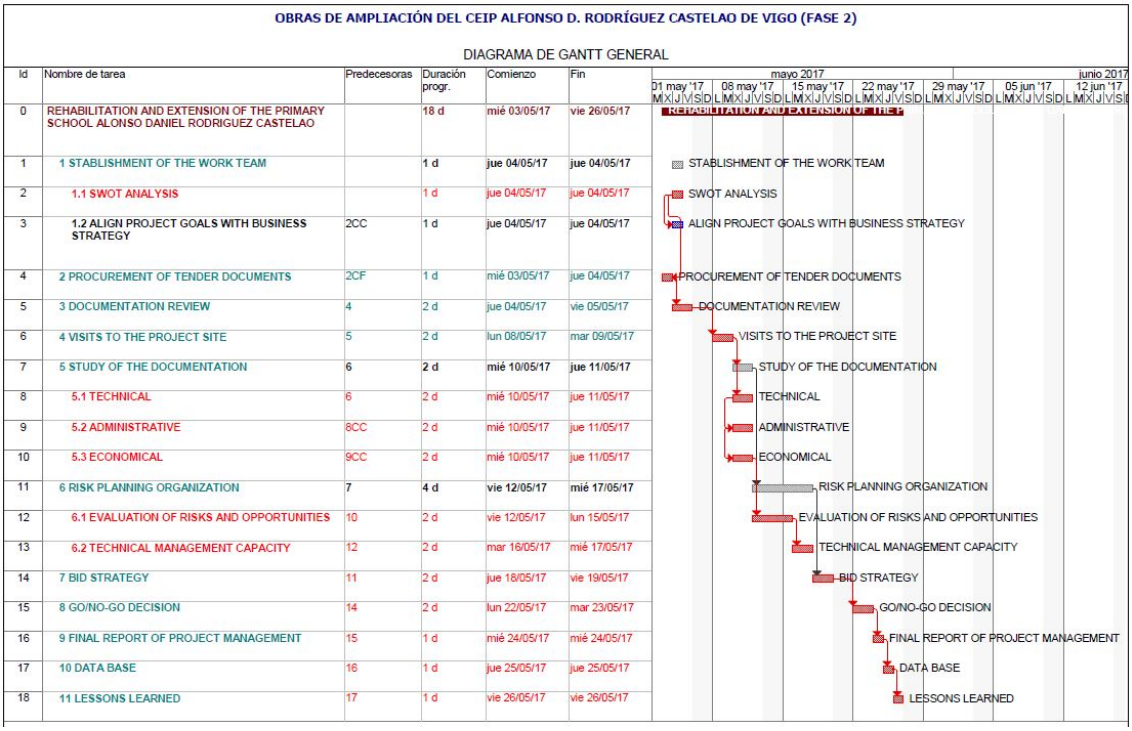
Table 12 -5.2.2 Case Study 1 Risk Analysis. Self-Produced.

Once the risks are identified the strategy of the bid must be performed. For that, a workshop has to be carried out where the team members of the company, the architect in charge of the project, a school representative and a public representative will review and validate the information, set up the communication between them and if is necessary implement new requirements. Everything has to be collected and archived so that it can be easily accessible.

According with the results analyzed and after the workshop where risks were confirmed, the suggestion is not to continue with the project. The high risk of not being able to carry out the works during the short time in which the building would be unoccupied, with the consequent breach of deadlines will result in a violation of the contract with the consequent economic contributions.

After the communication of the decision to the whole team, every member in the company should be informed, and proceed with the storage in the database of the results found. Also a document establishing the LL should be performed.

The next Figure 14 -5.2.2 shows the complete process through the time line, displaying the time afforded with the final decision.



OBRAS DE AMPLIACIÓN DEL CEIP ALFONSO D. RODRÍGUEZ CASTELAO DE VIGO (FASE 2)

DIAGRAMA DE GANTT GENERAL

Id	Nombre de tarea	Predecesoras	Duración progr.	Comienzo	Fin
0	REHABILITATION AND EXTENSION OF THE PRIMARY SCHOOL ALONSO DANIEL RODRIGUEZ CASTELAO		18 d	mié 03/05/17	vie 26/05/17
1	1 STABLISHMENT OF THE WORK TEAM		1 d	jue 04/05/17	jue 04/05/17
2	1.1 SWOT ANALYSIS		1 d	jue 04/05/17	jue 04/05/17
3	1.2 ALIGN PROJECT GOALS WITH BUSINESS STRATEGY	2CC	1 d	jue 04/05/17	jue 04/05/17
4	2 PROCUREMENT OF TENDER DOCUMENTS	2CF	1 d	mié 03/05/17	jue 04/05/17
5	3 DOCUMENTATION REVIEW	4	2 d	jue 04/05/17	vie 05/05/17
6	4 VISITS TO THE PROJECT SITE	5	2 d	lun 08/05/17	mar 09/05/17
7	5 STUDY OF THE DOCUMENTATION	6	2 d	mié 10/05/17	jue 11/05/17
8	5.1 TECHNICAL	6	2 d	mié 10/05/17	jue 11/05/17
9	5.2 ADMINISTRATIVE	8CC	2 d	mié 10/05/17	jue 11/05/17
10	5.3 ECONOMICAL	9CC	2 d	mié 10/05/17	jue 11/05/17
11	6 RISK PLANNING ORGANIZATION	7	4 d	vie 12/05/17	mié 17/05/17
12	6.1 EVALUATION OF RISKS AND OPPORTUNITIES	10	2 d	vie 12/05/17	lun 15/05/17
13	6.2 TECHNICAL MANAGEMENT CAPACITY	12	2 d	mar 16/05/17	mié 17/05/17
14	7 BID STRATEGY	11	2 d	jue 18/05/17	vie 19/05/17
15	8 GO/NO-GO DECISION	14	2 d	lun 22/05/17	mar 23/05/17
16	9 FINAL REPORT OF PROJECT MANAGEMENT	15	1 d	mié 24/05/17	mié 24/05/17
17	10 DATA BASE	16	1 d	jue 25/05/17	jue 25/05/17
18	11 LESSONS LEARNED	17	1 d	vie 26/05/17	vie 26/05/17

Figure 14 -5.2.2 Time Line of the Tendering Process. Self-Produced.

