

STUDY OF THE APPLICATION OF THE FORMAL RISK MANAGEMENT PROCESS IN THE CONSTRUCTION INDUSTRY IN MEXICO

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Table of Content

ACKNOWLEDGMENTS	I
ABSTRACT	II
ACRONYMS	II
1 INTRODUCTION	1
1.1 PROBLEM STATEMENT	1
1.2 RESEARCH OBJECTIVES	2
1.3 PROBABLE OUTCOMES	2
1.4 RESEARCH METHODOLOGY	3
1.5 THE STRUCTURE OF THE REPORT	3
2 CONTEXT OF THE STUDY	4
2.1 BACKGROUND OF THE CONSTRUCTION INDUSTRY IN MEXICO	4
2.2 BACKGROUND OF THE COMPANY	5
2.3 SELECTION OF THE CASE STUDY	5
3 LITERATURE REVIEW.....	7
3.1 UNCERTAINTY, RISK AND OPPORTUNITY MANAGEMENT.....	8
3.2 RISK MANAGEMENT PROCESS (RMP).....	9
3.2.1 <i>Initiate</i>	10
3.2.1.1 Define the Project	10
3.2.1.2 Focus RMP	14
3.2.2 <i>Identify</i>	14
3.2.2.1 The process.....	14
3.2.2.2 Tools and techniques	16
3.2.2.3 Risk Register	17
3.2.3 <i>Assess</i>	17
3.2.3.1 The process.....	17
3.2.3.2 Tools and Techniques	20
3.2.4 <i>Plan Responses</i>	21
3.2.5 <i>Implement Responses</i>	21
3.2.6 <i>Manage the Process</i>	22
3.3 RMP THROUGHOUT THE PLC.....	22
4 FINDINGS AND ANALYSIS OF INFORMATION	26
4.1 UNDERSTANDING TELIN'S PROJECTS	26
4.1.1 <i>The Front End</i>	26
4.1.2 <i>Procurement Phase</i>	28
4.1.3 <i>Design Phase</i>	28
4.1.4 <i>Construction Phase</i>	29
4.1.5 <i>Use Phase</i>	29
4.1.6 <i>Key Decision Points (Gates)</i>	30
4.2 ANALYZING THE INTUITIVE RMP OF THE FIRM	32
4.2.1 <i>Initiate</i>	32
4.2.2 <i>Identify & Risk Register</i>	33
4.2.3 <i>Assess</i>	35
4.2.4 <i>Plan and Implement Responses</i>	35
4.3 EXPERTISE & SUPPLY CHAIN OF THE FIRM.....	36
4.4 BEYOND THE EXPERTISE OF THE FIRM	37
4.5 RM AT THE KDP	41
5 CONCLUSIONS AND RECOMMENDATIONS	43
5.1 FOR THE MEXICAN CONSTRUCTION INDUSTRY (TYPICAL FIRMS)	43
5.2 FOR TELIN.....	45
5.3 LIMITATIONS AND CONSTRAINTS	45
BIBLIOGRAPHY.....	47
INTERVIEWEES.....	49

**“Uncertainty and expectation are the joys of life.
Security is an insipid thing.”**

William Congreve

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I remember:

Fani and Sari who will always live in my heart...their lives were gentle.

Abstract

Current literature suggests that a formal RMP has to be adopted in order to ensure successful results in achieving the project objectives. However, the typical group of companies operating in the Mexican construction industry have managed to stay in business by using an intuitive approach to RM, so this paper analyze a case study of a typical Mexican company to assess the effectiveness of its intuitive RMP, with the objective of determining if it would be useful for them to adopt a formal RMP as literature suggests, and if so, determine to which level of formality.

Key Words: Risk, Formal Risk Management Process, Intuitive Risk Management Process, Project Life Cycle, and Key Decision Points.

Word Count: 10977

Acronyms

APM Association for Project Management

CMIC Camara Mexicana de la Industria de la Construcción/Mexican Chamber of the Construction Industry.

KDP Key Decision Points

OGC Office of Government Commerce

PLC Project Life Cycle

PMI Project Management Institute

PM Project Management/Manager

RM Risk Management

RMP Risk Management Process

RIBA Royal Institute of British Architects

1 Introduction

1.1 Problem Statement

Risks are present in a greater or lower degree in every single project and it is just not possible to completely avoid them, instead their sources have to be managed in a proactive way so that the project objectives can be met. There is no only one way to achieve this goal, and there is no a single factor influencing the performance of the project team, nevertheless there are some ways more effective than others. Most of the Mexican construction companies manage the risks of their projects in an informal and more intuitive way, without using explicit risk management processes; however, there is a common agreement in the academic world that a formal risk management process is necessary to ensure an effective management of risks and therefore projects, with some disagreement in the level of detail & complexity of the process and the level of formality in its implementation. This gives rise to the questions: would it be useful for typical construction companies in Mexico to adopt a formal RMP? And if so, with which level of formality should it be implemented?

1.2 Research objectives

The aim of the research is to find out whether it is useful or not for the construction companies in Mexico to adopt a formal RMP or under which circumstances it would be useful, and if so, determine the level of formality that should be used in its implementation. It leads to a number of sub goals:

- Review and analyze the existing literature on risk management to create a frame of reference for the case study.
- Identify and understand the processes of the projects of the company of the case study.
- Identify and analyze the key decision points in the project life cycle.
- Identify and analyze the informal risk management process used by Telin.
- Emit recommendations for a successful management of risks to Telin and typical Mexican companies in the construction industry.

1.3 Probable Outcomes

The research is aiming to add a piece of information about the application of formal risk management process in the construction industry in Mexico, which potentially can benefit:

- The specific firm analyzed in the case study, since the recommendations resulted from the analysis could be further developed for its implementation in order to improve the performance of the company regarding the management of projects.
- Other Mexican companies in the construction industry that could find useful the ideas and recommendations presented in this report, and could be interested in its further development to be implemented in their own companies.
- Other students interested in the application of the RMP in Mexico, that could find this piece of work useful, to be used as a starting point for further research.

1.4 Research methodology

The research method used in this work is a combination of primary research and secondary research. The secondary research, in the form of literature review, is needed to create a frame of reference to analyze the information obtained with the primary research. The primary research collects new evidence -through a case study- of how risks are managed by a typical construction company in Mexico. The data was gathered using telephone interviews to three strategic roles of the company: the Project Director, the Construction Director, and one well experienced Project Manager. Such interviews allowed the author to get a more complete and wider understanding of the informal risk management process followed by Telin.

1.5 The Structure of the Report

The report consists of five chapters: *Chapter 1* focuses on defining the problem, the research objectives and the methodology to be used. *Chapter 2* introduces the company of the case study and the reasons for its selection. *Chapter 3* presents a review of the current literature on Risk Management Process with the purpose of setting a frame of reference for the analysis of the case study. *Chapter 4* presents the findings from the interviews and the analysis of such information based on the literature reviewed. And finally, *Chapter 5* shows the conclusions drew from the case study and gives recommendations for a successful application of the RMP to Telin and those typical Mexican companies in the construction industry.

2 Context of the Study

2.1 Background of the Construction Industry in Mexico

According to the World Economic Forum, Mexico is located in the 61st place out of 117 countries with regards infrastructure competitiveness, not a very good position (CMIC 2008), and it is the reason why the Mexican Chamber of the Construction Industry (CMIC) makes emphasis in the fact that the country requires quickly to improve its infrastructure, and it adds that developed countries first created competitive infrastructure and then they became competitive, not the other way around. It follows that the creation of such infrastructure should be done in a competitive way, by delivering functional projects with a good quality, and of course in time and within budget.

On the other hand, HSBC (2008) analysts state: "all indications point to a very different balance of economic power in the years to come". Emerging economies represent 80% of the population of the world and around 40% of the shared global GDP, and expected to be 50% in ten years time (HSBC 2008). These trends in the global economy and the very close relationship of Mexico to the USA (one of the three strongest trade partners of USA) makes easy to forecast a heavy demand of new infrastructure all along the country in the years to come.

2.2 Background of the Company

Telin is a Design & Build construction company that was born 25 years ago in 1983. During all these years it has completed more than a hundred and twenty different light industrial projects, covering a construction area larger than thirteen million square feet. It is a medium size firm formed by 102 employees; it undertakes an average of ten projects per year valued in the range of 10 to 20 million USD.

The goal of the company is to deliver industrial construction projects (which many times include offices areas, cafeterias, warehouses and parking lots) that create superior value for customers. Three strategies can be identified: work for repeat clients, work in a partnering arrangement with the main players of the supply chain, and deliver high quality products and services, all these mainly in the light industrial building market sector.

About 85% of its work is for subsidiaries of American firms that find Mexico a good place to invest. Some examples are: Lexmark, Johnson & Johnson, and ADC Telecommunications, among others. The firm makes proud of itself on the fact that about 90% of its work have been done for repeat clients, which for the company is an indicator of high client's satisfaction.

A high percentage of the cost of the projects comes from works executed by subcontractors, between 60 and 80% of the project cost, leaving the architectural design and the management tasks for Telin. The company has been working with the same subcontractors for more than twenty years, which has let them get to know Telin and adapt to the way it works. This outstanding relationship with the supply chain is according to the company, one of its strengths and a source of competitive advantage.

2.3 Selection of the Case Study

The types of companies that exist in the Mexican Construction Industry can be classified in three groups: the first group formed by very successful companies with outstanding performance and capable of competing internationally; the second group formed by healthy companies that are regionally successful and that have been capable of staying in business for a long period of time, and although they are performing OK, such performance is not outstanding at an international level; and finally the third group of firms that consist of those companies that are

underperforming and do not really deliver value to its clients, and which usually do not have a long life time.

This research focuses on the second group, those typical companies that have been or are expected to be in the market for a long period of time. It is interesting to study them because in order to endure for so long necessarily they have been successful in managing the risks threatening the company and its projects. For the purpose of this research one company (Telin) classified as typical was selected for the case study. Telin has been in the market for more than a quarter of a century, it is performing reasonable good, is profitable, and moreover many of its clients have come back to the company, so this firm is representative of the second group mentioned above.

3 Literature Review

Risks exist in every single project and it is the responsibility of the Project Manager to manage them in a proactive and effective way. To achieve this objective a formal and structured approach has to be used to assist the project team to make good decisions based on a deep understanding of the risks, their likelihood, and their potential impact on the project objectives, instead of just managing them intuitively and reactively (Morris & Pinto 2004). Risk Management aims to offer such structured approach; some of the benefits it claims to deliver are a contribution to (OGC 2002):

- A better and more informed decision-making.
- A higher certainty and fewer surprises.
- A better service to clients.
- A higher value for money.
- A more efficient use of resources.
- Innovation

The rest of this chapter focuses in analyzing *how* and *when* in the PLC the RMP should be performed, in order to create a frame of reference to analyze the RMP of the company studied later on.

3.1 *Uncertainty, Risk and Opportunity Management*

Every single book that talks about risk management gives a definition of **Risk**; nevertheless there is no agreement on what exactly should be understood by this concept and how it relates to uncertainty and opportunity.

Uncertainty is defined as the amount of information that is required to make a decision but is not available (Winch 2002). It is illustrated in Figure 3.1:

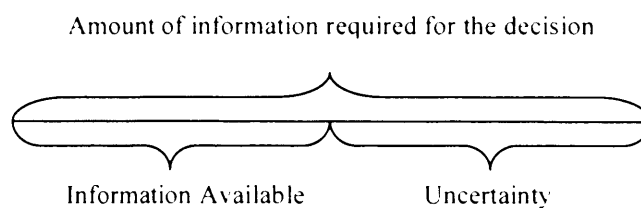


Figure 3.1 Definition of uncertainty: Adapted from Winch 2002

Risk is defined by the APM (2004) as “an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective”. In this case risk is understood as a concept with two varieties: threats that are the negative effects of uncertainty, and opportunities that have positive effects (Hillson 2002).

On the other hand, according to the Concise Oxford Dictionary risk is defined as a “hazard, chance of bad consequences, loss, exposure to chance of injury or loss” (Pearsall 1999). Due to this general understanding of risk as only the unwelcome negative effects of uncertainty, there is a natural tendency of practitioners to think of risk management merely as the management of threats, which does not facilitate and does not fully exploit the RMP (Ward & Chapman 2003).

Ward and Chapman (2003) state that the terminology should be changed, and instead of using the term Risk Management, it should be referred to as Uncertainty Management, comprising both, the management of threats and opportunities and their sources. Nevertheless, the term Risk Management is so well established that it is difficult to change it in the short term (Chapman & Ward 2003). On the other hand, Hillson (2002) argues that it does not matter which term is used as long as it manages both threats and opportunities, as he quotes: “at the end that which we call a rose, by any other name would smell as sweet”. For the purposes of this report the terminology Risk Management is kept, but comprising both, *the positive and the negative outcomes of the uncertainty*.

