Risk Management in Enterprise Resource Planning projects

Davide Aloini

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University of Rome "Tor Vergata"

University of Pisa
Faculty of Engineering
Department of Electric Systems and Automation
Building Polo A, Via Diotisalvi 2, 56126 Pisa, Italy
Phone +39 0502217384, Fax +39 0502217333
davide.aloini@dsea.unipi.it
www.dsea.unipi.it

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Tutor: Prof. Valeria Mininno
(University of Pisa)

Coordinator: Prof. Andrea D'Angelo
(University of Rome "Tor Vergata")

Alla mia famiglia
e a tutte le persone che mi sono
state veramente vicino.

Summary

In recent years Enterprise Resource Planning (ERP) systems have received much attention. ERP are extremely complex information systems, whose implementation is often a complex adventure for business enterprises. The organizational relevance and risk of ERP projects make it important for organizations to focus on ways to make ERP implementation successful.
However, dealing with risk management in ERP project introduction is an ambitious task. Numerous risk factors have to be taken into account which include technological and managerial aspects, both psychological and sociological; moreover they can be deeply interconnected and have indirect effects on the project. Therefore, the risk management process is highly difficult and uncertain.

The general purpose of this study is to develop an innovative risk management methodology supporting the formulation of risk treatment strategies and actions during ERP introduction projects in order to finally improve the success rate. In this thesis, the research context, framework and methodology are presented; then main phases are introduced and results discussed.

Keywords: Enterprise Resource Planning, Risk Management, Assessment, Mitigation, Case Studies.

Preface

This thesis has been realised at the Department of Electrical System and Automation of the Faculty of Engineering of the University of Pisa (Italy) in fulfillment of the requirements for acquiring the Ph.D. degree in Economic-Managerial Engineering at the Faculty of Engineering of the University of Rome "Tor Vergata".

The thesis deals with the different aspects and phases of the Project Risk Management during the Enterprise Resource Planning introduction projects. The main focus is on the extension or the development of innovative approaches, methodologies and techniques supporting the different phases of the Project Risk Management process. Finally a first verification of the model applicability is proposed by a number of retro-perspective case studies.

The thesis consists of a summary report and collects also references to research papers written during the years 2006-2008, and elsewhere published.

Pisa, November 2008

Davide Aloini

Papers included in the thesis

1) Aloini D., Dulmin R. & Mininno V. (2007).

   Risk management in ERP project introduction: Review of the literature. *Information Management*, vol. 44, pp. 547-567.

2) Aloini, D., Dulmin, R., & Mininno, V. (2008).

   Risk Assessment in ERP Introduction project: dealing with Risk factors inter-dependence. *Proceedings of GITMA 2008 Conference*, Atlanta (USA), 22-24 June 2008.

Acknowledgements

I apologize with readers since the acknowledges of this thesis are written in Italian, my native language; I'm feeling more confident with it for this purpose.

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Davide

Contents

Chapter 1

Introduction

No risk, no reward.
Companies must take risk both to launch new products or services and to innovate themselves. "However risk processes do not require a strategy of risk avoidance but an early diagnosis and management".

(Keizer et. al, 2002)

This chapter initiates the dialogue on the adoption of a risk management philosophy in the hard project to introduce an Enterprise Resource Planning (ERP) system in the company. Here the main aim is to introduce readers into key issues about the research context, and in particular to answer the following questions:

- Why are the ERP introduction projects complex?
- Why do we investigate ERP risk management?
- What is the purpose and scope of this thesis?
- What is the outline of the thesis?

1.1 Background and motivation

In recent years Enterprise Resource Planning (ERP) systems have received a lot of attention, nevertheless the ERP projects have often been found to be complex and risky to implement in business enterprises.
The integrated e-business marketplace and the external environments have highlighted the needs for companies to quickly react signals to customer and behave competitively. To achieve this target, companies need an effective Communication Systems and an integrated Information Systems (ICT) fitting their business goals and processes, both inside and outside the company's boundaries. Companies are often forced to establish strong partnerships and form an effective supply chain (Robey and Farrow, 1982); with this aim ERP and SCM system applications are frequently implemented to improve firm's performance (Tarn et al., 2002).

Over the last decade, many world-wide firms have implemented ERP systems, which are packaged business software systems that help in managing an efficient and effective use of resources (materials, human resources, finance, etc.) (Mabert et al., 2000; Kumark and Hillegersberger, 2000). They assist enterprises in automating and integrating corporate cross-functions, such as inventory control, procurement, distribution, finance, and project management (Slooten and Yap, 1999). As estimated by AMR Research (AMR research, 2000; 2002a; 2002b; 2005), with an ERP penetration at 67 percent (2002), the ERP market is the largest segment of a company's applications budget (34 percent). The global market grew 14 percent in 2004 to become a 23.6 billion dollar business, moreover the European ERP market revenues are expected to increase 7% annually through 2009.

However, ERP projects are complex; PMP (PMP research, 2001) found that the average implementation time of an ERP project was between six months and two years and the average cost was about one million dollars. Researchers have pointed out there is a substantial difference between an "ERP" project and a simple "Software" project (Bingi et al., 2001), since the first not only involves several components of software but also business systems, consequently raising organizational problems.

Despite the significant benefits ERP software packages provide, millions of dollars is the cost to buy them, while several times that amount is the cost for installing, and they often require disruptive organizational changes (Volkoff, 1999). Time and costs can be enormous (Jacob and Wagner, 1999; Reda and Susan, 1998) both since ERP implementation involves a large number of stakeholders as observed by Soh et al. (2000), and because the hidden costs during the ERP life cycle dramatically increase the total implementation cost. Therefore some

companies have experienced considerable advantages while others have had to reduce their initiatives and accept minimum payoffs, or even relinquishing ERP implementation altogether (Soh and Sia, 2004).
To sum up, IT projects have an high failure rate: according to the estimation of the Standish Group International, 90 percent SAP R/3 ERP projects run late (Baki and Cakar, 2005); a SGI study on 7400 IT project confirms that 34 percent were late or over budget, 31 percent were abandoned, scaled or modified, and only 24 percent were completed on time and on budget.

Even if the organizational relevance and risk of ERP projects make it important for organizations to focus on the ways to make an ERP implementation successful, unfortunately difficulties in the implementation process still exist, affecting complex IT projects as the introduction of an Enterprise Resource Planning.
A possible explanation for such a high ERP project failure rate is that managers do not take the appropriate measures to assess and manage the risks involved in these projects (Wei et al., 2005). In this field a gap in scientific literature still exists (Aloini et al. 2007) and actionable knowledge is needed. This work suggests a risk management methodology to manage the project of ERP systems introduction and achieve the guidelines for dealing with the risk in this kind of projects.

1.2 Research objective and framework

The general purpose of this research is to develop an integrated and effective risk management methodology supporting the formulation of risk treatment strategies and actions during the ERP introduction projects in order to finally improve the project success rate.