5.2.3 RESULTS & DISCUSSION

As it is possible to observe, several risks were identified during the overall process. The conclusion given by the application of the methodology is the NO-GO decision with this project. The main reasons about the final decision were:

- The new requirements that appeared after the documentation was published and could change the objectives of the company.
- The factor of high inconsistence of time, quality and cost is a risk that the company is taken very seriously since is in its policy, and as it is possible to see is the highest risk analysed.
- The possible breach of deadlines that will result in a violation of the contract and will be affected the economic strategy of the project.

Real results revealed that the project was not gained by ORECO and given to another company. Only the evaluation of the climate conditions and the traffic affections were performed during the tendering process and only one person of the stuff were in charge of the whole procedure basing the risk assessment in his experience.

If this project was analyzed with a risk perspective and the new methodology was applied, perhaps the company could discard the project in an early stage and be able to dedicate with more determination to the multiple projects that it had at that time. As it is showed in the previous Figure 14 -5.2.2 in 19 natural days the whole process would be done, saving 33 days to dedicate to other tasks or projects which were being carried out at that time and were more urgent.

5.3 CASE STUDY 2: CONDITIONING OF THE SPACE FOR THE ENLARGEMENT OF THE UNIVERSITY ROOM OF THE UNED IN PREMISES OF THE AUDITORIUM AND CONFERENCE HALL OF VIGO.

5.3.1 PROJECT DESCRIPTION

The project works consist in the conditioning of a series of spaces located in the 4th, 5th and 6th floors of the Auditorium and Conference Hall of the city. The works will not affect the facades or the structure of the building and will give rise to new classrooms, teacher's rooms, auditorium, computers room and coordination offices. The total area of the intervention, without the elevators and staircases is situated around 3400 m^2. Table 13 -5.2.1 shows the general data of this project. Plans and pictures can be found in Appendix C.

CONDITIONING OF THE SPACE FOR THE ENLARGEMENT OF THE UNIVERSITY ROOM OF THE UNED IN PREMISES OF THE AUDITORIUM AND CONFERENCE HALL	
CONSTRUCTION COMPANY	Oreco S.A.
CLIENT	Vigo Town Hall
DESIGNER	Iria Urdampilleta Pérez
LOCATION	Avenida de Beiramar Nº59 - Vigo (Pontevedra) - Spain
TOTAL AREA	3.400 m^2
TIME LIMIT	2 months
WORK INITIATION DATE	01/08/2016
WORK FINALIZATION DATE	30/09/2016
TYPE OF TENDER	Open Tender - Urgent Process
INITIAL BUDGET	600.000,00 €

Table 13 -5.3.1 Case Study 2 General Data. Self-Produced.

5.3.2 APPLICATION OF THE PROPOSED METHODOLOGY

The same procedure as the first project was applied. As it is a public project, the tendering process was the same (Open Tender) but in this case it was an urgent call so that the time to perform the bid proposal was limited to 25 natural days. Only few differences in the SWOT analysis and the risk identification and classification were found.

The SWOT analysis for this case will be similar to the previous one, with the only difference that in the box of threats it will no longer be the climate conditions affections because all the works will be perform inside the building (Table 14 -5.3.2).

STRENGHTS	WEAKNESSES
40 years of experience in this kind of works Committed and qualified staff Environmental quality certification (ISO 14001) Quality certification (ISO 9001) National and international location Relatively stable jobs	Use of programs without BIM methodologies Luck of knowledge in sustainable construction Luck of knowledge in Project Management techniques No cooperation with research institutes
OPPORTUNITIES	**THREATS**
Grow more as a company To be known in the public sector Procurement of contracts with public entities Educate new people in the company More experience for employees To have more work to do	Recent financial crisis Possibility of not winning the tender Price inflation Companies with more economical and technical resources

Table 14 -5.3.2 Case Study 2 SWOT Analysis. Self-Produced.

Continuing with the recommendations of the previous project, and with the similarities that both projects have, the election of the work team will be the same:

- Work experience in the field.
- Workload at the start of the process.
- Work experience in the company.

In this case, based on the smaller area to cover and the less complexity of the works to performed only one Project manager and the site manager will be part of the team.

The same procedure was applied for the study of the documentation taking into consideration plans, budget and measurements. In this case the results found were the following:

- Few incoherence's between budget and measurements
- The Budget was adjusted in a proper way
- All plans were well defined and they provided the AutoCAD files
- The objectives were easily achievable

Following the study of the documentation, Table 15 -5.3.2 shows the risk identification and evaluation through the same techniques previously showed.