3.2 Risk Management Process (RMP)

There is a general agreement on what should be included in the RMP; however different authors suggest different levels of detail of the process (Raz & Michael 2001). The Project Management Institute (PMI) and the Association for Project Management (APM) present two well-accepted processes. Their risk management processes are shown in Table 3.1.

PMI	APM
1. Risk Management Panning	1. Initiate 1.1 Define the project 1.2 Focus RM Process
2. Risk Identification	2. Identify
3. Qualitative Risk Analysis	3. Assess
4. Quantitative Risk Analysis	3.1 Structure 3.2 Ownership 3.3 Estimate 3.4 Evaluate
5. Risk Response Planning	4. Plan Responses 4.1 Plan Risk Event Responses 4.2 Plan Project Risk Responses
	5. Implement Responses
6. Risk Monitoring and Control	6. Manage the Process

Table 3.1. Risk Management Process: Adapted from PMI 2004 & APM 2004.

The APM present a more elaborated RMP than the PMI, so in the rest of this chapter it is analyzed. It is comprised by five phases and a “Manage the Process” activity. Each phase can be elaborated in sub-phases, as shown in Table 3.1. Firms that are experienced in the management of risks will feel more comfortable using a more complex RMP, whereas companies with limited experienced in RM will prefer simplified RMP (APM 2004). Nevertheless Chapman and Ward (2003) suggest that the more inexperienced in risk management a company is, the more elaborated the RMP should be. After that, as it gains experience and understanding of the process, it can start taking shortcuts. Figure 3.3 shows the basic RMP of the APM.

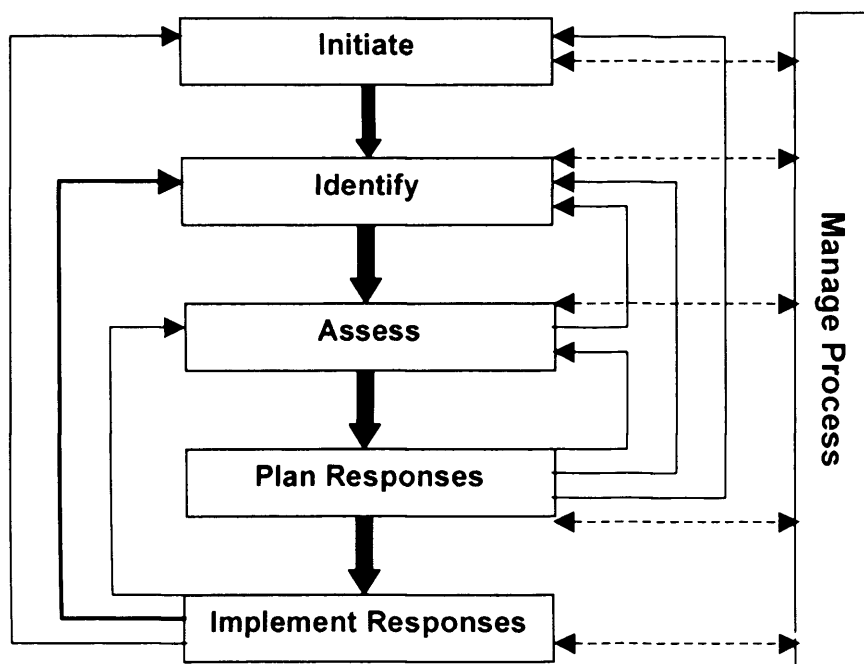


Figure 3.3. Risk Management Process: Adapted from APM 2004.

3.2.1 Initiate

The purpose at this phase is first to ensure a common understanding of the project by **defining the project**, and second to adapt the generic RMP to the needs of the specific project by **focusing the RMP**.

3.2.1.1 Define the Project

It is logical that to be able to control something, first it must be understood (Dallas 2006). The main goal of this sub-phase is to consolidate all the relevant information of the project to fill in gaps and solve inconsistencies in order to ensure a common understanding by the project team. This process is illustrated in Figure 3.4.

According to Chapman & Wards (2003) there are six questions (referred as the six W's) that have to be answered in order to define a project; these are: a) Who are the parties involved? (Who), b) What do they want to achieve? (Why), c) What is it the parties are interested in? (What), d) How is it to be done (Which way), e) What resources are required? (Wherewithal), and f) When does it have to be done? (When).

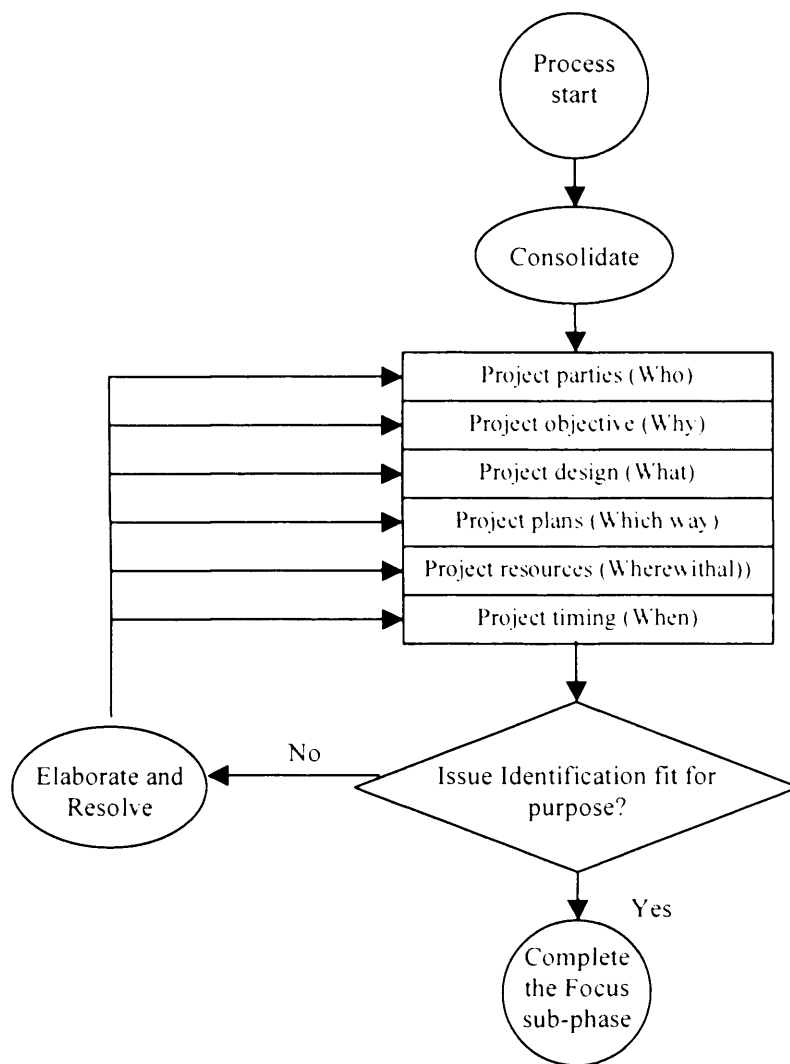


Figure 3.4. Define Phase: Adapted from Chapman & Wards 2003.

a) Project Parties (Who): The first piece of information that has to be consolidated is about the project parties, so it has to be clear who are the key players involved in the project, either directly or indirectly, and what is the relationship between them.

b) Project Objectives (Why): They are in the centre of Risk Management. From the definition of Risk Management presented in Section 3.2: "an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective" (PMI 2004), it can be seen that a failure in the identification of the project objectives, or a misunderstanding of them, will lead to a inefficient management of risks and of the project as a whole.

Those project objectives first of all reflect the client's needs in terms of symbolic desires, functional requirements and investment criteria (Winch 2002). Symbolic

desires refer to the appearance, the quality of the architectural design, and their contribution to the urban landscape. The functional requirements are captured in the quality of specifications; the facility should perform the functions that it was designed for. It is important to mention that for some authors as Dallas (2006) the greatest risk of a project is indeed, that it fails to deliver the functions and benefits expected of it. Finally the investment criteria refer to the goals with regards schedule (time) and budget (cost). It is illustrated in Figure 3.5. Notice that trade-offs take place among those three dimensions since once one of them is modified, the others will have to be modified as well.

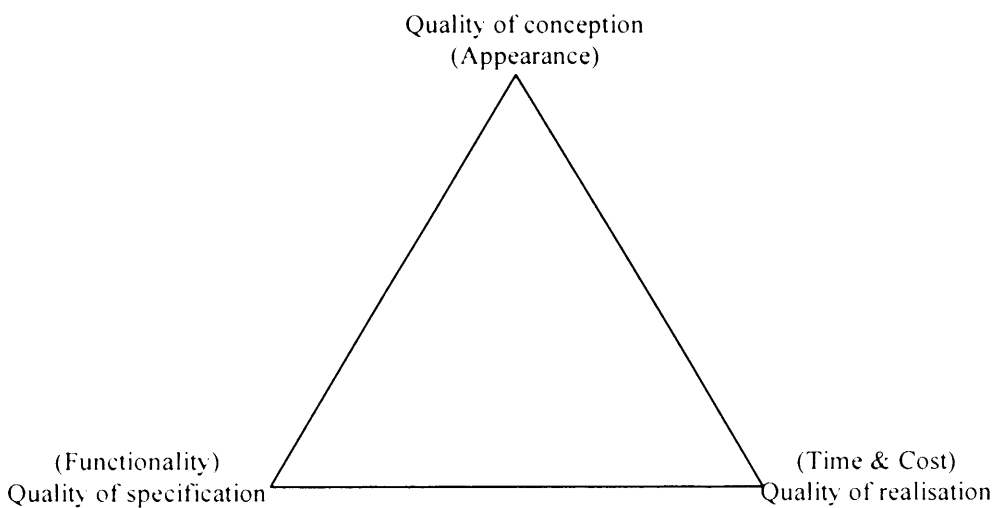


Figure 3.5. Product integrity in construction: Adapted from Winch 2002.

On the other hand, the project objectives must also reflect the goals of other key stakeholders identified in the *Project Parties*, for instance the planning authority (Weatherhead et al. 2005).

The projects objectives, which can be approached as strategies, as explained by Winch (2002), are never fully realised due to internal or external factors. In that sense they have to be reassessed continuously throughout the PLC and adapted to the changing environment of the project, and it is within the risk management scope to ensure it happens. Figure 3.6 illustrates the difference between intended strategy and realized strategy.

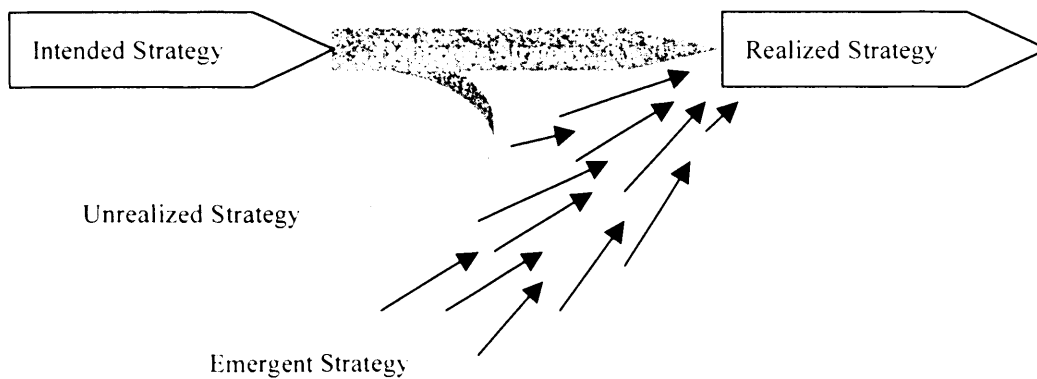


Figure 3.6. Changing strategies: Adapted from Mintzberg et al. 2003.

Winch (2002) identifies three reasons why the intended strategy is not fully realised. The first reason is because the project objectives are formulated at the inception of the project when uncertainty is the highest in every aspect; a second reason is simply because every client changes his/her mind; and finally because throughout the PLC new opportunities arise to which the project can be adapted. The process followed to update the project objectives is illustrated in Figure 3.7.