Dealing with risk management in ERP introduction projects is an ambitious task. ERP projects are highly interdisciplinary; as they affect interdependencies between business processes, software and process reengineering (Xu et al., 2002). Critical factors include technological and managerial aspects, both psychological and sociological; moreover they are often deeply interconnected and have indirect effects on the project. This makes the risk management phases, and particularly the risk assessment, more difficult, uncertain and important than traditional one.

In the past, various methods were proposed to try improving the success rate of ERP introduction or implementation efficiency and a large number of processes, some more general (Chapman and Ward, 2003; Standards Australia, 1999; PMI, 2001; Keizer et al., 2002), some other more specific for ERP project (Bandyopadhyay et al., 1999; SAP white paper, 2003; Yang et al., 2006), were generated both from academics and practitioners to address the need of a more effective risk management. Unluckily some gaps still remain: almost all these contributions present quite qualitative and not integrated approaches to risk assessment; they do not explicitly deal with the problem of the risk factors interdependence or their relationships with the effects; and do not suggest any suitable ERP risk management strategy.

To be effective, in fact, a risk management methodology should be correctly contextualized, should consider several concurrent aspects (technology, market, financial, operational, organizational, and business) and link them to the project life cycle. This enables the correct selection of the most appropriate risk treatment strategy.

The main objectives of this dissertation is a methodology with supporting tools and techniques for managing risks in an innovative ERP specific risk management approach, which could sustain managers in ERP introduction process, both during the early stages of ERP introduction projects, as support to the activity planning (concept and reduction of a Risk Management Plan) and during the implementation and post-implementation phases as support to project management and the control processes.

This work gives managers and researchers valuable information in the following outcomes, providing:

- a review of the state of the art about risk management in ERP field;
- an in-depth knowledge of risks in ERP introduction projects (risk factors identification, homogenization, contextualization and analysis are dealt in the previous stages of the work);
- proposals of new and old techniques (customized for the ERP project needs) to be used for an innovative and more effective management of the risk identification, assessment, treatment and control stages during these projects;
- evidences from retro-perspective tests on the field through the analysis of a number of relevant case studies in Italian companies recently involved in ERP introduction projects;
- conclusions, considerations about the conceptual validity and applicability in firms, and the potential future improvement of the model.

1.3 Overview and contribution of thesis

Following the general framework presented in Figure 1.1, this thesis is divided into 3 sections according to the main research phases: **Section 1**, composed by *Chapter 1, 2* and *3*, assesses the motivation for this work, reports the current state of the art on the project risk management and on ERP introduction projects and finally focuses on the ERP risk management field; **Section 2**, including *Chapter 4* and *5*, proposes a general risk management model to develop a specific risk management approach for ERP introduction projects, suggesting innovative methodologies and techniques for the different risk management phases or adapting the existing ones to the ERP context. **Section 3**, counting *Chapter 6, 7* and *8*, presents test evidences from a number of case studies in Italian firms recently involved in ERP introduction projects and reports some considerations about the introduction of the methodology in firms, the limits and the potential improvements to this work, the future developments and researches.

To briefly resume the main outline of each chapter:

Section 1:
Chapter 2 deals with Risk Management and focuses in particular on Project Risk Management to clarify the meanings of uncertainty and risk in projects. A literature review, investigating on the existing risk management approaches and techniques is performed to assess the state of the art in this field. The main contributions are analyzed discussing differences, advantages and disadvantages of the different applied methodologies.
Then the attention moves on the Risk Management in IT projects, reviewing most relevant contributions explaining why and how risk management should be addressed in these kind of projects and identifying the areas needing further deployment.

In *Chapter 3* the background of the ERP systems is discussed with particular attention to the life cycle phases, players and critical factors of the introduction project.
An extended literature review is then presented (130 peer-reviewed articles were collected and 75 were selected for the analysis) in order to define the main issues and research approaches in literature, identify the areas needing an ERP risk management deployment and the most relevant risk factors assessed. The different research approaches were compared from a risk management point of view to highlight the key risk factors and their impact on the project. Four major research branches are finally identified: ERP selection, ERP implementation, ERP risk management and general ERP projects. The review concludes with a list of the most critical risk factors prioritized by the frequency they appear in

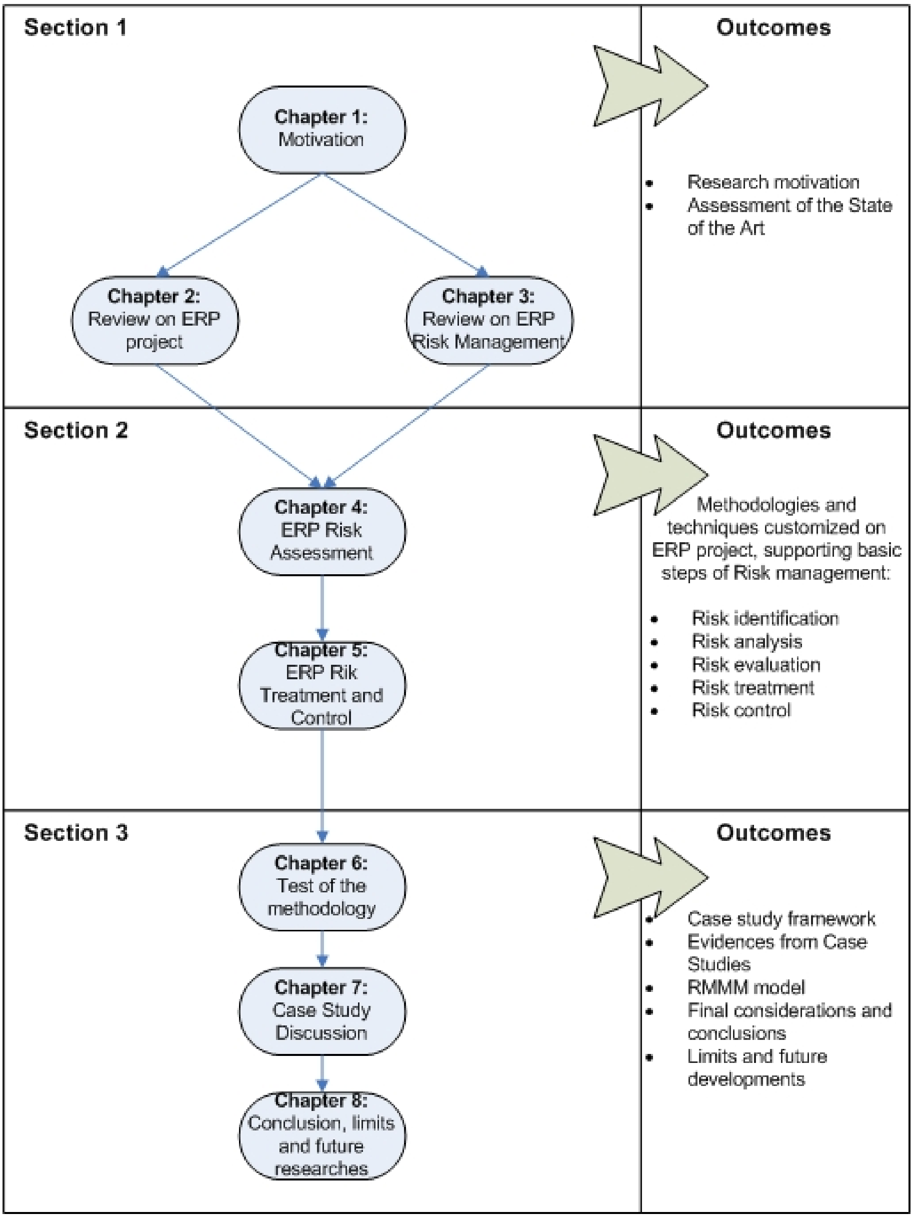


Figure 1.1: Thesis framework

literature. Furthermore it evidences that, despite the great importance reserved to the factors linked to risk, project and change management areas, only a few