CONDITIONING OF THE SPACE FOR THE ENLARGEMENT OF THE UNIVERSITY ROOM OF THE UNED IN PREMISES OF THE AUDITORIUM AND CONFERENCE HALL							
RISK IDENTIFICATION				QUALITATIVE ANALYSIS			
Risk Code	Category	Risk	Threat (T)/Opportunity (O)	Probability (P)	Impact (I)	PxI	Risk ranking
P01-TR01	Technical	Luck of information	T	0,1	0,1	0,01	10
P01-TR02	Technical	Incongruity between plans and reality	T	0,1	0,1	0,01	10
P01-TR03	Technical	Incomplete design	T	0,1	0,1	0,01	10
P01-TR04	Technical	Modifications in the project due to external factors	T	0,1	0,2	0,02	9
P01-LR05	Logistical	Inconsistence of cost time and quality	T	0,1	0,8	0,08	5
P01-LR06	Logistical	Capacity of the company surpassed by the volume of work	T	0,3	0,2	0,06	6
P01-LR07	Logistical	Use of different programs or obsolete programs	T	0,5	0,1	0,05	7
P01-LR08	Logistical	Operational Accidents	T	0,3	0,8	0,24	1
P01-LR09	Logistical	Force Majeure	T	0,1	0,2	0,02	9
P01-LR10	Logistical	Suppliers	T	0,7	0,2	0,14	3
P01-LR11	Logistical	Specific delays, labour or material availability	T	0,1	0,1	0,01	10
P01-LR12	Logistical	Location of the plot	O	0,5	0,1	0,05	11
P01-LR13	Logistical	Transportation	O	0,5	0,1	0,05	11
P01-MR14	Management	Wrong actions due to the incorrect communication or luck of information	T	0,3	0,8	0,24	1
P01-MR15	Management	Changes in the scope and objectives	T	0,1	0,4	0,04	8
P01-MR16	Management	Inexperience of the team work and/or project manager	T	0,1	0,8	0,08	5
P01-MR17	Management	Modification or lose of project files by the team	T	0,1	0,4	0,04	8
P01-MR18	Management	Changes or rotation in the company personnel in charge of the project	T	0,3	0,4	0,12	4
P01-MR19	Management	Contractor do not participate in the design phase	T	0,9	0,2	0,18	2
P01-ER20	Environmental	Interference with existing public service networks	T	0,3	0,4	0,12	4
P01-ER21	Environmental	Reuse and recycling of work materials	O	0,9	0,2	0,18	13
P01-ER22	Environmental	Climate considerations	O	0,9	0,8	0,72	15
P01-FR23	Financial	Variation of labour costs	T	0,1	0,4	0,04	8
P01-FR24	Financial	Variation of material costs	T	0,1	0,4	0,04	8
P01-FR25	Financial	Work itself	O	0,9	0,4	0,36	14
P01-FR26	Financial	Cashflow initiatives	O	0,5	0,2	0,1	12
P01-PR27	Socio-Political	Strikes, termination of contracts or organizational breakdowns	T	0,1	0,8	0,08	5
P01-PR28	Socio-Political	Presence of press, neighbours and municipal entities	T	0,3	0,4	0,12	4
P01-PR29	Socio-Political	Delays in obtaining licenses	T	0,1	0,4	0,04	8
P01-CR30	Contractual	Need to perform new procedures or permits	T	0,1	0,2	0,02	9
P01-SR31	Security	Lose of information due to technical problems, electric damage or lose of database	T	0,1	0,8	0,08	5
P01-SR32	Security	Impacts of accidents	T	0,1	0,8	0,08	5
P01-SR33	Security	Stolen material in the company and in the plot	T	0,1	0,4	0,04	8
P01-SR34	Security	Corruption	T	0,1	0,8	0,08	5
P01-SR35	Security	Terrorism	T	0,1	0,8	0,08	5
P01-HR36	Human errors	In general	T	0,3	0,4	0,12	4

Table 15 -5.3.2 Case Study 2 Risk Analysis. Self-Produced.

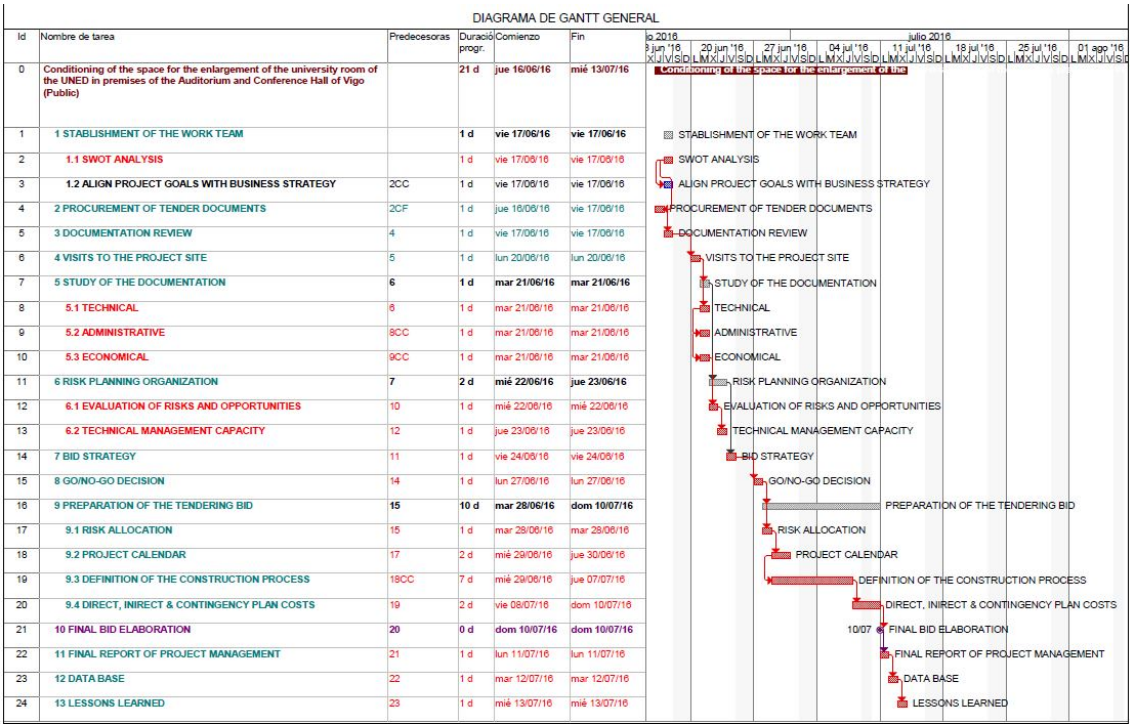
For the workshop performance, in addition to the team members selected for this project, a technical representative of the municipality of Vigo as well as a member of the university community and the architect who signed the plans will meet at the early stage and prearrange how will be the way of communication, identify more risks or if new requirement are needed.

In the same way as the previous case, the GO/NO-GO decision is the important matter. In this situation, the impact and probability of the opportunities are higher than the threats and the final decision is to continue with the process.

The steps related with the preparation of the tendering process were not analyzed deeply. But it is important to emphasize that every risk has to be assigned to a specific stakeholder and the contracts have to be developed taking care about every consideration previously mentioned.

An important value is given to the data storage and LL. Every risk has to be named with a specific code where the project number, the category and the number of the specific risk have to appear. Every document has to be storage in a specific folder easily accessible for every member of the company and including a document listing all the LL about the project.

Table 15 -5.3.2 showed all the steps of the methodology and its duration.