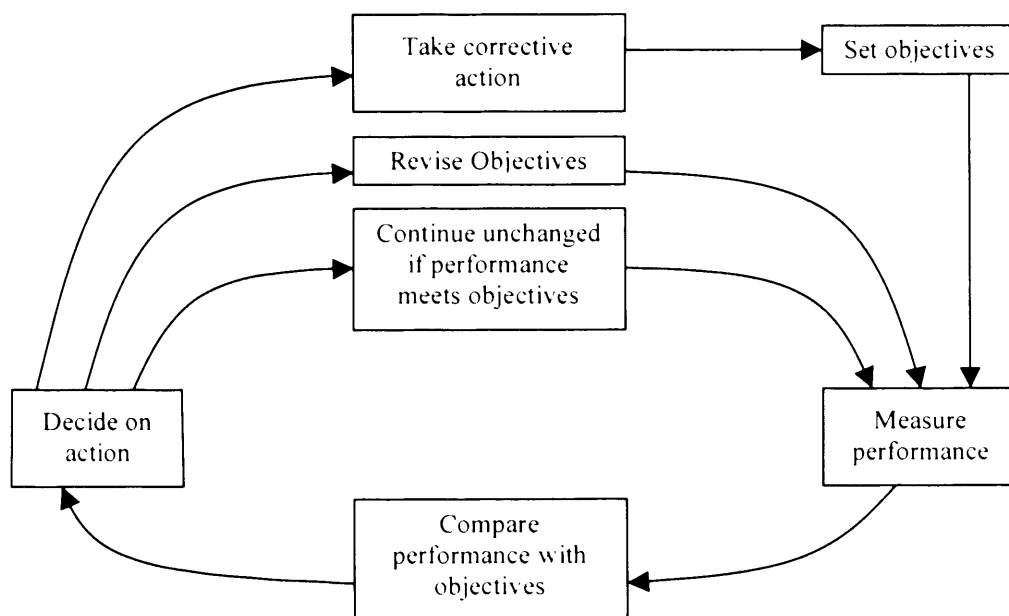


Figure 3.7. The generic information loop: Adapted from Winch 2002.

c) *Project Design (What)*: The purpose here is to gather all the information about design issues and make them available to all the stakeholders.

d) Project Plans (Which way): It is about answering the question how is it to be done? The project activity structure for risk management purposes should be kept as simple as possible. One activity for very small projects is adequate, whereas for major projects it is advisable to have between twenty and fifty activities, but four or five are the most common amounts.

e) Project Resources (Wherewithal): The objective is to identify the key resources required to undertake the project, and ensure they will be available when needed and where needed.

f) Project Timing (When): The question here is: when does it have to be done? It is advisable to have a Gantt chart with the activities defined in the project planning showing exclusively the precedence relationships between the activities, but also to have a second chart with the same activities that shows the timing, and that considers the interdependency with Project Plan and Project Resources.

3.2.1.2 Focus RMP

The purpose of this sub-phase is to adapt the generic RMP by selecting an appropriate level of detail, suitable tools and techniques and appropriate allocation resources, which are commensurate with the importance and complexity of the project.

3.2.2 Identify

3.2.2.1 The process

The purpose of this phase is precisely to identify the sources of risks (Smith 1999, Flanagan & Norman 1993), however it is very important to distinguish risk sources from risk effects, since it is a very common mistake to focus on identifying only the risk effects rather than their sources (Morris & Pinto 2004). Table 3.2 contrast clearly both concepts.

Source	→	Event	→	Effects
The project is undertaken in a particular city.		There may not be enough suitably qualified labour in the city.		Additional labour from outside the city is required, which adds cost to the project.

Table 3.2 Source and risk effect. Adapted from Morris & Pinto 2004.

The identification of risks should be done as complete as possible but in a practical and cost effective way (APM 2004). In order to achieve this objective a structured approach has to be adopted (AIRMIC, ALARM & IRM 2002). For Chapman & Wards (2003) the identification process is comprised by two activities, the search and the classification of sources of risk at the project objectives, the other five W's, the PLC, and the responses, as illustrated in Figure 3.8.

Project Objectives: As explained in Figure 3.5, project objectives are expressed in terms of time & cost, functionality and appearance. So at this point the goal is to search and classify the sources of risk that affect directly any of those dimensions, starting with the criteria that dominates the trade-offs among them.

Other Five W's: First of all, sources associated with the stakeholders (Who) must be identified. It involves their objectives, their requirements, and the perception they have of project risks. The design (What) is a rich source of risk, so the identification process has to focus on it too; for instance, changes in design is one of the major threats to the project, but most of the times it is unviable to freeze the design to avoid changes, in practice the design has to be updated many times throughout the PLC, however changes should be anticipated. On the other hand, it is also at the design stage where most of the opportunities of the project lie, and should be identified here. Another source of risks is associated with the resources (Wherewithal), since they should be available when needed and where needed. Sources associated with the project plans (Which way) and with the project timing (When) can be primary sources of risks too. It is important to notice that none of the W's is independent, but they are interrelated. For instance, allocating the same resources to two activities implies they will not be carried out at the same time. And if the same two activities are carried out at the same time, it implies that different resources were allocated.

Project Life Cycle (PLC): This structured view of the project process makes it possible to look ahead for sources of risk hidden in the early stages that will potentially materialize later in the project. It is obvious that in order to identify and manage those risks, there must be a clear understanding of what is involved in each of the stages of the PLC. Different authors consider slightly different PLC models, but it is discussed later at section 3.4.

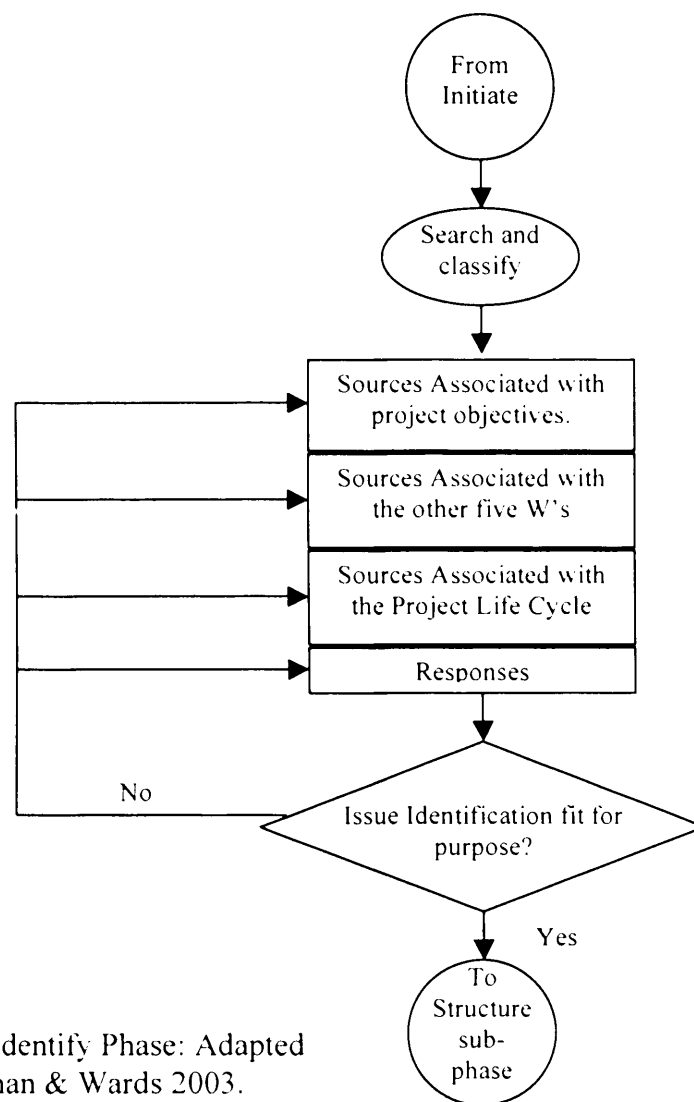


Figure 3.8. Identify Phase: Adapted from Chapman & Wards 2003.

Responses: Chapman and Wards (2003) suggest that once a source of risk is identified, at least one response should be assigned too. The effectiveness and the cost implications of such response will be assessed later in the RMP.

3.2.2.2 Tools and techniques

There are quite different tools and techniques available for the identification of sources of risk, however there is no a best one, instead it has to be adopted a combination of them that suits the specific circumstances of the project (Hillson 2002). This process can be carried out either as an individual activity or as a group activity. Individual identification of risks is the simplest approach; it only requires a person with a pencil and a sheet of paper. A common practice when workshops are used is to ask the participants to identify individually and in advance the sources of

risk, in order to avoid being in a rush during the session (Dallas 2006). Chapman and Wards (2003) suggest that this approach could be also useful as a first pass of the identification process, however it is not enough, it is important to bring together a group of experienced people with expertise in different fields, and with the ability to approach the project from different perspectives, in order to get a comprehensive list of risks.

Some of the most common tools and techniques used at this phase are listed below (See the sources of information for a detail description of each of the techniques. Morris & Pinto 2004; Dallas 2006; APM 2004; Chapman & Ward 2003; Hillson 2002, PMI 2004):

- Brainstorming in a workshop environment
- Checklists and prompt lists
- Interviews and questionnaires
- SWOT analysis
- Constrains and assumptions analysis
- Cause and effects diagrams

3.2.2.3 Risk Register

The risks identified at this phase must be documented in a risk register (OGC 2002), which for some authors is the most useful tool in the RMP (Morris & Pinto 2004). It serves as a repository of information, including not only the source of risk, but also the probable consequence, the response, the risk owner, etc (Cooper et al. 2005). It is the starting point of the risk assessment (Williams 1994), and it also helps the project team to review all the information regarding risks in a regular basis throughout the PLC (Patterson & Neailey 2002).

3.2.3 Assess

3.2.3.1 The process

The goal at this phase is to get an appropriate level of understanding of each of the risks identified so that a good decision can be made. This phase can be seen as a set of

four sub-phases: structure the issues, clarify ownership, estimate variability and evaluate over all implications.

Structure the Issues: The structure of the list of risks and responses identified has to be reviewed to make it as simple as possible. It includes identifying those sources of risks that are closely related and that can be treated as one with a single response, or to split those risks that involve many issues and has to be assigned more than one response. So the three main steps of this sub-phase are: developing an order for the risks and responses identified; analyzing interdependencies between activities (which way), the other five W's, the sources of risks and their responses; and making the appropriate modifications to the structure of risks and responses.

Clarify ownership: It is very important that every issue has a responsible in terms of managerial and financial terms. Therefore the aim of this sub-phase is to make clear for all the stakeholders what are the issues they own.

Estimate Variability: The main purpose at this stage is to size the identified sources of risk in terms of probability of occurrence and its impact in time, cost, or other project objectives. When a response has already been identified, it is sized too in terms of its likelihood of effectiveness and cost implications. Many times the data needed for such analysis is not available, therefore this process has to be based on subjective estimates of probabilities, for which there is plenty of experimental evidence showing how inaccurate and inconsistent experts make them (Winch 2002). The danger here is that people that read those results can take them as if they were objective measurements. Nevertheless some authors (Chapman & Wards 2003, Blockley & Godfrey 2000) argue that in spite of the downsides, subjective estimates are still justifiable since they lead to a more precise definition and understanding of the risks, clarification of what is important and what is not, and to clearer reasons that support decision making, however it is important to keep in mind the subjectivity of those measures and apply them with caution (Blockley & Godfrey 2000).

There are different approaches to the analysis of risks, for instance the PMI approach is comprised by a qualitative analysis and a quantitative analysis. The main purpose of the qualitative analysis is to prioritize risks based on their likelihood and impact on project objectives. The most common tool to perform this activity is the Probability-Impact Matrix (PIM), shown in Figure 3.9. When a risk requires further analysis, a

quantitative analysis is performed. The quantitative analysis assesses numerically the likelihood of each risk and its impact on the project objectives (time, cost, etc.).

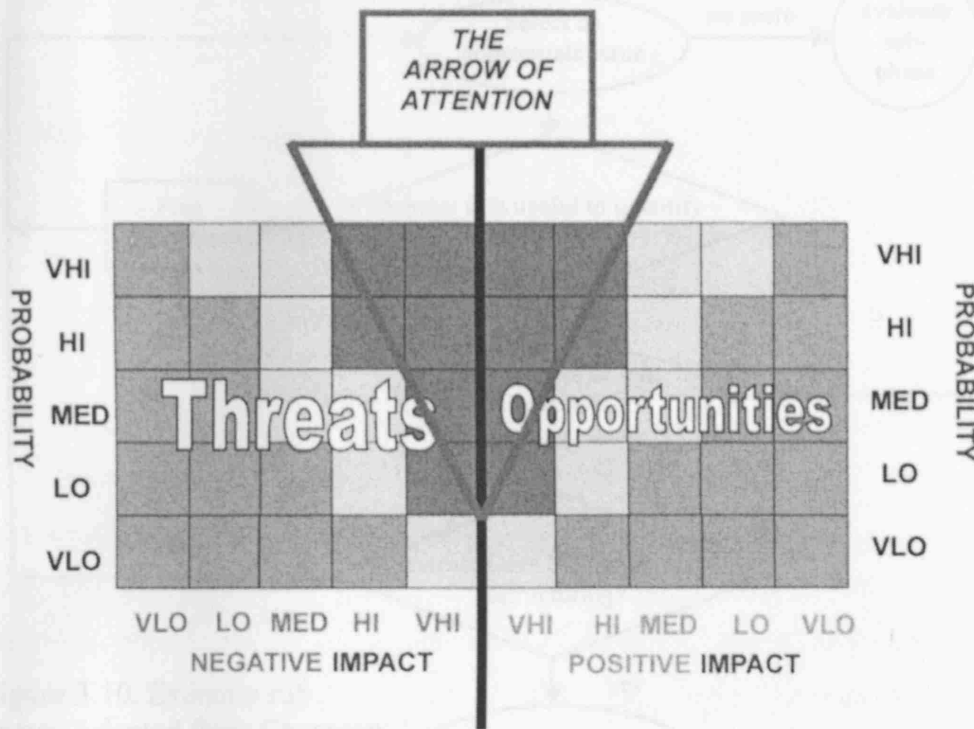


Figure 3.9. Probability Impact Matrix. Adapted from Hillson 2002.