articles explicitly deal with them.
Thereafter, the Chapter focuses on the contributions explicitly dealing with risk management in ERP projects. A literature review, investigating on the existing risk management approaches and techniques both from academic and practitioner world, is performed to assess the state of the art in this field. The main contributions to ERP risk management are identified and analyzed; finally gaps and shortcomings are discussed.

Section 2:
In *Chapter 4*, according to the general risk management model presented in Chapter 3, the *Risk Assessment* phase is presented.
Risk assessment is a core step of the risk management process, in this phase it is needed to understand the nature of risk in terms of which factors could impact on project success, their interactions, probability of occurrence, difficulty of detection and potential impact on the project in order to quantify their risky and prioritize them. March and Shapira (1987) found that the perceptions of risk held by managers were much different from the theoretical concept linked to factor probability and potential impact.
This phase consists of two principal issues: a) *Risk Identification* and b) *Risk Quantification*. The current state of the art in these fields is discussed reporting some relevant contributions supporting the different activities in risk assessment. An extended literature review responds to the need of risk identification, focusing on the classification and the taxonomy of the main risk factors, then effects were identified and risk factors analyzed starting from the Lyytinen and Hirschheim's (1987) classification of project failures, literature evidences and semi-structured interviews to practitioners. Finally, an overall framework, enumerating risk factors, effects and macro effects, was drawn.
As for Risk Quantification, in Risk Analysis stage, risk factors were analyzed and re-classified according to a number of relevant decisional attributes such as control-ability, detect-ability, project life cycle, responsibility and dependence. Then an ISM-based (Interpretive Structural Modelling) technique is proposed to model dependences and interconnections among the risk factor and between risk factors and effects, to draw a risk event tree.
Lastly in Risk Evaluation a probabilistic network is introduced with the purpose to simultaneously take into account the risk factor dependences, their probability of occurrence and impact on project effects. A software prototype automates this phase.

Chapter 5 discusses *Risk Treatment and Control* phases. No risk management approach, in fact, is really effective if does not lead to an appropriate support for the selection of the right strategy in Risk Treatment and Control phases. Once risk factors are ranked and risk classes identified, an effective strategy has to be adopted to manage risk. Risk management strategies consist of four classic approaches: (PMI 2000): 1) Avoidance 2) Transference 3) Mitigation and

4) Acceptance. In this work, an innovative approach is presented in order to enable the selection of an appropriate and timely strategy in Risk Treatment and Control phases. Suitable strategies are then explained according to the project life cycle, the risk factors profile and impacts on the project. A roadmap of the possible actions is finally drawn from literature and from semi-structured interviews to managers.

Section 3:
In *Chapter 6* the risk management methodology, techniques and tools are tested through case studies in order to examine their conceptual validity, applicability, utility and usability in risk assessment, treatment and control phases. Here, the case study framework is presented, as well the questionnaire guiding the semi-structured interviews. A number of case studies from Italian firms recently involved in the introduction project of ERP systems is analyzed by in-depth interviews, ex-post evaluations on the project performance and a simulation of the risk assessment methodology.

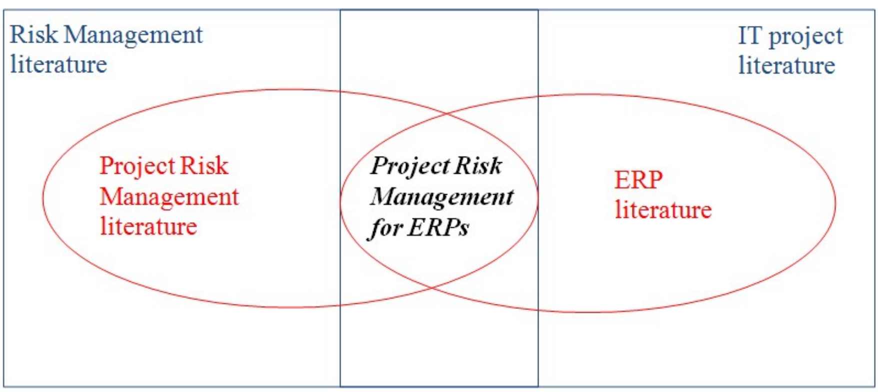
Chapter 7 presents discussions and main results from the case study compared analysis; then a Risk Management Maturity Model (RMMM) is introduced in order to investigate on the introduction of the methodology in firms and to understand how the proposed methodology could assist this process. Finally evidences from other researches in literature are reported and commented at the light of the achieved findings.

Chapter 8 presents the conclusions, the limits and the directions for further researches.

Section 1

I like to think of this work as an exploratory voyage through an open-sea. This section could be considered as the lighthouse of this work. As a lighthouse is supposed to indicate the sailor where the shore line is, but not exactly where the seaport is, giving him confidence and awareness about the boundaries, limits and dangers of the known countries. In the same way, this section would drive readers trough the existent body of literature in Risk Management and ERP field showing the explored topics and gaps.

In this purpose, Chapters 2 and 3 assess the current state of the art on the project risk management, on ERP introduction projects and finally focusing the attention on the ERP risk management field. An useful roadmap of literature is drawn in figure below.



Chapter 2

Project Risk Management

This chapter finds its rationale in the need of clarifying the concept of risk and uncertainty in project management and provide readers a clear definition of project risk to be useful for the assessment of the different activities in the risk management process. As a result, it will address a number of specific questions, and in particular:

- What do risk and uncertainty mean?
- What does project risk management mean?
- What is the state of the art in this field?
- Why shall we apply a project risk management to IT projects?

In the first part, the chapter is mainly a review about uncertainty, risk, project risk management approaches and techniques, whose contents are drawn from "Project Risk Management: Processes, Techniques and Insights" (Chapman and Ward, 2003), "PMI book" (PMI, 2000), "Risk Management" (Standards Australia, 2004) and (PRAM) "Project Risk Analysis and Management Guide" (APM, 1997). Then the discussion focuses on the evaluation of the introduction of Risk Management in IT projects reviewing most relevant contributions about why and how risk management should be addressed in these kind of projects.