Id	Nombre de tarea	Predecesoras	Duración progr.	Comienzo	Fin
0	Conditioning of the space for the enlargement of the university room of the UNED in premises of the Auditorium and Conference Hall of Vigo (Public)		21 d	jue 16/06/16	mié 13/07/16
1	1 STABLISHMENT OF THE WORK TEAM		1 d	vie 17/06/16	vie 17/06/16
2	1.1 SWOT ANALYSIS		1 d	vie 17/06/16	vie 17/06/16
3	1.2 ALIGN PROJECT GOALS WITH BUSINESS STRATEGY	2CC	1 d	vie 17/06/16	vie 17/06/16
4	2 PROCUREMENT OF TENDER DOCUMENTS	2CF	1 d	jue 16/06/16	vie 17/06/16
5	3 DOCUMENTATION REVIEW	4	1 d	vie 17/06/16	vie 17/06/16
6	4 VISITS TO THE PROJECT SITE	5	1 d	lun 20/06/16	lun 20/06/16
7	5 STUDY OF THE DOCUMENTATION	6	1 d	mar 21/06/16	mar 21/06/16
8	5.1 TECHNICAL	6	1 d	mar 21/06/16	mar 21/06/16
9	5.2 ADMINISTRATIVE	8CC	1 d	mar 21/06/16	mar 21/06/16
10	5.3 ECONOMICAL	9CC	1 d	mar 21/06/16	mar 21/06/16
11	6 RISK PLANNING ORGANIZATION	7	2 d	mié 22/06/16	jue 23/06/16
12	6.1 EVALUATION OF RISKS AND OPPORTUNITIES	10	1 d	mié 22/06/16	mié 22/06/16
13	6.2 TECHNICAL MANAGEMENT CAPACITY	12	1 d	jue 23/06/16	jue 23/06/16
14	7 BID STRATEGY	11	1 d	vie 24/06/16	vie 24/06/16
15	8 GO/NO-GO DECISION	14	1 d	lun 27/06/16	lun 27/06/16
16	9 PREPARATION OF THE TENDERING BID	15	10 d	mar 28/06/16	dom 10/07/16
17	9.1 RISK ALLOCATION	15	1 d	mar 28/06/16	mar 28/06/16
18	9.2 PROJECT CALENDAR	17	2 d	mié 29/06/16	jue 30/06/16
19	9.3 DEFINITION OF THE CONSTRUCTION PROCESS	18CC	7 d	mié 29/06/16	jue 07/07/16
20	9.4 DIRECT, INIRECT & CONTINGENCY PLAN COSTS	19	2 d	vie 08/07/16	dom 10/07/16
21	10 FINAL BID ELABORATION	20	0 d	dom 10/07/16	dom 10/07/16
22	11 FINAL REPORT OF PROJECT MANAGEMENT	21	1 d	lun 11/07/16	lun 11/07/16
23	12 DATA BASE	22	1 d	mar 12/07/16	mar 12/07/16
24	13 LESSONS LEARNED	23	1 d	mié 13/07/16	mié 13/07/16

Figure 15 -5.3.2 Time Line of the Tendering Process. Self-Produced.

5.3.3 RESULTS & DISCUSSION

The risks analysed in this project showed that opportunities have more weight than threats at the time of making the GO/NO-GO decision. The most risky threats can be minimized if a proper analysis is made and those in which the values of the company are present were minimised comparing the previous case study.

In the real case, the procurement process for obtaining the bid was awarded to the company and the works were successfully solved on time. But according with the Project Manager, with a full analysis of risks in previous stages more problems could be avoided by the duration of the construction phase and time and effort could be minimised having a clear and organised workflow inside the company.

5.4 CASE STUDY 3: SUPERMARKET REFORM

5.4.1 PROJECT DESCRIPTION

The next project arises from the order of a private supermarket chain with the intention of conditioning a local for a subsequent commercial activity. The building is located within the municipal district of Vigo but far from the city center and with an easy access by road.

The edification has ground floor, mezzanine and basement and a total plot area of 5.028,46 m^2. The main activity will be developed in ground floor and in the mezzanine, where the machinery will be placed while the basement, with independent access will be dedicated to parking. It is a reform project where the only interventions are made in the facades, interior walls, vertical connections, finishes and installations, leaving the foundations, structural system and roof intact. Table 16 -5.4.1 shows the general data of this project.

SUPERMARKET REFORM	
CONSTRUCTION COMPANY	Oreco S.A.
CLIENT	Private Supermarket
DESIGNER	Classified
LOCATION	Vigo (Pontevedra) - Spain
TOTAL AREA	5.028,46 m^2
TIME LIMIT	7 months
WORK INITIATION DATE	07/04/2016
WORK FINALIZATION DATE	14/10/2016
TYPE OF TENDER	Private
INITIAL BUDGET	1.819.615,96 €

Table 166 -5.4.1 Case Study 3 General Data. Self-Produced.

5.4.2 APPLICATION OF THE PROPOSED METHODOLOGY

STRENGHTS	WEAKNESSES
40 years of experience in this kind of works Committed and qualified staff Environmental quality certification (ISO 14001) Quality certification (ISO 9001) National and international location Relatively stable jobs	Use of programs without BIM methodologies Luck of knowledge in sustainable construction Luck of knowledge in Project Management techniques No cooperation with research institutes
OPPORTUNITIES	**THREATS**
Grow more as a company Get new contracts with the same client Educate new people in the company More experience for employees To have more work to do More probability due to less competitors	Recent financial crisis Price inflation Climate conditions of the area Problems with suppliers Ambiguity in the final decision

Table 177 -5.4.2 Case Study 3 SWOT Analysis. Self-Produced.

In this case the SWOT analysis will vary because of the condition of the client (Table 17 -5.2.2). The private condition of the project makes the procurement easier due to the fewer competitors that participate but at the same time there are more specialise and the final decision lies in the client.