Chapman and Wards (2003) offer a different approach, which totally avoid the qualitative analysis and the use of Probability-Impact Matrices. It is illustrated in Figure 3.10. It starts with the selection of an appropriate issue, which means that issues considered more important have to be selected first, since more time will be spent on them. Not all the issues have to be quantified, so for every risk it has to be asked: Is it useful to quantify this issue? The next step is to size the source of risk/response with regards to its likelihood and impact on project objectives, but only for those issues that were found useful to be quantified. Finally, after sizing the issue, it can be concluded either that the results are satisfactory and it has to move to the next issue or that the current issue warrants a more detailed/simplified analysis, and probably it will be needed to restructure that specific issue, as explained earlier in the *Structure the Issue* sub-phase. After the issue has been restructured, it has to be sized again.

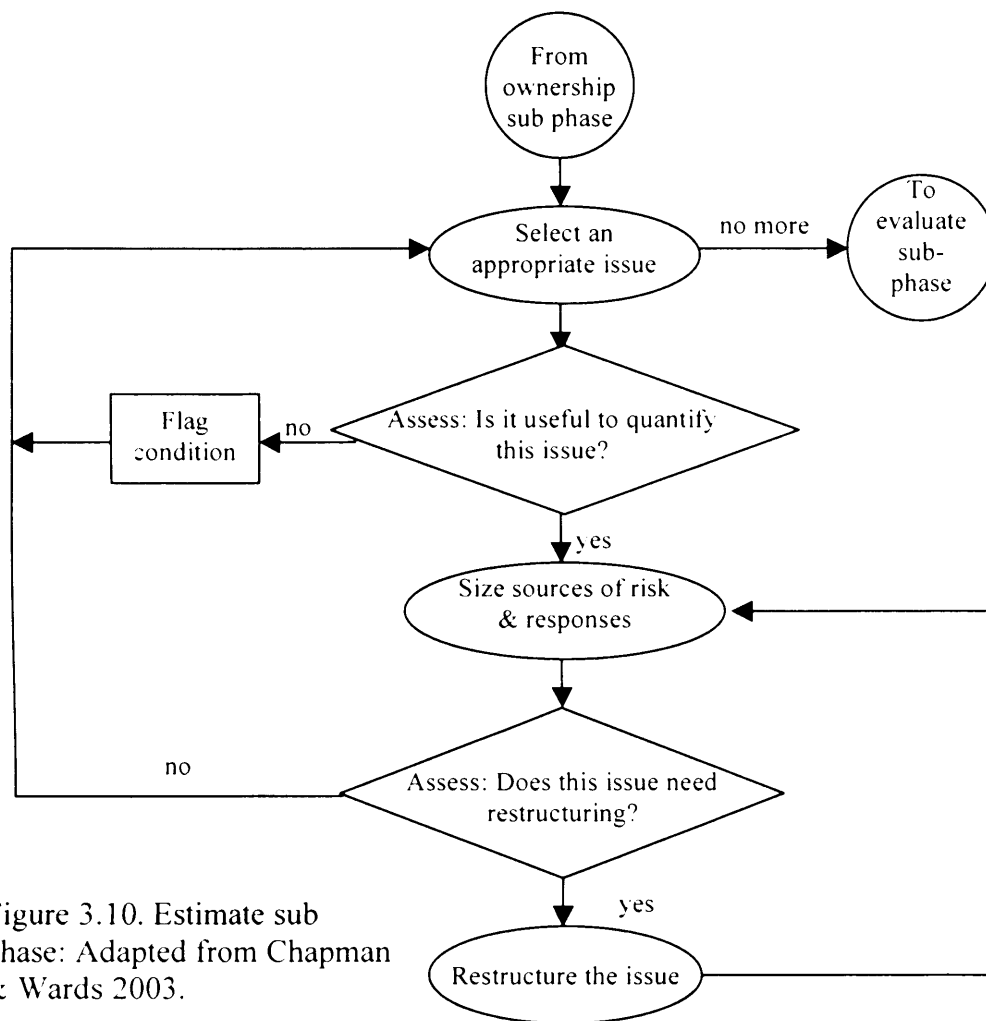


Figure 3.10. Estimate sub phase: Adapted from Chapman & Wards 2003.

Evaluate overall implications: This last sub-phase deals with deeper numerical analysis, this time to consider not only the impact of individual sources of risk, but also the impact of the combination of individual risks. The main downside at this point is the large amounts of data needed and the time required to do the analysis.

3.2.3.2 Tools and Techniques

There are plenty of tools and techniques for qualitative analysis as well as for quantitative analysis, some of them listed below (See the sources of information for a detailed description of each of the techniques. Morris & Pinto 2004; Dallas 2006; APM 2004; Chapman & Ward 2003; Hillson 2002, PMI 2004):

Qualitative Analysis:

- Influence diagrams
- Probability-impact matrices
- Risk Register

Quantitative Analysis:

- Monte Carlo analysis
- Decision Trees
- Sensitivity analysis

3.2.4 Plan Responses

The purpose at this phase is to look for responses for individual sources of risks, and also for the joint effect of groups of risks. It is a continuous process that runs in parallel with the other phases of the RMP, for instance, it was stated that as part of the identification process at least one response for each risk should be assigned.

The APM (2004) identify eight possible responses to risks, as illustrated in Figure 3.11. The first option is to *avoid the threat/exploit the opportunity* by changing the project objectives; a second respond is to *plan fallbacks/options* to respond to the risk in case it occurs or the level of risk becomes unacceptable; a third response is to *reduce the probability of threats or enhance the probability of opportunities*; a fourth response is to *reduce the negative impact of threats or enhance the positive impact of opportunities*; a fifth option is to *accept the threat or reject the opportunity*; as a sixth option the risk can be *shared contractually* as well, it could be either completely transferred to the supply chain, or partially transferred, which means that the positive/negative consequences are shared; the seventh option is to *keep the response opened* by delaying choices and commitments; and the last option is to *insure against the threat or invest in the opportunity*. The insurance is a financial cover for those events that are outside human control.

3.2.5 Implement Responses

This phase, as the previous one, is a continuous process that runs in parallel with the other phases of the RMP. The main purpose here is to ensure that effective actions are taken to implement the plans agreed in the previous stage. For this purpose it is very important that responsibilities are unambiguously allocated to specific individuals and those individuals are empowered with enough authority and resources.

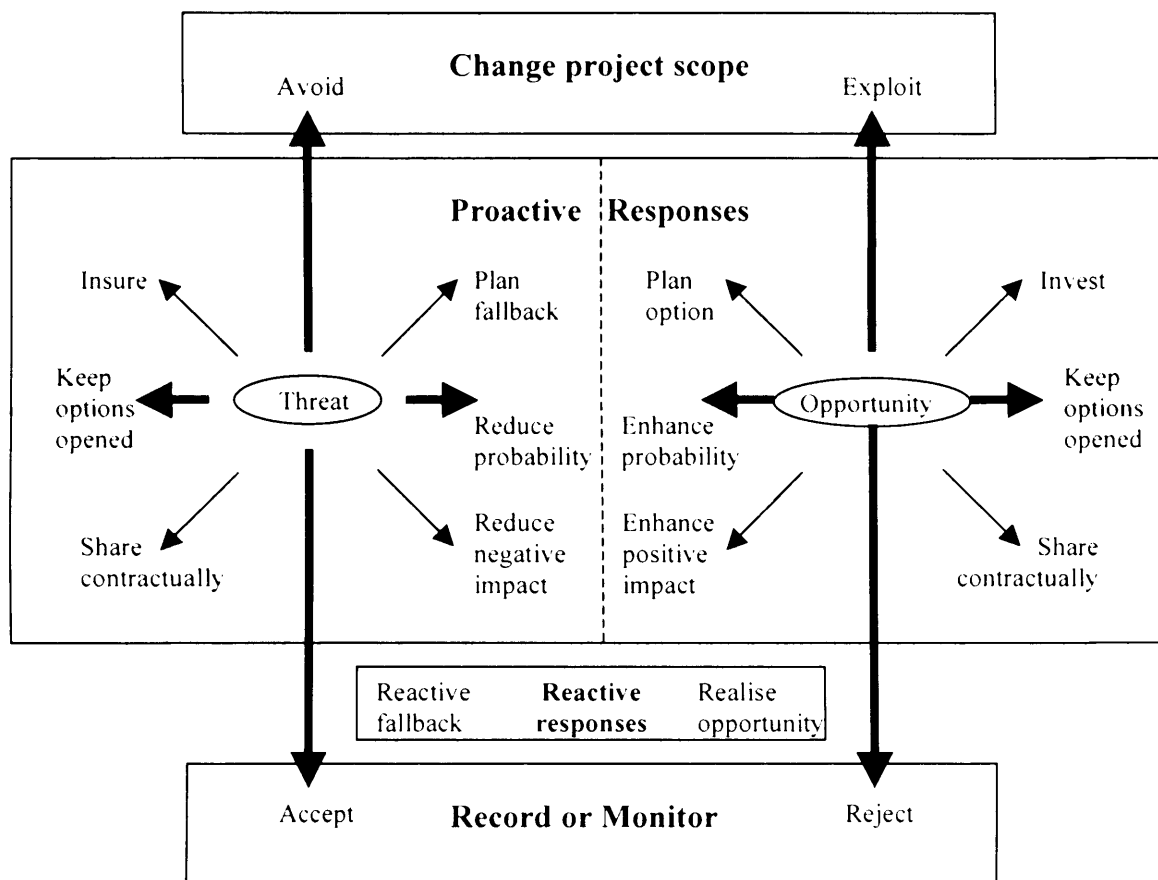


Figure 3.11. Risk Responses Strategies. Adapted from APM 2004 and Chapman & Wards 2003.

3.2.6 Manage the Process

This phase can be performed either formally or informally throughout the PLC. The main purpose of this activity is to ensure the RMP effectively manages the sources of risks, including every aspect of the process, as tools and techniques to be used, roles and responsibilities, intensity of implementation, etc.

3.3 RMP throughout the PLC

In order to improve the understanding of the project there should be a structured view of the whole life of the project that makes possible to break it down into simpler phases, which altogether are known as Project Life-Cycle (PLC). The conclusion of each phase is marked by the completion of well-defined deliverables that characterize each stage. A finished phase is marked by a review of the performance of the project

with regards to the project objectives, in order to decide whether it should continue to the next phase or not, and to identify and solve risks (PMI 2004).

One of the greatest benefits of having this structured view of the project is that key decision points (KDP) can be identified (See Figure 3.13 for the KDP proposed by the OGC). Before making those key decisions and passing to the next stage, it is recommended to carry out a formal risk assessment and a gateway review (Smith 1999, APM 2004), *nevertheless this should not be the sole activity of the RMP, since it is a continuous process that should be embedded in the daily activities of the project team.*

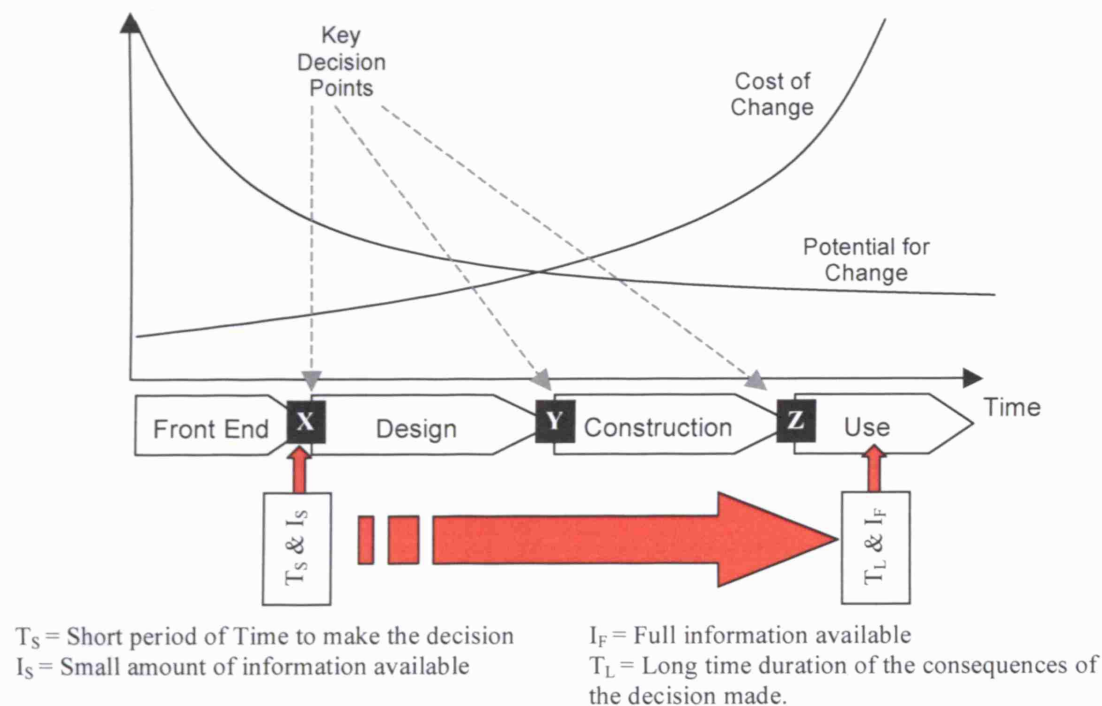


Figure 3.12. Scope to change reduces with time. Adapted from Dallas 2006 & Interview with Edkins, September 2008.