2.1 Introduction

Risk is part of our lives; thus risk management is universal but in most circumstances is an unstructured activity, based on common sense, relevant knowledge, experience and instinct. Consciously or unconsciously, we all see hazards and evaluate their risk to determine which ones we choose to notice, ignore, or perhaps making decisions to do something about them, taking the consequences of some risks for granted and, for others, considering our own chance of being harmed. In short, the way we treat risks depends on our own perception of how they relate to us and on things we value (Etherton, 2007). Adams and Thompson (2002), for example, analyse how people view risks and apply value judgements in an orderly risk assessment process.

All projects involve risk - the zero risk project is not worth pursuing. This is not purely intuitive but also a recognition that acceptance of some risks is likely to yield a more desirable and appropriate level of benefit in return for the resources committed to the venture. In general, unexpected events occur in projects and may result in either positive or negative outcomes that are a deviation from the project plan. Hence, risk involves both threat and opportunity. Organizations that better understand the nature of the risks and can manage them more effectively cannot only avoid unforeseen disasters but can work with tighter margins and less contingency, freeing resources for other endeavours, and seizing opportunities for advantageous investment that might otherwise be rejected as “too risky”.

These words introduce the book Project Risk Management by Chapman and Ward (2003) and give a clear direction to risk management practice towards a more general recognized uncertainty management approach. Successful risk management, in fact, is not just about reducing threats to project performance. A key motive is the identification of opportunities to change base plans and develop contingency plans in the context of a search for risk efficiency, taking an aggressive approach to the level of risk that is appropriate, with a view to long-term corporate performance maximization.

2.2 Uncertainty and risk management in projects

The need to manage uncertainty is inherent in most projects that require formal project management, using “uncertainty” in the plain English “lack of certainty” sense.
Consider the following illustrative definition of a project:

"...an endeavour in which human, material and financial resources are organised in a novel way, to undertake a unique scope of work of given specification, within constraints of cost and time, so as to achieve unitary, beneficial change, through the delivery of quantified and qualitative objectives."

(Turner, 1992)

This definition highlights the change-inducing nature of projects, the need to organize a variety of resources under significant constraints, and the central role of objectives in project definition. It also suggests inherent uncertainty related to novel organization and a unique scope of the work, which requires attention as a central part of the effective project management.

2.2.1 Uncertainty

Based on ordinary usage, uncertainty is a state of not knowing whether a proposition is true or false. In projects, uncertainty is partly about "variability" in relation to performance measures like cost, duration, or "quality". It is also about "ambiguity" associated with lack of clarity because of the behaviour of relevant project players, lack of data, lack of details, lack of structure to consider issues, working and framing assumptions being used to consider the issues, known and unknown sources of bias, and ignorance about how much effort it is worth expending to clarify the situation (Chapman and Ward, 2003).

In a project context these aspects of uncertainty can be present throughout the Project Life Cycle, but they are particularly evident in the pre-execution stages, where they contribute to uncertainty in five areas:

- variability associated with estimates;
- uncertainty of the basis of estimates;
- uncertainty of design and logistics;
- uncertainty of objectives and priorities;
- uncertainty of the fundamental relationships between project parties.

There are six basic questions that need to be addressed dealing with uncertainty:

- (the who) who are the parties ultimately involved? (parties);

- (the why) what do the parties want to achieve? (motives);
- (the what) what is it the parties are interested in? (design);
- (whichway) how is it to be done? (activities);
- (wherewithal) what resources are required? (resources);
- (the when) when does it have to be done? (timetable).

In this aim, Chapman and Word (2003) introduce the following framework (Figure 2.1) the influences on project definition that are the roots of uncertainty.

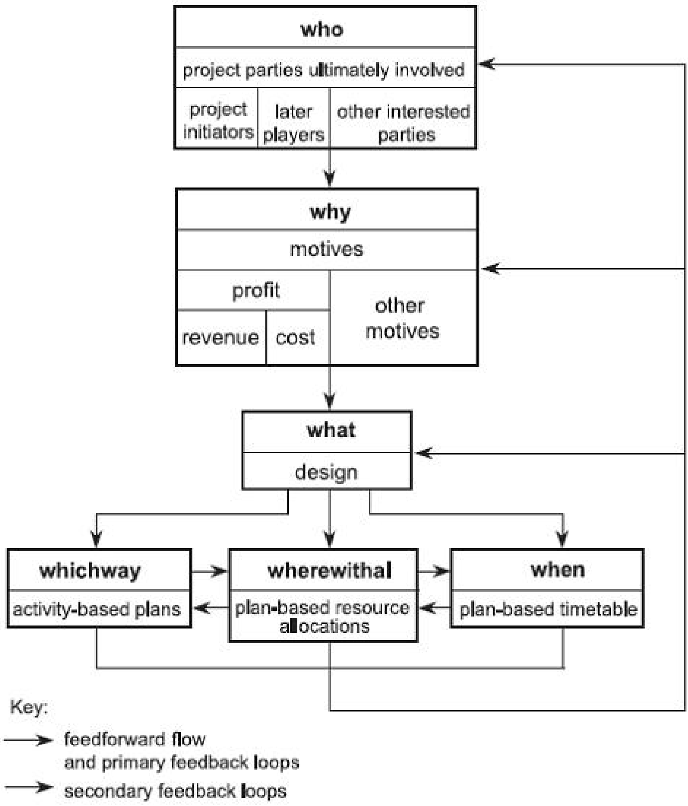


Figure 2.1: Root of Uncertainty, Source: (Chapman and Ward, 2003)

Efficient and effective project management requires an appropriate management of all the sources of uncertainty outlined above. Risk Management Processes

(RMPs) that adopt a simplistic focus on threats will not address many of these sources of uncertainty. RMPs concerned with threats and opportunities using the APM (1997) or PMI (2000) definitions of "risk" will do better, but will still tend to be focused on uncertain events, conditions, or circumstances.

Finally it is useful to define "risk" as *an uncertain effect on project performance rather than as a cause of an (uncertain) effect on project performance.* Such a definition of project "risk" is "the implications of uncertainty about the level of project performance achievable". Probability is often used as a metric of uncertainty, but its usefulness is limited. At best, probability quantifies perceived uncertainty.

2.2.2 What is risk?

Project Risk can be very subjective depending on who is the subject looking at it. Moreover an historical distinction exists in literature between the term "risk" and "uncertainty", even if they have a common origin. All uncertainties produce an exposure to risk which, in terms of project management, may cause a failure to:

- keep within budget;
- achieve the required completion date
- achieve the required performance objective.

The most famous definition of risk is the one provided by Frank Knight (1921) during a period of active research into the foundations of probability. Knight distinguished between:

- A priori probabilities, derived from inherent symmetries, as in the throw of a die;
- Statistical probabilities, obtained through the analysis of homogenous data.

"To preserve the distinction... between the measurable uncertainty and an unmeasurable one we may use the term "risk" to designate the former and the term "uncertainty" for the latter."