The same steps proposed for the tendering process that was applied in the public projects is used in the supermarket reform: establishment of the work team, study of the documentation and the planning organization. Table 18 -5.4.2 shows the risk identification and evaluation of the project:

SUPERMARKET REFORM							
RISK IDENTIFICATION				QUALITATIVE ANALYSIS			
Risk Code	Category	Risk	Threat (T)/Opportunity (O)	Probability (P)	Impact (I)	PxI	Risk ranking
P01-TR01	Technical	Luck of information	T	0,1	0,1	0,01	11
P01-TR02	Technical	Incongruity between plans and reality	T	0,1	0,1	0,01	11
P01-TR03	Technical	Incomplete design	T	0,1	0,1	0,01	11
P01-TR04	Technical	Modifications in the project due to the client	T	0,3	0,1	0,03	9
P01-TR05	Technical	Modifications in the project due to external factors	T	0,3	0,2	0,06	6
P01-LR06	Logistical	Inconsistence of cost time and quality	T	0,1	0,8	0,08	5
P01-LR07	Logistical	Capacity of the company surpassed by the volume of work	T	0,5	0,2	0,1	11
P01-LR08	Logistical	Use of different programs or obsolete programs	T	0,5	0,1	0,05	7
P01-LR09	Logistical	Operational Accidents	T	0,3	0,8	0,24	1
P01-LR10	Logistical	Force Majeure	T	0,1	0,2	0,02	10
P01-LR11	Logistical	Suppliers	T	0,7	0,2	0,14	2
P01-LR12	Logistical	Specific delays, labour or material availability	T	0,1	0,1	0,01	11
P01-LR13	Logistical	Location of the plot	T	0,3	0,2	0,06	6
P01-LR14	Logistical	Transportation	T	0,3	0,1	0,03	9
P01-MR15	Management	Wrong actions due to the incorrect communication or luck of information	T	0,3	0,8	0,24	1
P01-MR16	Management	Changes in the scope and objectives	T	0,1	0,4	0,04	8
P01-MR17	Management	Inexperience of the team work and/or project manager	T	0,1	0,8	0,08	5
P01-MR18	Management	Modification or lose of project files by the team	T	0,1	0,4	0,04	8
P01-MR19	Management	Changes or rotation in the company personnel in charge of the project	T	0,3	0,4	0,12	3
P01-MR20	Management	Contractor do not participate in the design phase	T	0,9	0,1	0,09	4
P01-MR21	Management	Integrating PM methodologies	O	0,1	0,8	0,08	12
P01-ER22	Environmental	Environmental liabilities	T	0,3	0,4	0,12	3
P01-ER23	Environmental	Climate considerations	O	0,9	0,8	0,72	16
P01-ER24	Environmental	Reuse and recycling of work materials	O	0,9	0,2	0,18	14
P01-FR25	Financial	Variation of labour costs	T	0,1	0,4	0,04	8
P01-FR26	Financial	Variation of material costs	T	0,1	0,4	0,04	8
P01-FR27	Financial	Work itself	O	0,9	0,4	0,36	15
P01-FR28	Financial	Cashflow initiatives	O	0,7	0,2	0,14	13
P01-PR29	Socio-Political	Strikes, termination of contracts or organizational breakdowns	T	0,1	0,8	0,08	5
P01-PR30	Socio-Political	Presence of press, neighbours and municipal entities	T	0,1	0,4	0,04	8
P01-PR31	Socio-Political	Delays in obtaining licenses	T	0,1	0,4	0,04	8
P01-CR32	Contractual	Promotor Insolvency	T	0,1	0,8	0,08	5
P01-CR33	Contractual	Other contractors by the promotor	T	0,1	0,2	0,02	10
P01-CR34	Contractual	Need to perform new procedures or permits	T	0,1	0,2	0,02	10
P01-SR35	Security	Lose of information due to technical problems, electric damage or lose of database	T	0,1	0,8	0,08	5
P01-SR36	Security	Impacts of accidents	T	0,1	0,8	0,08	5
P01-SR37	Security	Stolen material in the company and in the plot	T	0,1	0,4	0,04	8
P01-SR38	Security	Corruption	T	0,1	0,8	0,08	5
P01-SR39	Security	Terrorism	T	0,1	0,8	0,08	5
P01-HR40	Human errors	In general	T	0,3	0,4	0,12	3

Table 188 -5.4.2 Case Study 3 Risk Analysis. Self-Produced.

In this occasion the workshop will be carried out by the team members, the private client and a representative of the neighbours with the same intention as the previous cases. Results show that for the establishment of the GO/NO-GO decision only two important threats have to be taken into consideration. In any case, as well as the previous case, the value gained by the opportunities is much higher than by the threats and the decision at the end is to GO and continue with the overall process.

For the completion of the next steps the information provided by the company was not enough but the procedure should be like in the previous cases.

5.4.3 RESULTS & DISCUSSION

Even with the little information obtained of this project risks could be analysed to have a clear idea of whether or not continue with the tendering process. The risks identified were minimal and easy to plan a response to them and that is why the whole process should be developed.

Oreco, by that time won the tendering process and the reform of the supermarket is nowadays executed. Any RM methodology was implemented and only quality standards were followed by the company. There is no data collection about the problems that arose in the following steps of the PLC so in this case the implementation of the method is not clear enough.

This case study helps to understand the need to file in the database the every document related with the PLC for later analysis, especially for members of the company who may need to have access and know what happened in the work site, which where the main problems and why did they happen in order to provide solutions for future projects with similar characteristics.

5.5 GENERAL DISCUSSION

The tree cases studies were developed over a very similar period of time and the type and characteristics of the works analyzed are also close. Hence, the objectives set in the SWOT analysis are very similar also.

The following results collected in Table 19 -5.5 have been obtained from the three projects proposed by the company:

RISK IDENTIFICATION & ANALYSIS					
Category	Risk	Threat (T)/Opportunity (O)	CASE STUDY 1	CASE STUDY 2	CASE STUDY 3
Technical	Incongruity between plans and reality	T	0,01	0,01	0,01
Technical	Luck of information	T		0,01	0,01
Technical	Incomplete design	T	0,01	0,01	0,01
Technical	Modifications in the project due to the client	T			0,03
Technical	Modifications in the project due to external factors	T		0,02	0,06
Logistical	Inconsistence of cost, time and quality	T	0,72	0,08	0,08
Logistical	Capacity of the company surpassed by the volume of work	T	0,06	0,06	0,1
Logistical	Use of different programs or obsolete programs	T	0,2	0,05	0,05
Logistical	Operational Accidents	T	0,24	0,24	0,24
Logistical	Force Majeure	T	0,02	0,02	0,02
Logistical	Suppliers	T	0,07	0,14	0,14
Logistical	Specific delays, labour or material availability	T	0,03	0,01	0,01
Logistical	Location of the plot	O	0,05	0,05	0,06
Logistical	Transportation	O	0,05	0,05	0,03
Management	Wrong actions due to the incorrect communication or luck of information	T	0,24	0,24	0,24
Management	Changes in the scope and objectives	T		0,04	0,04
Management	Inexperience of the team work and/or project manager	T	0,08	0,08	0,08
Management	Modification or lose of project files by the team	T	0,04	0,04	0,04
Management	Changes or rotation in the company personnel in charge of the project	T	0,12	0,12	0,12
Management	Contractor do not participate in the design phase	T	0,18	0,18	0,09
Management	Integrating PM methodologies	O			0,08
Environmental	Interference with existing public service networks	T	0,04	0,12	
Environmental	Environmental impacts not foreseen in the environmental impact assessment	T	0,08		
Environmental	Environmental liabilities	T	0,08		0,12
Environmental	Reuse and recycling of work materials	O		0,18	0,18
Environmental	Climate considerations	O	0,28	0,72	0,72
Financial	Variation of labor costs	T	0,04	0,04	0,04
Financial	Variation of material costs	T	0,04	0,04	0,04
Financial	Work itself	O	0,36	0,36	0,36
Financial	Cashflow initiatives	O		0,1	0,14
Socio-Political	Strikes, termination of contracts or organizational breakdowns	T	0,24	0,08	0,08
Socio-Political	Presence of press, neighbours and municipal entities	T	0,04	0,12	0,04
Socio-Political	Delays in obtaining licenses	T	0,04	0,04	0,04
Contractual	Promotor Insolvency	T			0,08
Contractual	Other contractors by the promotor	T			0,02
Contractual	Need to perform new procedures or permits	T	0,02	0,02	0,02
Security	Lose of information due to technical problems, electric damage or lose of database	T	0,08	0,08	0,08
Security	Impacts of accidents	T	0,08	0,08	0,08
Security	Stolen material in the company and in the plot	T	0,12	0,04	0,04
Security	Corruption	T	0,08	0,08	0,08
Security	Terrorism	T	0,08	0,08	0,08
Human errors	In general	T	0,12	0,12	0,12

Table 1919 -5.5 Results Comparison. Self-Produced.

High risks were identified and assessed in the first public project, where one of the most important factors, the aim of every project: quality, cost and time was the fact with more probability and impact to happen. On the other hand, the analysis of the opportunities was not enough to consider this project viable, so that the suggestion is not to continue with the procurement of the project and dedicate time and effort to the other projects that the company were constructed at the same time.

The data obtained from the other two projects, one public and one private, revealed a lower impact of the threats and a positive influence of the opportunities. The GO/NO-GO decision is clear and in both cases the proposed process could be continued until the final bid elaboration.

In addition, this chapter will answer the research questions proposed at the beginning of the final dissertation based on this results and the comparison with the literature reviewed.

Which is best way to identify, implement and manage risk in construction industry?

It is difficult to establish a unique path where best practices are defined to identify and assess risks because every construction project and every construction company is different. Taking into consideration that the initial phase of a project is where risks are more difficult to identify and evaluate, most efforts should be made in this part of the PLC. Also a new mentality among the workers of the company is necessary as well as greater education in RM in the processes of professional training. The new methodology proposed intends to bring this knowledge of risk closer to the companies or managers without the proper education and facilitates another way to implement RM in construction industry.

How can we improve RM in terms of cost, time and quality in SMEs of the construction sector in Europe?

Applying the new methodology during this critical phase will help to have a clear view of the overall PLC, will allow to anticipate problems that may arise along the following phases of the construction process and will save time in case is not convenient to continue with the project procurement. This will be reflected in the fact that the projects will have a greater quality, time consuming at the end will be less and consequently the overall cost will be reduced.

Is there any difference between the public and the private sector while taking care of risks?

As it is mentioned before, risks can be found in every project. The severity and probability of each one could vary depending on each project. It is true that in private tendering processes only the invited companies are in the game, and this causes that some of the risks are reduced and some other erases. Is the client who will finally decide which is the offer more interesting for him and

But the process of taking care of these risks must be the same; the methodology has to be applied in the same way both for private and public projects in order to achieve the best results possible.

6 CONCLUSIONS

Through this Final Dissertation is possible to include a new methodology for RM in construction projects of SME´s. The following paragraphs summarises the most important conclusions from the master thesis.

Three projects of a construction company were analysed and the results showed that identifying and assessing risks during the tendering phase will help to establish the GO/NO-GO decision that will derive in benefits not only in quality and money, but also time consume by the workers of the company.

Despite of being three cases studies with similar characteristics where the works were done on an existing building, it is possible to observe how risks, whether they are threats or opportunities are different or their impacts are not the same. This makes each case study unique and therefore makes the risk identification and assessment more difficult.

Most of the professionals in construction are taking care of risks but they are not aware of it. They have them in mind and through its experience they manage to solve some of them, but the fact is that they are not doing it in a structured way.

Even risks are seeing as negative actions mostly, the fact is that the positive understanding of these risks generates more value whether or not making the GO/NO-GO decision. The opportunities generated by the construction project and the possibility to work in a sector where every day is more difficult to get inside are greater than the negative facts. This does not mean that the negative risks have to be forgotten. Quite the opposite, it is necessary to have a control of the negative consequences in order not to decrease value, quality and time of the PLC.

It is true that quantitative analysis provide more exact results than qualitative analysis, but for SME´s with less trained workers in risk management practices and with less resources and time to perform small and medium projects, qualitative techniques are more powerful tools to develop the methodology proposed.

Every project is different but risks stored in the database of the company as well as the Lessons Learned properly analysed, classified and easily accessible will make the methodology more efficient as many projects are carried out.

For the successful of a construction project leadership, management ability, and technical excellence are needed but also and effective planning and control and agile solutions during the development of the project. Selecting the right team, the clear communication inside the team and the rest of the stakeholders of the project and the support are key factors for the success of the project.

The analysis of risks during the tendering phase will establish the basis on which Risk Management could be developed during the execution phase, in case of winning the tender.

With only three cases study is difficult to determine the veracity of the methodology, but taking into consideration all of these aspects proposed in this final dissertation the intention is to stablish a conscience that would help to reduce the risks generated in the tendering process to avoid possible negative consequences in the subsequent processes of the project.