It is also important to keep in mind that the scope for influencing the project outcomes decreases as the project progresses (APM 2004); moreover notice that the earlier in the project a decision is made, with limited time (T_S) and limited information (I_S), its consequences last longer, so the company has to live with them long period of time (T_L). Figure 3.12 illustrates this.

The number and name of phases a project can be broken down varies depending on the author; nevertheless all the models propose essentially the same structure (Smith

1999). Figure 3.13 shows the models proposed by the PMI, the APM and RIBA, as well as the gateways reviews (KDP) proposed by the OGC. Figure 3.14 shows the RMP carried out throughout the PLC.

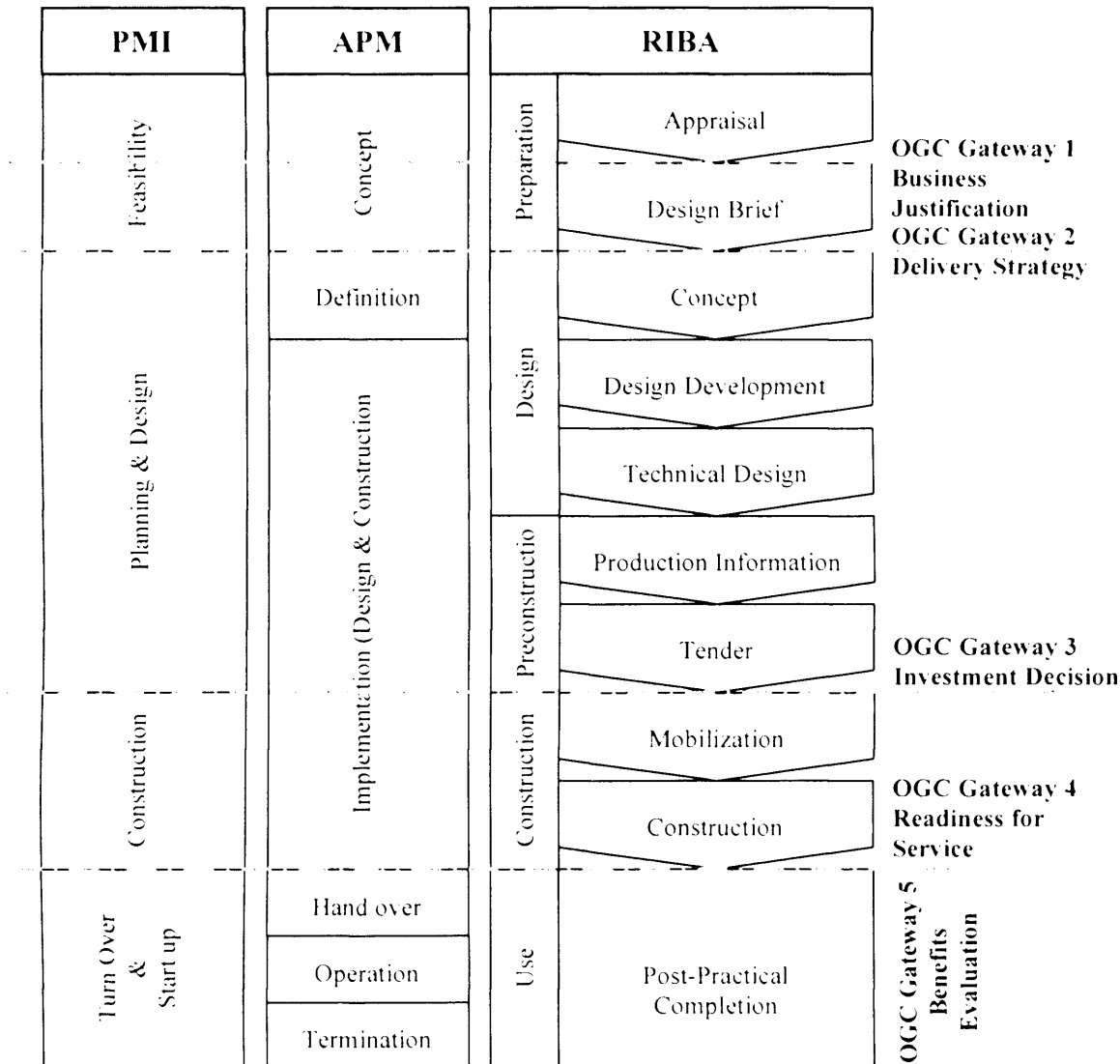


Figure 3.13. PLC and OGC Gateways Reviews. Adapted from RIBA 2008, APM 2004, and PMI 2004.

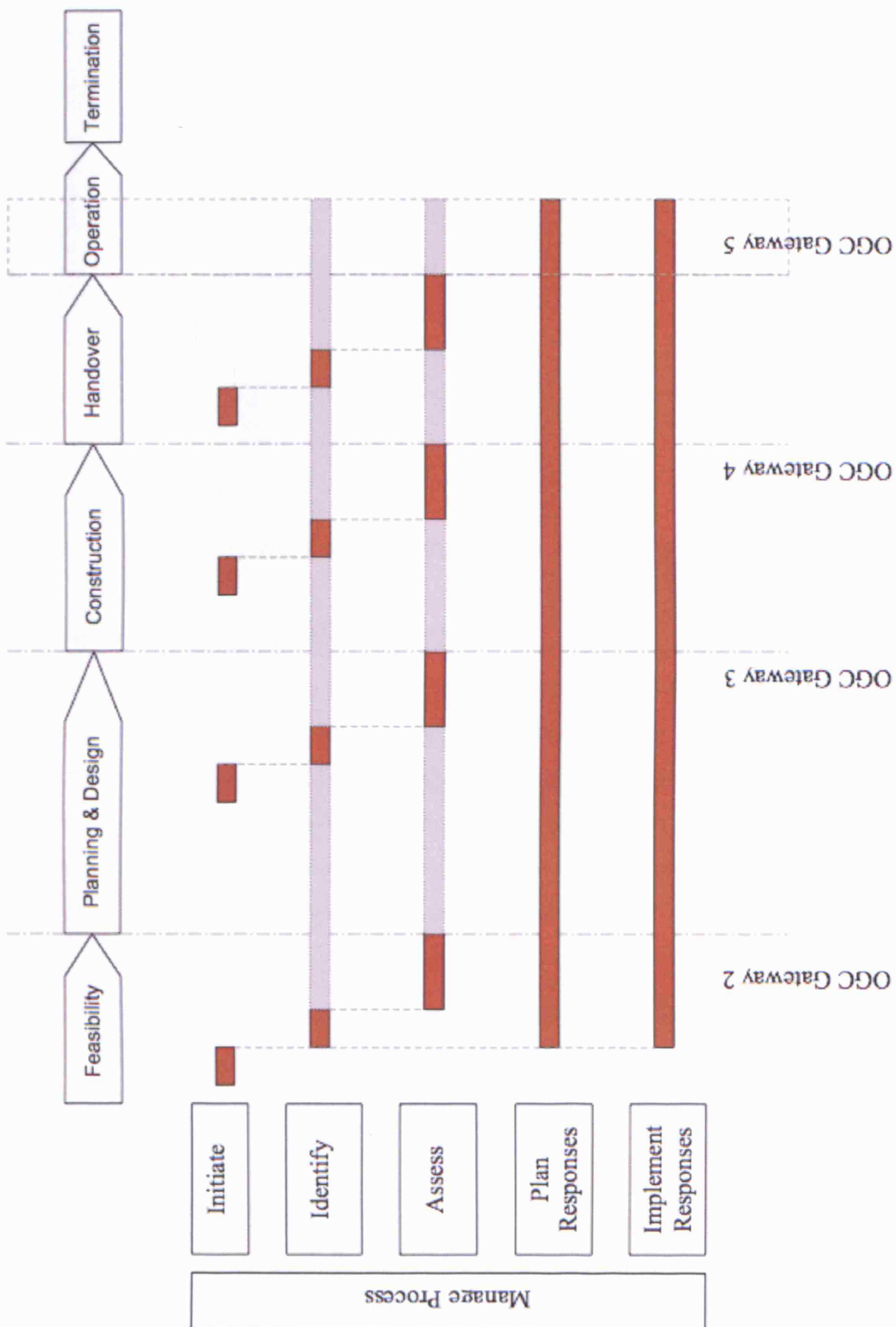


Figure 3.14. RMP throughout the PLC. Adapted from APM 2004.

4 Findings and Analysis of Information

4.1 Understanding Telin's Projects

Before moving on to analyze the intuitive RMP used by the firm, it is important to understand the processes it follows throughout the PLC to design and build the facilities and satisfy the client's needs. The PLC model the company uses is shown in Figure 4.1; however, a more detailed model that best shows Telin's processes was created based on RIBA's model, Telin's model, and the information gathered from the interviews; moreover, it was verified by the Projects Director (see Figure 4.2).

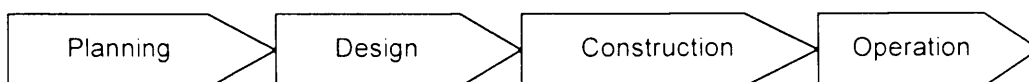


Figure 4.1. PLC model used by *Telin*. Adapted from *Lintel* 2002.

4.1.1 The Front End

As shown in Figure 4.2, by the time *Telin* joins the project at the procurement phase, the Client has already passed through three stages, which are briefly described in the next paragraphs. It is important to emphasize that the procurement phase was located just after the Concept Phase because *Telin* uses mainly Design & Build Contracts.

*When the client goes for sole tendering usually they ask Telin to develop the Outline design as well, so it could be seen as a two stage tendering.