(Knight, 1921, p. 233)

This statement is Knight's famous definition of risk. Risk relates to objective probabilities. Uncertainty relates to subjective probabilities. But Knight's is really not a definition of risk. According to common usage, in fact, risk entails both uncertainty and exposure - possible consequences. Knight's distinction addresses only the uncertainty.

Several definitions of risk are available in literature and risk is usually referred as an exposure to losses in a project (Webb, 1994; Chapman and Ward, 1997) or as a probability of losses in a project (Risk Management Standard AS/NZS 4360, 1999; Larson and Kusiak, 1996; Remenyi and Heafield, 1996; Jaafari, 2001; Kartam and Kartam, 2001).

A fairly common definition of Risk is:
"An uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives."

(PMBOK 2000 Guide, p. 207)

There are three characteristics we may commonly find in all the definitions of risk:

- A risk is a future event that may or may not occur;
- The probability of the future event occurring must be greater than 0% but less than 100%;
- The consequence of the future event must be unexpected or unplanned.

In this thesis, the definition of risk entails two essential components:
$\mathrm{R}_i \approx U_i * E_i$

- uncertainty (U); and
- exposure (E).

A situation where it is not possible to attach a probability of occurrence to an event is defined as uncertainty (Clemen, 1996; Taha, 1997). While uncertainty is not measurable, it can be estimated through subjective assessment techniques (Raftery, 1994). Like uncertainty, exposure is a personal condition, but it is entirely distinct from uncertainty. The degree to which you are uncertain of a proposition does not affect the degree to which you are exposed to that proposition.

In this view: *"Risk is exposure to a proposition of which one is uncertain".*

(Holton, 2004)

This definition presents some operational troubles, depending on the notions of exposure and uncertainty, neither of which can be defined operationally. In the case of exposure, one can be exposed without being aware of the exposure which can be perceived. At best, we can hope to operationally define only our perception of exposure. Similarly for uncertainty: uncertainty that is not perceived cannot be defined operationally. All we can hope to define operationally is our perception of uncertainty. According to this perspective (Holton, 2004) operationalism suggests that this problem is insurmountable. Because operational definitions apply only to that which can be perceived, we can never operationally define risk. At best, we can operationally define only our perception of risk. A more manageable task is to operationally define some aspects of perceived risk. Risk metrics, such as variance of return, are used for this purpose. It is meaningless to ask if a risk metric captures risk. Instead, ask if it is useful. Doing research in IT field from a practical perspective, we will use subjective probabilities to operationally define perceived uncertainty. We use utility or state preferences to operationally define perceived exposure. Even if it is not so easy to operationally define perceived risk, we may operationally define some aspects of perceived risk and we can adopt metrics to assess specific class of uncertainty and exposure and to address this process.

2.2.3 From Risk toward Uncertainty management

Chapman and Ward (2003) argue that all current project risk management processes induce a restricted focus on the management of project uncertainty. This is partly due because the term "risk" encourages a threat perspective, and partly because it has become associated with "events" rather than more general sources of significant uncertainty. Rather than a focus on the occurrence or not of an event, condition, or set of circumstances, it is important to take uncertainty about anything that matters as the starting point for risk management purposes, defining uncertainty in a simple "lack of certainty' sense. Uncertainty management is not just about managing perceived threats, opportunities, and their implications; it is about identifying and managing all the many sources of uncertainty that give rise to and shape our perceptions of threats and opportunities (Chapman and Ward, 2003) Guides published by the US Project

Management Institute (PMI) and the UK Association for Project Management (APM) have already adopted a broad view of risk in terms of threats and opportunities. Their definitions of risk are very similar, as follows:

Risk - *an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective* - PMI (2000, p. 127).

Risk - *an uncertain event or set of circumstances that, should it occur, will have an effect on the achievement of the project"s objectives* - APM (1997, p. 16).

These widely used definitions embrace both welcome upside and unwelcome downside effects. In spite of this, there is still a tendency for practitioners to think of risk management in largely downside, threat management terms (a tendency that authors are not always able to resist).

It could be argued this starting point means we are talking about "risk and uncertainty management" or just "uncertainty management" (including risk management), rather than "risk management". That is the direction we are taking (Chapman and Ward, 2002; Ward and Chapman, 2003), but the term "project risk management' is too well established to be widely replaced.

2.3 An overview of Risk Management approaches

All the organizations intending to make extensive use of risk management, need to develop a formal Risk Management Process (RMP) framework that is tailored to the specific kinds of project and context that organization faces. Frameworks provide a guide for the development of the best practice and formality is desirable because it provides structure and discipline, which efficient facilitates and effective risk management (making sure the right questions get asked and answered, making sure everyone understands the answers and help people to develop the right answers).

There are numerous Risk Management researches and development projects concurrently ongoing. Some among the most established RMP frameworks are outlined in the PRAM Guide (Simon et al., 1997), the PMBOK Guide (PMI, 2000), the RAMP Guide (Simon, 1998; see also Lewin, 2002), Australian Standard (1999) and SHAMPU (Shape, Harness, And Manage Project Uncertainty) process (Chapman and Ward, 2003), PRINCE2 manual (Bentley, 2002) and SAFE approach (Meli, 1998). These are useful representative samples of alternative of Risk Management Process frameworks. Any other process framework of interest could be characterized in relation to these to gain insights about the relationships. Although some alternatives may require a quite new approach to comparison, the basic issues will be similar. No doubt we have missed some, and others will be forthcoming. Williams (1995) provides an useful review of earlier research, Williams (2003) some more recent views.

Each approach tries to systematize in an overall framework risk management processes, establishing a taxonomy about risk, uncertainty and risk management and finally offering a compendium of useful techniques (both qualitative and quantitative) to be used during the different stages of the Risk Management process. However providing a review of these techniques and the way they work is out of the focus of this thesis (for more details see literature: PRAM guide by Simon et al., 1997; AS/NZS 4360, 1999; Ahmed et al., 2007).

2.3.1 Project Risk Analysis and Management (PRAM) Guide (1997)

In the mid-1990s the APM (Association for Project Management) started to develop the Project Risk Analysis and Management (PRAM) Guide (APM, 1997). Project Risk Analysis and Management (Figure 2.2) is a process which enables the analysis and management of the risks associated with a project, dividing the overall process into two constituents or stages: Risk Analysis and Risk Management.

PRAM phases and subphases from the PRAM Guide (Simon et al., 1997)
define project **focus PRAM** **identification**
assessment—structure **—ownership** **—estimate** **—evaluate**
planning **management**

Figure 2.2: PRAM phases, Source: (Chapman and Ward, 2003)

Risk analysis stage is generally split into two "sub-stages"; a qualitative analysis "sub-stage" that focuses on the identification and subjective assessment of risks and a quantitative analysis "sub-stage" that focuses on an objective assessment of the risks. The Qualitative Analysis allows the main risk sources or factors to be identified (check lists, interviews or brainstorming sessions) and it is usually associated with some forms of assessment that could represent the description of each risk and its impacts or a subjective labelling of each risk (ex. high/low) in terms of both its impact and its probability of occurrence. The Quantitative Analysis often involves more in depth analysis with sophisticated techniques (sensitivity analysis, Monte Carlo Simulation, Influence Diagrams, Decision trees, etc.) usually requiring computer software. For some people this is the most formal aspect of the whole process requiring:

- measurement of uncertainty in cost and time estimates;
- probabilistic combination of individual uncertainties.