Further research is needed in order to stablish a proper manner to transfer Lessons Learned and improve the internal communication between different departments inside the company. This will create a really valuably assets for the company itself and will be reflected in the way to manage risk in construction.

Looking towards the future and with the new laws that are being incorporated or are already incorporated in many countries of the EU, it would also be advisable to study the ways in which SME´s can apply new technologies inside its normal practices. The combination of the technology with Risk Management Practices will help with the identification, analysis and monitoring and control of every risk. In recent years, Building Information Modelling (BIM) methodologies have been broken in the construction sector and its combination with RM practices would be a breakthrough. In any case, it will not be easy due to the same reasons that have been exposed previously since this kind of companies does not have the same economic and manoeuvring capacities as the big companies.

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8 APPENDIXES

APPENDIX A

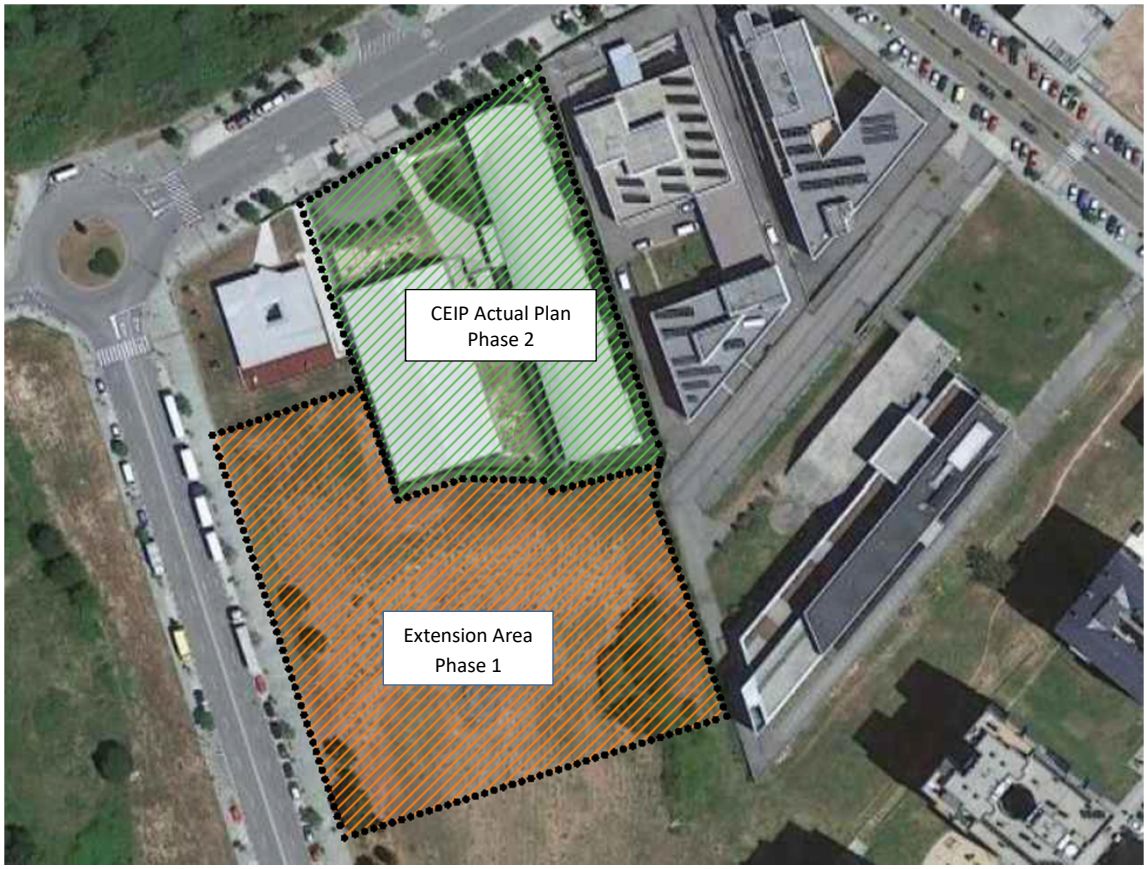
PROBABILITY AND IMPACT MATRIX

PROBABILITY AND IMPACT MATRIX										
PROBABILITY	THREATS					OPPORTUNITES				
0,7	0,04	0,07	0,14	0,28	0,56	0,56	0,28	0,14	0,07	0,04
0,5	0,03	0,05	0,1	0,2	0,4	0,4	0,2	0,1	0,05	0,03
0,3	0,02	0,03	0,06	0,12	0,24	0,24	0,12	0,06	0,03	0,02
0,1	0,01	0,01	0,02	0,04	0,08	0,08	0,04	0,02	0,01	0,01
IMPACT	0,05 (Very Low)	0,1 (Low)	0,2 (Mode rate)	0,4 (High)	0,8 (Very High)	0,8 (Very High)	0,4 (High)	0,2 (Mo dera te)	0,1 (Low)	0,05 (Very Low)

THREAT	0,8 - 0,18	OPPORTUNITY	0,8 - 0,18	High
	0,17 - 0,07		0,17 - 0,07	Moderate
	0,01 - 0,06		0,01 - 0,06	Low