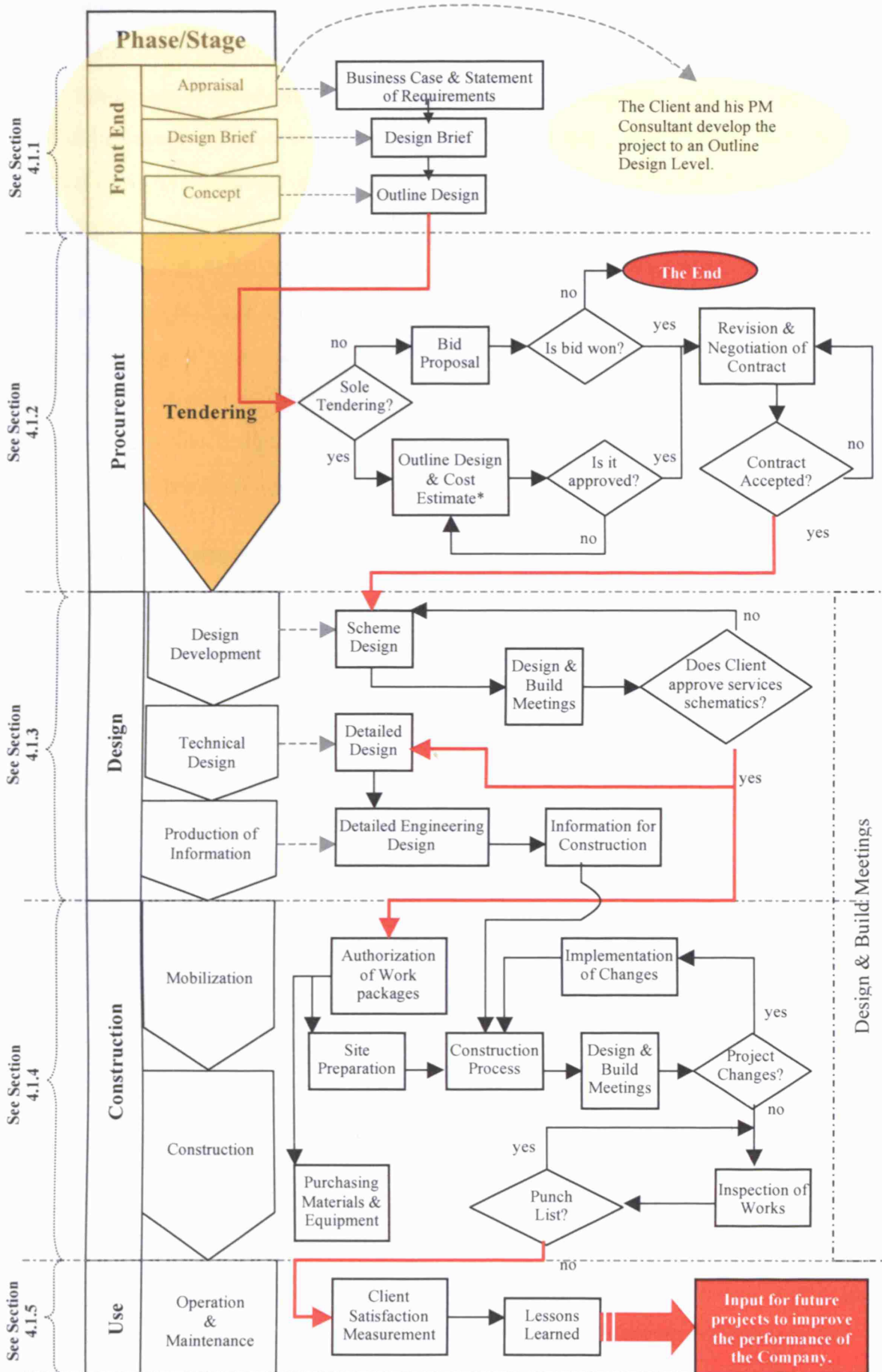


Figure 4.2. Processes of *Telin* throughout the PLC. Adapted from RIBA 2008 & Telin 2002.

The client with the help of its consultants develops a **Business Case** at the **Appraisal Stage**. This stage involves identifying and verifying the client's needs, making sure those needs are aligned with the *corporate strategy/business strategy*, performing feasibility studies to assess the options that satisfy the client's needs and selecting the best one. At this stage the statement of requirements is developed too, which has the purpose to state all the activities the facility has to accommodate and the functions it has to perform. At the **Design Brief Stage**, based on the statement of requirements and the Business Case, a **Design Brief** should be developed with the purpose of communicating all the relevant information to the design team and the D&B contractor. It is also at this stage where a Procurement Route is identified. At the **Concept Stage** the design brief is implemented into an **Outline Design** and outline proposals for structural and building services.

4.1.2 Procurement Phase

For Telin it is at this point when a project starts. As shown in Figure 4.2, a project can be either assigned directly or through a tender competition, but the tendency is that clients prefer to use a tender competition. When Telin enters a tendering process, it usually receives either the design brief or just the statement of requirements, and a couple of drawings containing the outline design, nevertheless the outline proposals for structural and building services are usually developed by Telin for cost estimation purposes. Notice that in the cases when a project is assigned directly to Telin it has to fully develop the concept design (it is actually a two stage tendering), in such case the concept stage should be located after the procurement phase (not before as shown in Figure 4.2). It is important to mention that this phase takes place in a very tight period of time, usually about three weeks, so Telin has to estimate costs and times in a very fast and accurate way.

4.1.3 Design Phase

The design actually starts with the development of the concept design at the Concept Stage. At the **Design Development Stage** the outline design is developed to a **Scheme Design** level, which includes floor plans, elevations and sections, preliminary specifications, and structural & services schematics. This stage finishes when the client approves the services schematics proposals; after this the **Detailed Design**

(Technical Design Stage) can be started, building services systems are developed in detail by the subcontractors so that they can pass all the required information to the structural designer to develop its final design, taking into consideration the size, weight and location of all the equipment and installations. At the same time than the detailed design, works on site can be started. Finally, based on the detailed design, the *Information for Construction* has to be generated so that every single element of the facility can be produced. It is important to make emphasis in the fact that all the design is a continuous process of interaction between the client, Telin and its subcontractors that mainly occurs at the Design and Construction Meetings, which run every one or two weeks throughout the project.

4.1.4 Construction Phase

The construction phase normally will start once the Scheme Design has been completed, and from that point onwards, they will run in parallel throughout the rest of the PLC. The construction starts with the site preparation, while at the same time the detailed design is taking place. A couple of weeks later when the design has been substantially developed there will be enough information to request the production of the steel structure, the special equipment required for the building services (mechanical and electrical), the materials for the foundations, and any other special materials or equipment.

Before the start of the construction phase, a pre-construction meeting takes place with the purpose of informing the construction team and the subcontractors about the project objectives (time, cost, appearance and functions of the new facility), as well as to confirm the subcontractors what are the services schematics proposal (in the case many options were presented to the client) that they have to develop at a detailed design level.

4.1.5 Use Phase

The construction process continues until the facility is finished and it can be delivered to the client. At this point a punch list is created where the imperfections of the facility are stated for their prompt correction.

In order to improve the company performance in future projects, clients are asked to feedback the performance of Telin regarding the execution of the project and

regarding the facilities delivered, and also an internal lessons learned meeting is performed to identify future opportunities and prevent the same mistakes to occur again.

4.1.6 Key Decision Points (Gates)

Once the processes of the company have been identified, the next step is to identify the key decision points, which can be easily seen in the PLC model. As stated in chapter 3, these gates are very important since it is there where the project can be measured and assessed against the project objectives, and it is at these points where formal Risk Assessments can be performed to help the project team to make better decisions.

Four key decision points are identified and shown in Figure 4.3. The *first one (KDP-0)* is located before the procurement phase; at this point the company has to decide whether or not to participate or bid for a project. With this decision Telin determines how far they want to go from their area of expertise (it is, the level of risks involved in the project), as analyzed in Section 4.4. The *second gate (KDP-1)* is found before the design phase and just after the project has been assigned to the firm; at this point the company has to decide whether or not to commit to undertake the project at a fixed price and in a certain period of time. At this point a clear and comprehensive list of risks should have been developed. A *third key decision point (KDP-2)* is located just before the start of the construction phase and after the design development stage is finished (scheme design). At this point it has to be analyzed whether or not the scheme design is well defined and meets the project objectives, because changes after this point could be extremely expensive. The *fourth gate (KDP-3)* can be found just before the delivery of the facility to client and after the construction has finished. At this point all the risks should have been resolved, and the remaining ones should be related only with the commissioning and operation phase.

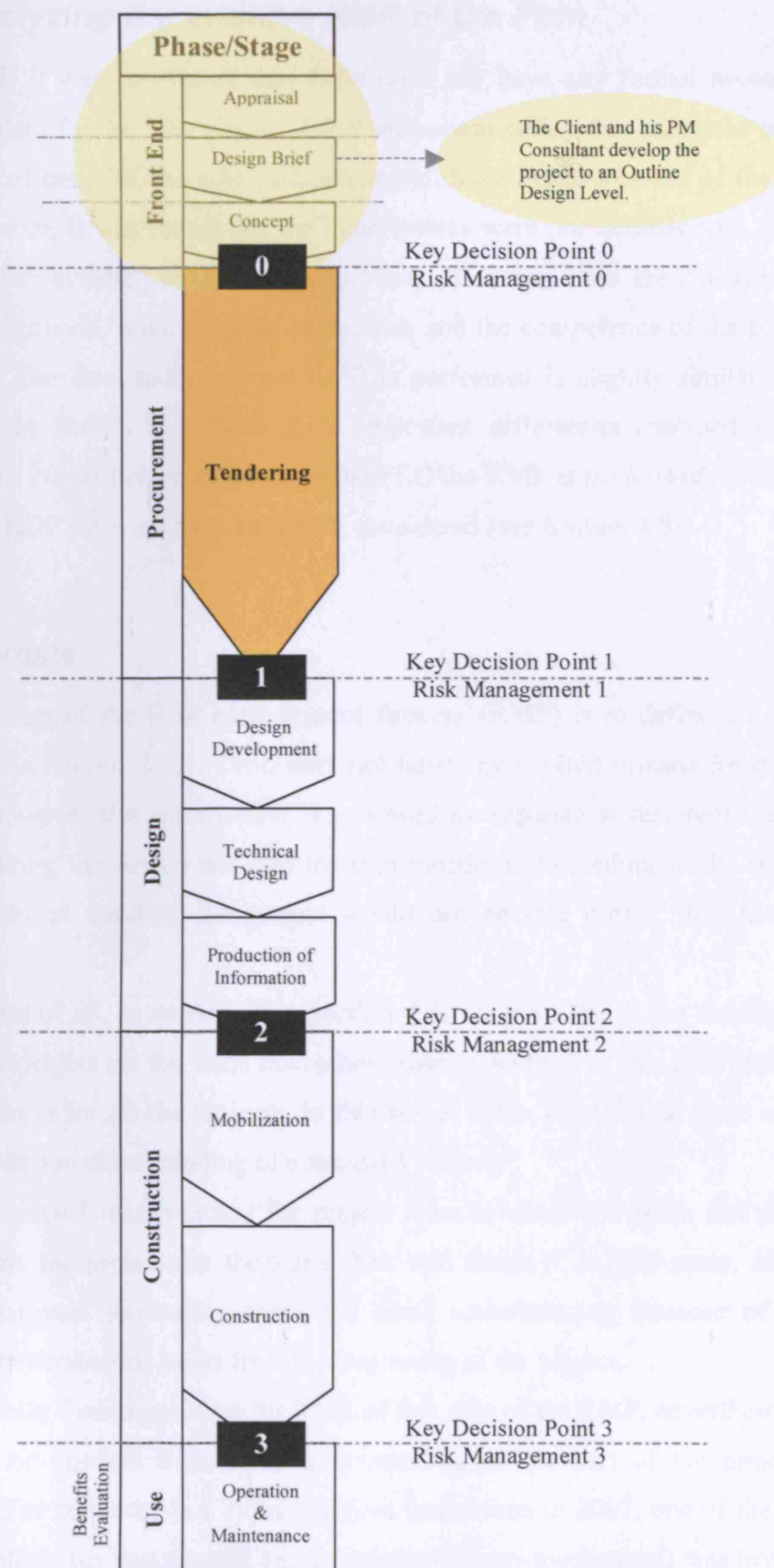


Figure 4.3. Key decision points at the PLC.

4.2 Analyzing the Intuitive RMP of the Firm

First of all it was confirmed that *Telin* does not have any formal process for the management of risks. There is no risk management policy that states the procedures, the expected benefits, the roles and responsibilities of each member of the company, etc. Moreover, it was found that the interviewees were not familiar with the concept of Risk Management neither with its process. However, risks are managed using an intuitive approach, relying on the experience and the competence of the project team members. The *how* such intuitive RMP is performed is slightly similar to the one described in Section 3.2, with some important differences analyzed in the next paragraphs. Nevertheless the *when* in the PLC the RMP is performed, is significantly different, KDP have not been explicitly considered (see Section 4.5).

4.2.1 Initiate

The first step of the Risk Management Process (RMP) is to define the project, as explained in Section 3.2.1. *Telin* does not have any explicit process for defining the project; however this information is reviewed by separate at different stages of the project during the design and construction meetings. According to the interviewees this process of defining the project would not be that useful, they mention two reasons:

- First of all, as explained in Section 4.4, around 85% of the characteristics of the project are the same than other projects; so most of this information is very similar for all the projects. In this sense, it can be said that there is already a common understanding of a standard project.
- A second reason is that the project team is relatively small, and people who start the project are the same than will finish it. In this sense, all the team members necessarily share the same understanding because of the close interaction that exists from the beginning of the project.

So apparently there is no need for *Telin* of this step of the RMP, nevertheless, at least it should be ensured a common understanding of the part of the project that is different. For instance, in a *Telin*'s project undertaken in 2007, one of the variations of this project was that another big contractor (electro-mechanical) was involved, and even if the top managers were aware of the complexity of coordinating a project with

more stakeholders than usual, in that specific case neither this characteristic was properly communicated to the rest of the project team, nor proactive actions were taken to avoid disputes. Instead intuitive reactive actions were taken to tackle all the problems with the other subcontractor. So it is recommended that when a project has significant differences, a formal approach to define the project should be adopted (see Section 3.2.1.1).

Specifically with regards the project objectives (time, cost, functions and appearance), they are identified at the front end of the project, and it is at the tender stage where they are communicated to Telin to be analyzed, understood, and developed in detail. During the design and construction meetings with the client that run throughout the project, these objectives are updated, nevertheless those modifications are not documented, but it is important to do it, so that it can be communicated to the rest of the project team.