The *Risk Management* stage involves the formulation of management responses to the main risks. It includes feedback to project plan and well-defined criteria to close out risks. Iteration between the Risk Analysis and Risk Management stages is likely. Main actions are classified as:

- *remove* - the risks that can be eliminated from the project and therefore no longer propose a threat;
- *reduce* - the risks that can be decreased by immediately taking certain actions;
- *avoid* - the risks that can be mitigated by taking contingency actions if they occur;
- *transfer* - risks can be passed on to other parties, unfortunately this action does not normally eliminate the risk, it just pass the responsibility to someone else;
- *acceptance* - the benefits that can be gained from taking the risk should be balanced against the penalties.

Risk Management can involve:

- identification of preventive measures to avoid a risk or to reduce its effect;
- establishment of contingency plans dealing with risks if they occur;
- initiation of further investigations to reduce uncertainty through better information;
- risk transfer to insurers;

- risk allocation in contracts;
- setting contingencies in cost estimates, float in programmes and tolerances or “space” in performance specifications.

The PRAM risk management is a very detailed and precise approach. There are detailed activities and tasks to adhere to with necessary inputs and expected outputs. With detailed techniques, it strongly guides the user throughout the project lifecycle. However, the used risk concepts are very broad and subjected to numerous discussions.

2.3.2 PMBOK Guide

The large membership, global reach, and accreditation programme of the Project Management Institute makes of its Project Management Book Of Knowledge (PMBOK Guide: PMI, 2000, chap. 11) an important RMP description. At a background level, the PMBOK Guide framework presents an input, technique and tool, and output structure for each phase that replaces the purpose, deliverable (output), and task structure of PRAM. Hence, all the main inputs and outputs from the main risk management sub-processes and potential techniques supporting the different stages of activity are here described (Figure 2.3.

PMBOK Guide phases (major processes)
Risk Management Planning
Risk Identification
Qualitative Risk Analysis **Quantitative Risk Analysis** **Risk Response Planning**
Risk Monitoring and Control

Figure 2.3: PMBOK phases, Source: (Chapman and Ward, 2003)

Chapter 11 of the Project Management Body of Knowledge (PMBOK) includes the following major areas (Figure 2.4):

- Risk Identification. Determining which risks are likely to affect the project

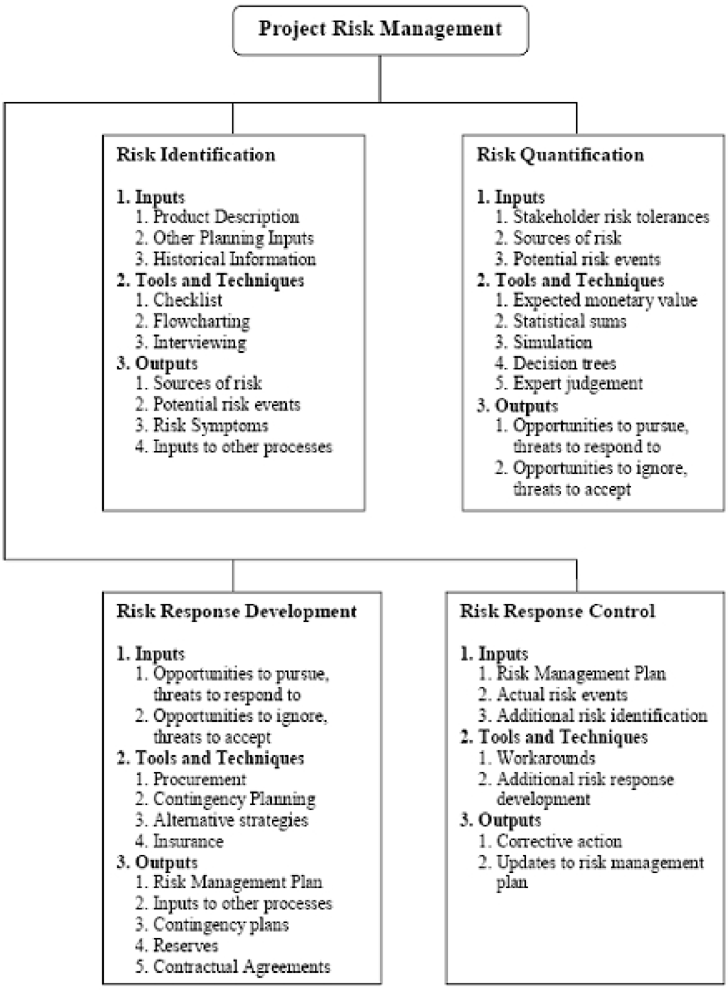


Figure 2.4: PMBOK framework, Source: (Chapman and Ward, 2003)

and document the characteristics of each one. Risk Identification helps in pinpointing the risks that may affect a project. Risk Identification has to be conducted at regular intervals throughout the life span of the process and has to take into consideration the internal and external factors.

- Risk Quantification. Evaluating risk and risk interactions to assess the range of possible project outcomes in order to determine the required activity for different risk occurrences. Risk Quantification analysis may include several aspects:
  - Complex calculations may result to incorrect accuracy and consistency;
  - Good prospects for one stakeholder may be a downfall for another;
  - A risk occurrence can have a snowball effect;
  - Chance and ways to exploit this chance communicate in unexpected ways.
- Risk Response Development. Defining the enhancement steps for opportunities and response to threats:
  - Avoidance abolishing a particular danger. This is by abolishing the root of the problem;
  - Mitigation lessening the cost of a risk occurrence by lessening the likelihood of this occurrence;
  - Acceptance to absorb the consequences.
- Risk Response Control. Responding to changes in risk over the course of the project.

While PRAM is more philosophical and creates the right atmosphere for success, free-flowing text, the PMBOK approach is more practical and focuses on helpful techniques, structured by inputs, tools, outputs and concerns both individual and overall project risk. Project Managers adhering to this technique are strongly guided by its detailed processes. One of the disadvantages is that this technique may be quite strenuous and unfair to large projects.

2.3.3 RAMP Guide

Risk Analysis and Management of Projects (RAMP Guide) was first published in 1998 (Simon, 1998) followed by a revised edition (Lewin, 2002) edited by the chairman of the working party responsible for both editions. It is a simple and straightforward process for evaluating and controlling risk in major projects, which has been developed by a joint working party of the actuarial and civil engineering professions. RAMP is a comprehensive framework within which risks can be effectively managed and financial values placed upon them. The RAMP process facilitates risk mitigation and provides a system for the control of the remaining risks. The process consists of four activities, which are generally carried out at different times in the life-cycle of an investment, from initial conception to eventual termination. Each activity is composed by several phases, each of which is made up of a number of process steps, as indicated below:

- Process launch: conducted early in the investment life-cycle. It aims to confirm the perspective from which the risk analysis and management is being carried out and identify the principal stakeholders interested in the outcome. Other tasks will be to prepare a RAMP process plan, to define objectives, scope and timing and finally to communicate the risk analysis and management strategy and form a risk team.