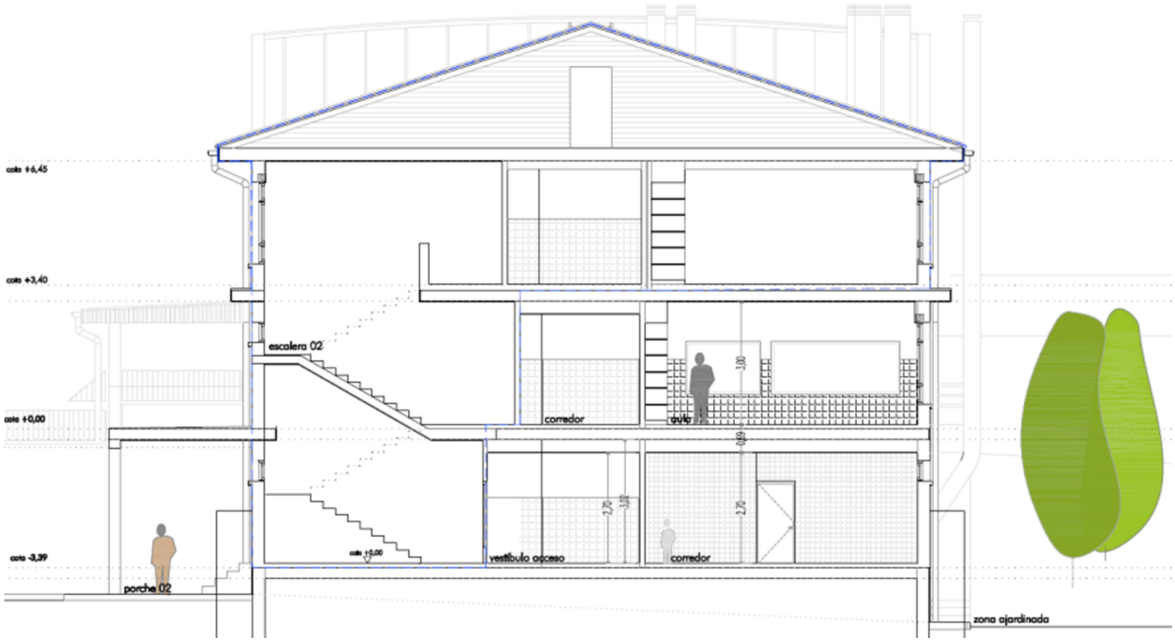
APPENDIX B

DOCUMENTATION REHABILITATION AND EXTENSION OF THE PRIMARY SCHOOL ALONSO DANIEL RODRIGUEZ CASTELAO (VIGO-PONTEVEDRA)



Location CEIP Alfonso Daniel Rodríguez Castelao

Actual Plan.Second Floor Phase 2 CEIP Alfonso Daniel Rodríguez Castelao.



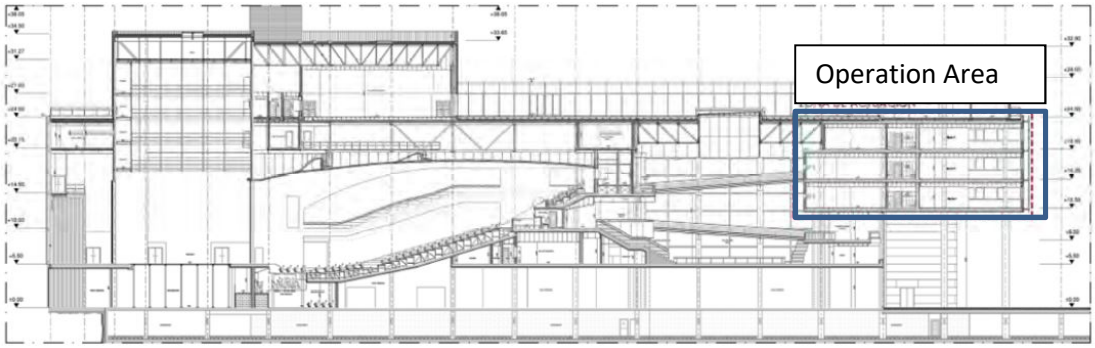
Section Phase 2 CEIP Alfonso Daniel Rodríguez Castelao.

Pictures Actual Building CEIP Alfonso Daniel Rodríguez Castelao.

APPENDIX C

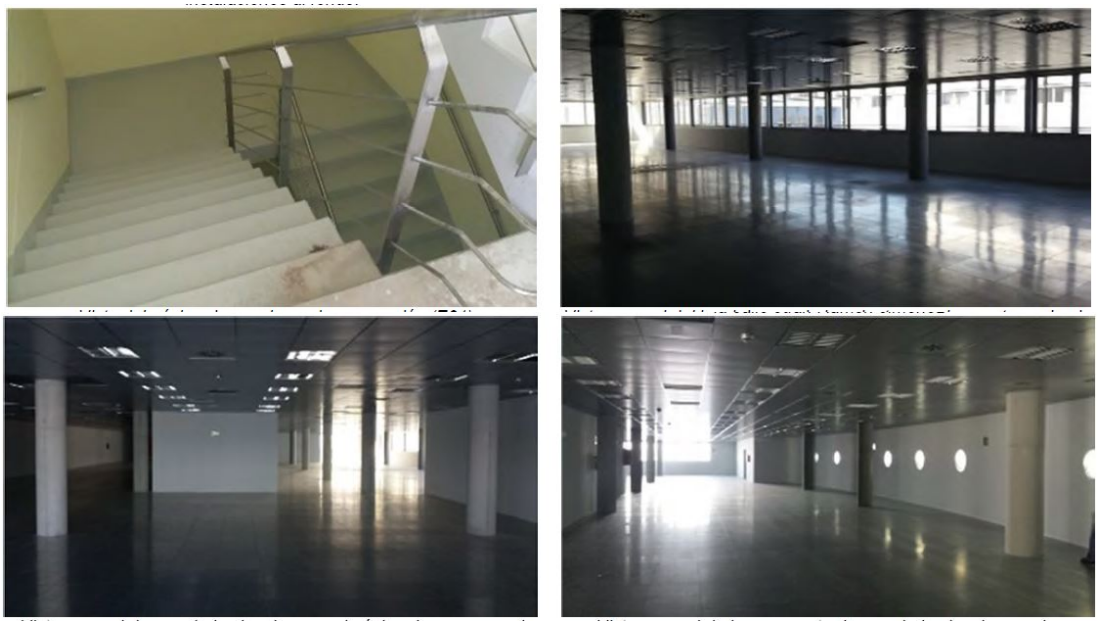
DOCUMENTATION CONDITIONING OF THE SPACE FOR THE ENLARGEMENT OF THE UNIVERSITY ROOM OF THE UNED IN PREMISES OF THE AUDITORIUM AND CONFERENCE HALL OF VIGO.

Location UNED & Auditorium and Conference Hall of Vigo



Section Auditorium and Conference Hall of Vigo

Plans for the conditioning of the space for the enlargement of the university room of the UNED in premises of the auditorium and conference hall.



Pictures of the UNED in premises of the auditorium and conference hall.