4.2.2 Identify & Risk Register

The identification of risks, the analysis, the planning & implementation of responses and the monitoring take place all along the PLC, but it is seen as a task that is implicit in the responsibilities of each department (e.g. construction, projects, purchasing, etc.), or of each role. For example, if a bid for a project is won, and the purchasing department identifies the risk of an increment in the price of steel, then this department will be responsible for ensuring the purchase is made in time, so that the change in price will not affect the project cost. For the company the management of this risk is a responsibility of the purchasing department, although more departments will be involved in the analysis of this risk. The project department will have to give enough information to the construction department so that they can quantify the amount of steel that will be required, and this number is the one that the purchasing department needs in order to make the purchase.

There are two problems with this way of identifying risks:

- The first one is that a holistic approach is not encouraged. Since each department identifies and manage only the risks where it is involved, there is no one trying to find risks that have sources in different departments. For instance, in one of the projects it had to be installed a set of playgrounds, so the obvious risk was that it could be delivered late to the construction site,

which at the end was managed reasonable ok, since it was delivered four working days before the deadline. At the site of construction a subcontractor with no experience with playgrounds was asked to install them, nevertheless, once they were received and opened, it was found that the level of complexity was high, and four days were not enough to complete the installation, so it was required either more time or an specialist subcontractor with experience. This risk was unforeseen, the construction team was expecting something easy to install, and nobody warned it about the probable complexity for its installation given the time restriction. So there are more chances these risks remain unforeseen unless a more holistic approach is adapted to the identification of risks.

- A second downside has to do with the timing of the identification of the risks. Although the company has established well-defined phases of a standard project, the pass (KDP) from one phase to the next one is not always managed in the best way, since the project moves without ensuring must of the risks have been already identified. As stated in Section 3.3 it is recommended to perform a risk assessment before moving to a new stage. Again, it is important to keep in mind that such risk assessment should focus not exclusively but mainly in the part of the project that is different.

For instance, the Project Director and the General Director as part of their roles get together to identify the points to which the project team has to pay special attention. This identification happens before presenting a price & time proposal to the client, in order to ensure the proposal is correct, and that all the main points and factors affecting the project have been considered, nevertheless none of the potential risks that could result from them are documented.

The documentation of risks is an important issue, because the company does not document any risk at all. The reason why they do not do it is because they think every single team member knows what he/she has to do. Nevertheless in practice it is not always like that, not even in the 85% (see Section 4.4) of the project that the company already is familiar with. For instance, in a project the excavation for a foundation had to be executed, and although the site manager knew there was a service line (fire protection system) crossing near the excavation, the civil contractor did not. So this

contractor started the work and broke the service line. The consequences were that the plant had to be evacuated (because the fire alarm was activated), and a couple of hours of production were lost. The same thing happened again a couple of months later in the same project, but this time with the main power line, stopping entirely the plant for about 4 hours. After this a process was established to reduce this risk at excavations. So, this example illustrates that the fact that risks are not documented and reviewed leads to communication problems and mistakes.

4.2.3 Assess

With regards the analysis of risks, the company prefers to take a qualitative approach, since most of the times it is not found useful to quantify risks. This activity relies 100% on experts from inside the company, the supply chain or brought from outside. For instance, when it comes to use a new system, usually expertise is brought from outside to help with the design as well as some technical supervision to assist in the installation. When it comes to analyze risks with in-house expertise, the most experienced people are the ones who participate. For instance, a couple of years ago, in one of the Telin's projects, a very strong wind made the structure of a building under construction fell down, of course one of the most important risks that arise after this event was not to finish in time. So, the General Director, the Construction Director, and the Site Manager analyzed the situation and based on experience developed a new strategy to speed up the construction (risk responses). At the end the situation was successfully managed, so, the way the company undertakes the analysis of risks based not on a quantitative approach but based on the experience of its managers and engineers or based on expertise brought from out-side, has resulted effective. Even so, the results of such analysis are not documented either, which should be done in the risk register.

4.2.4 Plan and Implement Responses

Since the company sees the management of risks as part of the responsibilities of each role, responses are usually planned and implemented by the responsible of that activity. But once again, neither the plans nor the status of the risks are documented, because there is no risk register.

Overall, this intuitive approach to RM used by *Telin* to undertake its light industrial building projects has resulted reasonable effective, and good enough to meet the project objectives when projects do not present significant differences, but this is thanks to some factors that allow this to happen, as explained in the next section.

4.3 Expertise & Supply Chain of the Firm

The company's expertise and the supply chain management are identified as two very important factors that help *Telin* to keep the level of risk for each project relatively low. According to Rodriguez about 95% of the projects meet the objectives with regards to time, cost, functionality and appearance. This subjective measure indicates that most of the risks are managed effectively, by using an intuitive approach. The 5%, as Rodriguez explains, comes mainly from those projects that involve aspects that fall outside the expertise of the company.

The interviewees agreed that one of the most important reasons why the levels of risk are low is because of the huge experience the company accumulated throughout many years of designing and constructing light industrial buildings. As the Project Director says "when clients when first approach us, they usually arrive only with the outline design, if we did not have the expertise, the probabilities we do not consider some aspects of the project in the cost estimation would be very high, but since the company is well experienced by knowing what are the characteristics of the building, we know what we have to consider. On the other hand, if we had to estimate the cost of a bridge, the risks would be very high because we do not know how to build bridges, and it is very likely we will fail to consider all the key points of that project" (Interview with Rodriguez, August 2008).

So, according to Rodriguez everybody in the company knows what to do and how to do it. In that sense he thinks a formal Risk Management Process is not necessary, but then the question is, when a new situation (outside the expertise of the firm) arises during a project, how is it approached? and how often does that happen? These questions are analyzed in Section 4.2.

On the other hand, the company has been working repeatedly with its main subcontractors for more than twenty-five years; in that sense the supply chain also knows what to do and how to do it. Part of the arrangement with the subcontractors is

that any project Telin wins will be directly assigned to them, but in return they have to work exclusively for the firm, and they have to commit to be updated in their own areas of expertise. All this experience of the supply chain and the partnering arrangement that exist with Telin, becomes especially important since (as Rodriguez calculates) 60-80% of the total cost of the project is due to the works undertaken by the main subcontractors. When a cost estimate is presented to the Client and it is approved, each subcontractor makes the commitment to undertake the works with the price they submitted to Telin. Risks with regards cost are then partially transferred to the supply chain, but then again, since both the firm and the supply chain are well experienced, those risks are perceived to be low.

4.4 Beyond the expertise of the Firm

“One of the most important tasks of both the Project and the Construction Directors is to recognize which projects or what characteristics of a project are beyond the area of expertise of the company, because it is a potential source of errors and problems” (Interview with Rodriguez, August 2008). All the interviewees agree that the main source of potential errors is when new circumstances arise, circumstances that are different from what the company knows or usually faces. The question then is: how often does that happen? It is modelled in Figure 4.4.

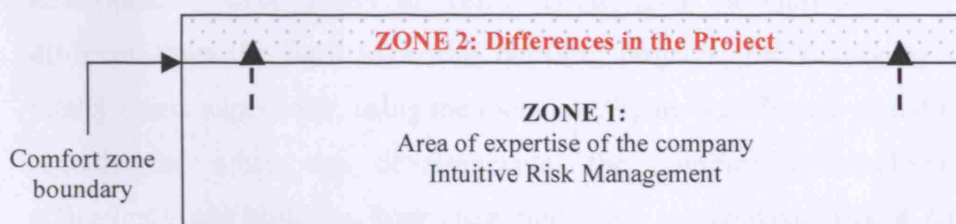


Figure 4.4. Model showing the comfort zone boundary of the firm. Adapted from interview with Edkins, August 2008.

Zone 1 represents the part of the projects where the firm is comfortable; its experience makes it possible to meet the project objectives by just using an intuitive RMP. Employees know how to do their work, the managers already know what part of the project they have to pay special attention, so in that sense the uncertainty is perceived to be low, therefore the chances that surprises arise during the project are relatively low.

Zone 2 is about differences that can be found in the projects with regards what the company is used to do. It can be related to any of the project objectives: time, cost, functions, appearance, or any other circumstances of the project that makes it different.

The interviewees were asked to assign a subjective measure for each zone. All of them agreed that it is between 10-15% for *Zone 2*, and 85-90% for *Zone 1*. It means that they think most of their projects are very similar, and the differences are very small. Even so, Sanchez makes clear that those subjective measures are average, but if it is to consider project by project, every year one or two projects (out of about ten) have significant differences, for Gonzalez that difference could be up to 30%. For instance, last year seven projects were undertaken valued in 65 million USD altogether:

- Four of them were industrial buildings.
- One four-story hotel with 113 rooms.
- One commercial development (including two fast food restaurants).
- One two-story office/restaurant building.

Three of the four industrial buildings were pretty similar to what the company is used to do, and the fourth one was slightly different, which according to Gonzalez was 70% for *Zone 1* and 30% for *Zone 2*. The other three projects were developments: the hotel was a joint venture of Telin with other two partners, while the other two developments were 100% of Telin. These three developments are significantly different from the light industrial building projects: for Rodriguez the hotel was totally a new experience, using the model of Figure 4.2, *Zone 2* would be 100%. With regards the other two developments, the commercial development and the office/restaurant building, Rodriguez thinks they would have 50% of *Zone 1* and 50% of *Zone 2* each, this is because the company developed a similar commercial building in 1994, so even if the uncertainty was high, it was not as high as with the hotel project.

It is clear that 2007 was not a common year for the company, since 40% of the projects were developments and 60% were light industrial buildings, when the common situation according to Rodriguez is that only 10% are developments and 90% are light industrial building projects.

Not surprisingly, when the Project Director was asked about the results in those developments, he recognized that they were not as successful as the ones they get in the industrial building projects, moreover, specially the Hotel Project, the project objectives with regards to cost and time were not met. Actually he recognizes that for such projects a more structured approach to manage the uncertainty would be useful. This response was not surprising because a development involves far more uncertainty than the design and build of light industrial buildings. First of all, Telin has to manage not only the design and construction phases, but also the front-end (See section 4.1.1 & Figure 4.2) of the project with all the strategic-level risks it involves. It is important then, to recognize which projects have to be approached with a formal RMP, and in which ones the intuitive RMP is good enough to succeed. Figure 4.5 shows a model to help the company decide what approach is adequate for each project. Notice that any development will require a formal approach to RM, whereas light industrial building projects will require either the formal approach or the intuitive one depending on how different is the project in terms of contract, construction method, type of design, time constraints, stakeholders involved, type of client, and any other criteria Telin finds useful. It is important to emphasize as well, that such process should be performed at the very beginning of the project.

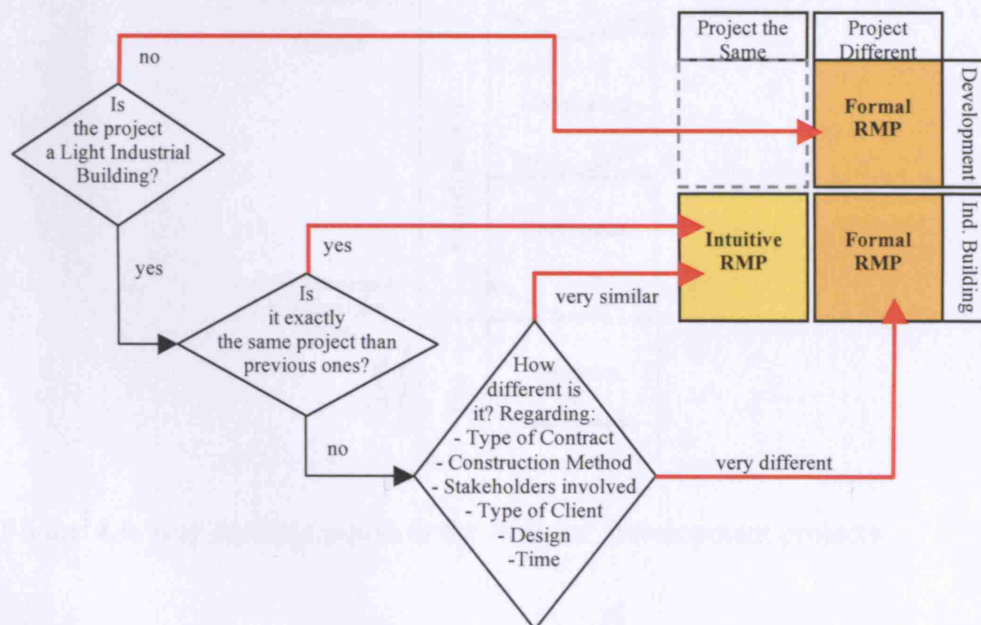


Figure 4.5. Deciding the approach to RM. Adapted from Interview with Edkins, August 2008.

From Figure 4.5, apart from the PLC model shown in Figure 4.3, which applies to light industrial building projects, a second PLC model has to be created for development projects of the company; it is shown in Figure 4.6. Since this time Telin is fully responsible for the whole PLC including the Front End, the KDP have to be adapted, and basically the gates that the OGC proposes suit perfectly to this type of projects. Notice that the procurement phase was omitted since Telin is the developer and constructor as well.