- Risk review: conducted before the key decisions or at intervals. It includes the stages of risk identification, analysis, evaluation and mitigation.
  The targets of the *identification phase* of RAMP are to:

  - identify all the significant types and sources of risk and uncertainty associated with each of the investment objectives and the key parameters relating to these objectives;
  - ascertain the causes of each risk ;
  - assess how risks are related to other risks and how risks should be classified and grouped for evaluation.

  The analysis phase aims to assess, for each identified risk, which has a "clearly significant" or "possibly significant" consequence (qualitatively or approximately establish the values described below):

  - The likelihood/frequency of the risk occurring per unit of time or some other convenient units;
  - The potential consequences if the risk occurs;
  - The most likely frequency of the risk occurring during the whole lifetime of the investment;
  - The likely timing of the risk impact;
  - The acceptance score, by combining the likelihood with the consequence, using the risk assessment tables.

  The evaluation phase determines the overall impact of risks on the whole-life Net Present Value (NPV) of the investment using investment models or parameter estimates. *The mitigation phase.* As the other RMP approach, RAMP asserts there are four main ways in which risks can be dealt with within the context of a risk management strategy:

  - reduce or eliminate;
  - transfer;
  - avoid;
  - absorb or pool.

- Risk management: continually conducted between risk reviews. At this stage of RAMP, the key task is the monitoring of risks included in the residual risk analysis, risk mitigation strategy and the risk response plan.
- Process close-down: conducted at the end of the investment life-cycle or on a premature termination. A retrospective review of the investment and of the contribution and real effectiveness of the RAMP process applied should be made. The production of a RAMP close-down report as a guide for other projects is likely to be particularly valuable in these circumstances because the most critical events in the history of the project will have recently occurred.

A key characteristic of the RAMP process structure is a strategic view of projects within a financial modelling perspective. It operates at a more strategic level than PRAM and PMBOK, with a stronger focus on financial issues. A second key characteristic of the RAMP process structure is a multiple-level approach that combines both the eight stage PLC and the nine phase PRAM structure in the four "activities". More details are available at the website www.ramprisk.com.

2.3.4 Australian Standard

The Australian Standard on Risk management prepared by the Joint Standards Australia/Standards New Zealand Committee OB-007 (2004) as a revision of AS/NZS 4360:1999 provides a generic framework for establishing the context, identifying, analysing, evaluating, treating, monitoring and communicating risk. It was developed to accommodate public sectors and private organizations on Risk Management. This Standard, after providing definitions on major issues and terminology about risk and risk management, specifies the elements of the risk management process, but it is not the purpose of this Standard to enforce uniformity of risk management systems. It is generic and independent of any specific industry or economic sector.

Some of the changes from the 1999 edition include:

- greater emphasis on the importance of embedding risk management practices in the organization's culture and processes;
- greater emphasis on the management of potential gains as well as potential losses (although the concept of risk is often interpreted in terms of hazards or negative impacts, this Standard is concerned with risk as exposure to the consequences of uncertainty, or potential deviations from what is planned or expected);
- moving and expanding indicative examples into a new handbook.

It is composed by seven iterative sub-processes of establishing the context of risk, identifying risks, analysing risks, evaluating risks, communication and consultation across stakeholders and monitoring and controlling risk events. The main elements of the risk management process, as shown in Figure 2.5 and 2.6, are the following:

- Communicate and consult. Communicate and consult with internal and external stakeholders is appropriate at each stage of the risk management process and concerns the process as a whole;
- Establish the context. Establish the external, internal and risk management context in which the rest of the process will take place. Criteria against which risk will be evaluated should be established and the structure of the analysis defined;
- Identify risks. Identify where, when, why and how events could prevent, degrade, delay or enhance the achievement of the objectives;
- Analyse risks. Identify and evaluate existing controls. Determine consequences and likelihood and hence the level of risk. This analysis should consider the range of potential consequences and how they could occur;
- Evaluate risks. Compare estimated levels of risk against the pre-established criteria and consider the balance between potential benefits and adverse outcomes. This enables decisions to be made about the extent and nature of treatments required and about priorities;
- Treat risks. Develop and implement specific cost-effective strategies and action plans for increasing potential benefits and reducing potential costs.
- Monitor and review. It is necessary to monitor the effectiveness of all the steps of the risk management process. This is important for continuous

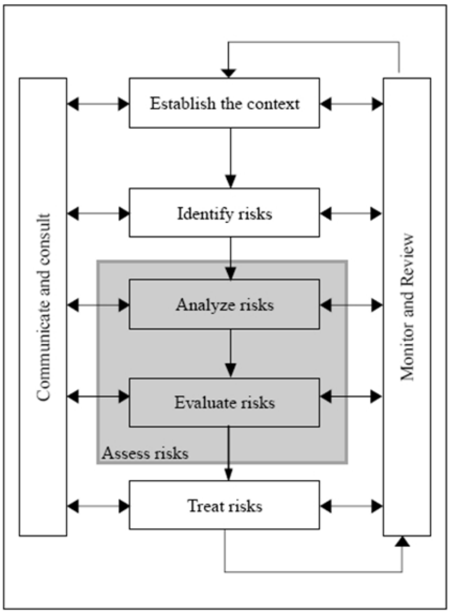


Figure 2.5: Australian Standard, Source: (AS/NZS 4360:1999)

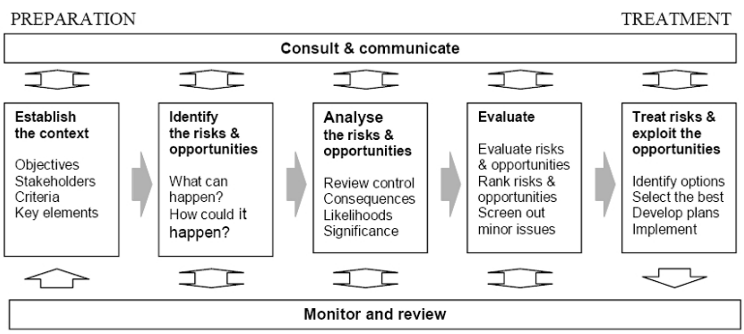


Figure 2.6: Risk management process in Australian Standard, Source: (AS/NZS 4360:1999)

improvement. Risks and the effectiveness of treatment measures need to be monitored to ensure changing circumstances do not alter priorities.

This standard is considered rather simple, but easy to adhere. Any type projects could easily follow this framework. It is scalable and able to support different levels of integration but has also its fair share of disadvantages; it is not implemented to accommodate evaluation of risks.