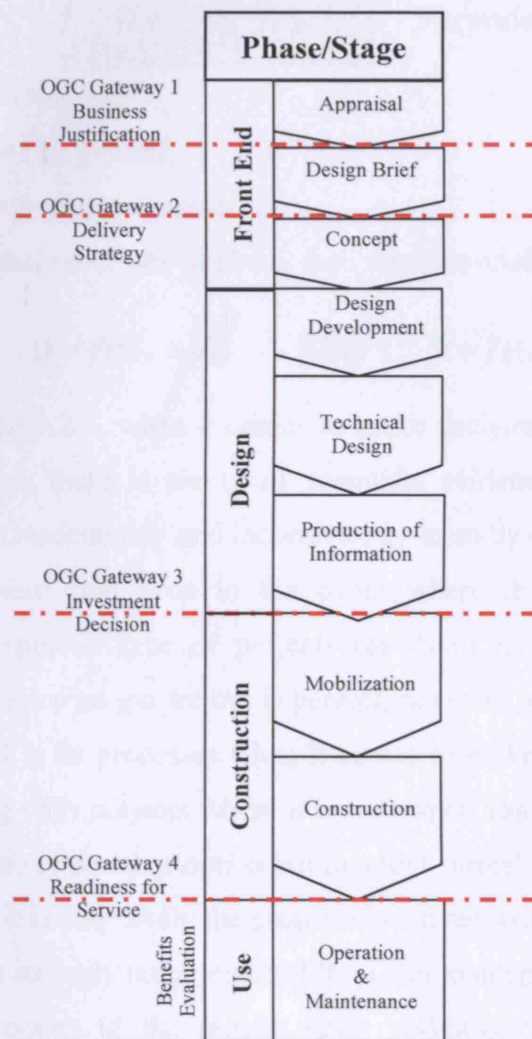


Figure 4.6. Key decision points at the PLC for Development projects.

4.5 RM at the KDP

From the analysis of the intuitive RMP of the company in Section 4.2, it was stated that one of the big differences with regards the formal RMP, has to do with the *when* in the PLC it occurs. This point is analyzed in deep in this section.

A decision is a function of the *gut feeling* of the decision maker and the formal processes in place that help him/her to make it better (Interview with Edkins, September 2008). It can be expressed as a formula as follows:

$$D = f(G_F + F_P)$$

Formula 1

Where: D = Decision
 G_F = Gut Feeling
 F_P = Formal processes

If there are no formal processes in place, then decision-making is 100% based on *gut feeling*:

$$D = f(G_F + \overset{0}{F_P}) \quad \Rightarrow \quad D = f(G_F)$$

As stated in Section 3.2.3, when it comes to make decisions based on *gut feeling* or subjective measures, there is plenty of scientific evidence that shows how those decisions are made inaccurately and inconsistently even by experts. So, from Formula 1, it can be inferred that even in the cases where the company is very well experienced in a specific type of projects (as Telin is regarding light industrial building projects), since no *gut feeling* is perfect, not even nearly, a minimum level of formality is needed in its processes when it comes to make decisions. And when the company is dealing with projects where it is not expert (as Telin does regarding new developments), there is no other option but to adopt formal processes to help decision making, otherwise it is very likely the project objectives will not be met.

For this reason it is strongly recommended for Telin to adopt such formal processes at the key decision points of the project (gate reviews), which have already been identified for both, the light industrial buildings and the new developments.

The formal RM at the key decision points will have four objectives, as illustrated in Figure 4.7. The first one is to verify the Business by confirming the project objectives still satisfy the client's needs (Initiate phase of the RMP). The second one is to verify that risks for the rest of the PLC have been identified, analyzed, and responses have been planned and implemented. The third one is to review the current phase and

ensure the predefined deliverables were already achieved. The fourth one is to verify the readiness for the next phase, by ensuring there is a plan to achieve the goals of the next phase.

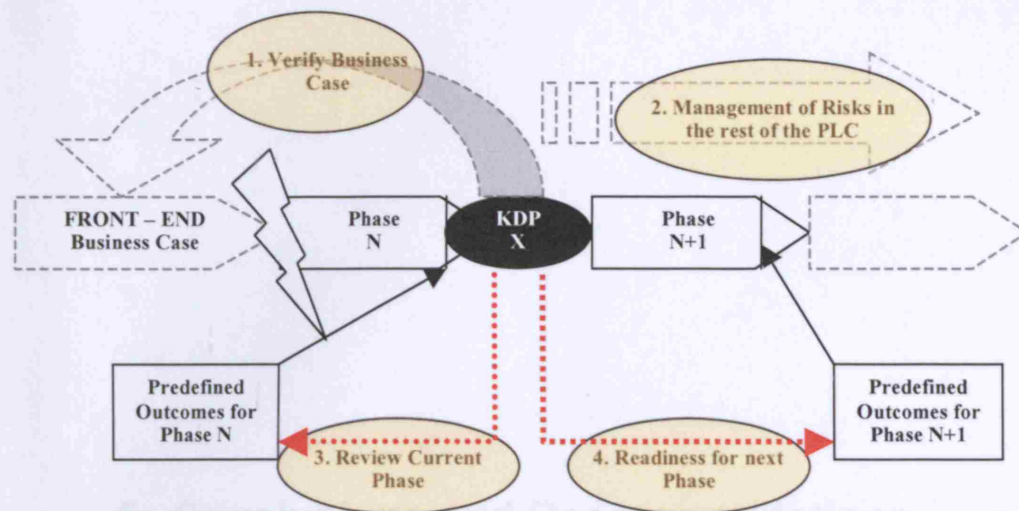


Figure 4.7. Risk Management at the KDP. Adapted from OGC 2008.

The management of risks was the main focus of this report (which involves points 1 and 2 of Figure 4.7). The author considers points 3 and 4 part of the risk management as well, but they are beyond the scope of this work, however it is recommended for Telin to define the deliverables at each phase of the PLC in order to perform the gate review.

From the analysis in Sections 4.2 and 4.4 it can be concluded that a KDP gate will be useful or not depending on the type of projects the firm is dealing with, and depending on the level of expertise the firm has on that specific type of projects. It can be better understood using the Formula 1 presented in Section 4.5.

$$D = \frac{1}{1 + e^{-x}}$$

Formula 1.

The higher and better the x of $f(x)$, which is directly proportional to the level of expertise of the firm on a specific type of projects, the better the decision will be. In order to get to a decision, therefore an iterative KDP should be enough to support the project decisions. On the other hand, the lower the level of expertise of the company in a specific type of projects, the greater the need of formalized processes to make decision makers. From Section 4.4, the model presented and applied

5 Conclusions and Recommendations

5.1 For the Mexican Construction Industry (Typical Firms)

This paper revolves around the two questions presented at the problem statement (Section 1.1), would it be useful for typical construction companies in Mexico to adopt a formal RMP? and if so, with which level of formality should it be implemented? From the analysis at Sections 4.2 and 4.4 it can be concluded that a RMP either will be useful or not depending on the type of project(s) the firm is dealing with, and depending on the level of expertise the firm has on that specific type of projects. It can be better understood using the *Formula 1* presented at Section 4.5.

$$D = f(G_F + F_P)$$

Formula 1

The higher and better the *gut feeling*, which is directly proportional to the level of expertise of the firm in a specific type of projects, the lesser formal processes are needed in order to get good decisions, therefore an intuitive RMP would be enough to achieve the project objectives. On the other hand, the lower the level of expertise of the company in a specific type of projects, the greater the need of formalized processes to assist decision makers. From Section 4.4, the model presented at Figure

4.5 can be adapted to assist Mexican construction companies in the selection of the approach to RM that has to be used. It is illustrated in Figure 5.1.

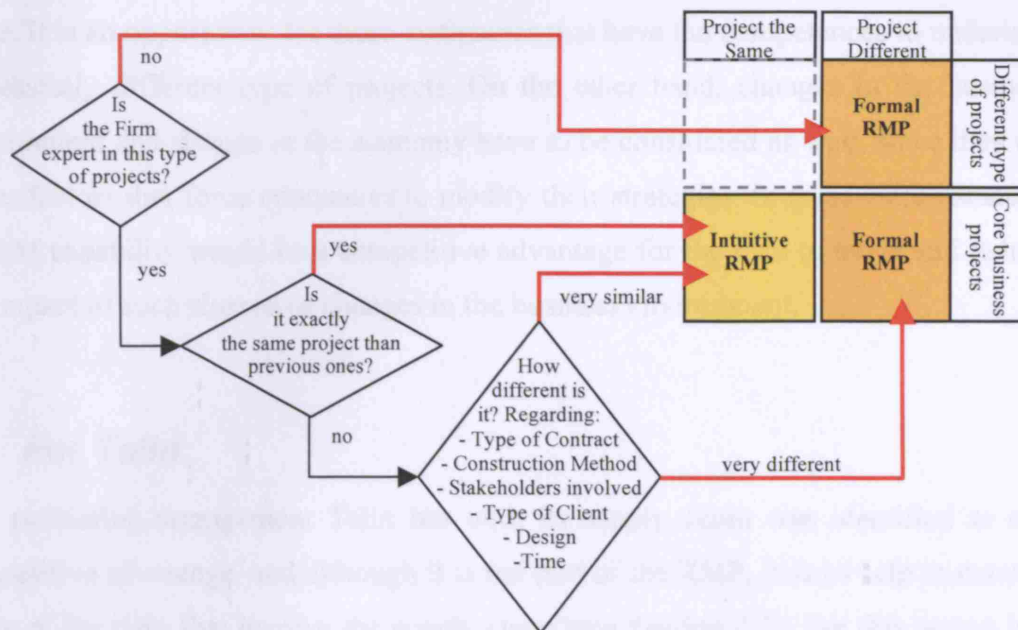


Figure 5.1 Deciding the approach to RM. Adapted from Interview with Edkins, August 2008.

Nevertheless, since none decision based on *gut feeling* is perfect, moreover there is enough scientific evidence that shows its inaccuracy (see Section 3.2.3.1), it is always needed some degree of formal processes. So the intuitive RMP of the company has to be identified and analyzed, and complemented with the parts of the formal RMP that are found useful.

When a formal RMP is required, the process described at Section 3.2 has to be explicitly adopted and performed at the key decision points (see Section 3.3). It is important to emphasize that the RM is a continuous process, as illustrated in Figure 3.14, so although the emphasis is at the KDP, the RM should be embedded in the daily activities of the project team (See section 3.3), for instance, the risk register has to be reviewed continuously throughout the PLC, adding new risks that could arise, and updating the status of risks already identified (see Section 3.2.2.3).

The use of the formal RMP can also have strategic reasons that Mexican construction companies should consider. The RM can be seen as a core competence of the company that allows it to move outside from its core business and undertake successfully other type of projects. Based on this idea, two opportunities can be easily

identified: As stated in Section 2.1, Mexico is a country with a relatively poor infrastructure which urgently needs to be developed, and since it is also an emergent economy it will require a heavy development of such infrastructure in the years to come. It is an opportunity for those companies that have the competences to undertake successfully different type of projects. On the other hand, changes in the business environment and slumps in the economy have to be considered as well, since they are major factors that force companies to modify their strategies. In these circumstances, the RM capability would be a competitive advantage for the firm to move and reduce the impact of such slumps or changes in the business environment.

5.2 For Telin

The partnering arrangement Telin has with its supply chain was identified as one competitive advantage, and although it is not part of the RMP, it does help to manage many of the risks that involve the supply chain (see Section 4.3). For this reason it is recommended for Telin to maintain and if possible improve such relationship with its key suppliers.

On the other hand, the intuitive management process Telin uses for its light industrial building projects, although it has resulted effective, it can be improved by adopting certain degree of formality from the formal RMP. From the analysis in Section 4.2 it is recommended for the company to adopt a risk register to document all the risks, its analysis, the responses, and the owners so that they can be reviewed at the design and construction meetings. It is also recommended to perform gate reviews at the KDP, although not as strictly as it would be in the formal RMP.

5.3 Limitations and Further Research

This report is based on the study of a single company, and although such company is considered to be representative of the typical companies in the construction industry in Mexico, the author recognizes that further evidence would be necessary to make the conclusions of this report more solid. It can be approached as an opportunity for further research.

The analysis, conclusions and recommendations regarding Telin are based on interviews made to three employees of the company, so it does not really cover all the possible different points of view, therefore such conclusions and recommendations should be further developed before their implementation.

Finally, it is important to mention that aspects as cultural issues, the financial implications of the implementation of the system, the time implications, etc, that are extremely important for a successful implementation of the formal RMP, are beyond the scope of this report, therefore they are not analyzed here. However, the author is aware of the importance of considering such factors, and is also an opportunity for further research.

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