2.3.5 The SHAMPU framework

The SHAMPU process framework was proposed by Chapman and Ward (2003) and much of its content is already known. It has mostly emerged from the synthesis of earlier project Risk Management Processes and models we reviewed above, as the same authors state. The starting point of SHAMPU is to shape the project strategy, which involves shaping project uncertainty at a strategic level to make the chosen approach to project uncertainty both effective and efficient in a risk efficient sense. This is followed by harnessing the plans (defined in terms of all six Ws), which involves harnessing the uncertainty shaped at a strategic level by developing risk efficient plans at a tactical level. These tactical level plans are necessary for implementation. Manage implementation, managing this harnessed uncertainty, is the third key ingredient. In Figure 2.7 the main phases and sub-phases suggested by this approach are shown. The middle level (five phase) framework provides more details in "shape the project strategy". The basis of analysis must be clarified, executing qualitative analysis provides the necessary holistic structure, and quantitative analysis serves essential roles within this holistic structure.

the basic nine phase SHAMPU process	*middle level (five phase) portrayal*	*simplest (three phase) portrayal*
define the project **focus** the process	clarify the **basis of analysis**	**shape** the project strategy
identify the issues **structure** the issues clarify **ownership**	execute the **qualitative analysis**	
estimate variability **evaluate** implications	execute the **quantitative analysis**	
harness the plans	**harness** the plans	**harness** the plans
manage implementation	**manage** implementation	**manage** implementation

Figure 2.7: SHAMPU phases, Source: (Chapman and Ward, 2003)

More in detail, the nine phase of the SHAMPU process outlining purposes and task phase purposes and tasks in outline are:

- Define the project. Consolidate relevant existing information about the project at a strategic level in a holistic and integrated structure suitable for risk management. Fill any uncovered gaps in the consolidation process, and resolve any inconsistencies.
- Focus the process. Scope and provide a strategic plan for the RMP. Plan the RMP at an operational level.
- Identify the issues. Identify sources of uncertainty at a strategic level in terms of opportunities and threats. Identify what might be done about it, in terms of proactive and reactive responses. Identify secondary sources of uncertainty associated with responses.
- Structure the issues. Complete the structuring of earlier phases. Test simplifying assumptions. Provide more complex or alternative structures when appropriate.
- Clarify the ownership. Allocate both financial and managerial responsibility for issues (separately if appropriate).
- Estimate the variability. Size the uncertainty that is usefully quantified on a first pass. On later passes, refine earlier estimates of uncertainty where this is effective and efficient.
- Evaluate implications. Assess statistical dependence (dependence not modelled in a causal structure). Synthesize the results of the estimate phase using dependence assumptions that fits for the purpose. Interpret the results in the context of all earlier phases. Make decisions about proactive and reactive responses, and about refining and redefining earlier analysis, managing the iterative nature of the process as a key aspect of these tasks.
- Harness the plans. Obtain approval for strategic plans shaped by earlier phases. Prepare detailed action plans. These are base plans (incorporating preventative responses) and contingency plans (incorporating reactive responses with trigger points) ready for implementation within the action horizons defined by appropriate lead times. Commit to project plans fit for implementation.
- Manage implementation. Manage the planned work. Develop action plans for implementation on a rolling basis. Monitor and control (make decisions to refine or redefine project plans as required). Deal with crises (unanticipated issues of significance) and be prepared to cope appropriately with disasters (crises that are not controlled).

SHAMPU process involves both Qualitative and Quantitative analysis. The first in identifying sources of uncertainty at a strategic level in terms of opportunities and threats, identifying what might be done in terms of reactive and proactive responses, and identifying secondary sources of uncertainty associated with responses. The second during the two key moments of estimate and evaluate phases, for sizing uncertainty that is usefully quantified; and on later passes, refining estimates of uncertainty. The evaluate phase involves assessing statistical dependence (dependence not modelled in a causal structure) and using this assessment to synthesize the results of the estimate phase, interpreting the results in the context of all earlier SHAMPU phases, making decisions about proactive and reactive responses, and about refining and redefining earlier analysis.

Some core issues suggested are in the SHAMPU against the other approach presented in literature. One concerns emphasis from project risk in terms of downside risk to project uncertainty, involving upside and downside issues (as the 2004 revision to the Australian Standard also reports). A second is the central importance of risk efficiency in terms of cost-effective analysis and solutions. Moreover, SHAMPU explicitly embraces the six Ws and the PLC, integrating cash flow and multiple criteria models in all the process phases. Only RAMP guide embraces the Project Life Cycle (PLC) of the project and the PLC of the risk management process in a joint manner during its process. However in RAMP, this is mostly true at an strategic level. An other key aspect is the iterative nature of the process (like other RPM frameworks). If a single pass (linear) approach to all SHAMPU phases is attempted, it will be highly inefficient and seriously ineffective. Iterations involve revisiting or looping back to earlier phases to develop, refine, or reconsider aspects of the analysis undertaken to date. The figure 2.8 shows an example of SHAMPU process over time and assumes initiation is round about the end of the plan stage of the project life cycle (PLC). More detailed comparisons about this approach are presented in Chapman and Ward (2003).

2.3.6 PRINCE2

Another well known Risk Management Process is described in PRINCE2 guide. The PRINCE2 method (Projects in Controlled Environments) is internationally accepted as a leading "best practice" project management approach. It is the standard approach within central and local government, the wider public sector and throughout the private sector. The method is scalable and can be tailored to reflect any organisation existing standards, approaches and business.

As the PMBOK, PRINCE2 set the risk management process in an overall project management framework. The figure shows the main steps through the risk

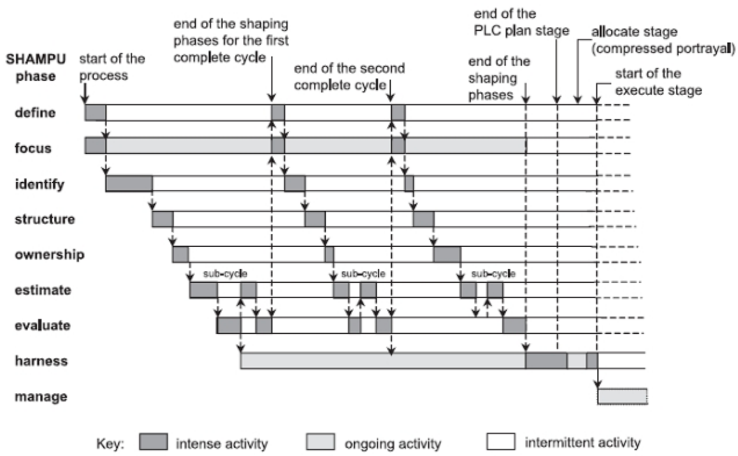


Figure 2.8: SHAMPU activities, Source: (Chapman and Ward, 2003)

Figure 2.9: The management of risk in the PRINCE2 template, Source: (Prince2 Manual 3rd edition, 2002)

management cycle (Figure 2.9). The steps are described in more detail below (Figure 2.10).

Figure 2.10: Risk management process in PRINCE2, Source: Prince2 Manual 3rd edition (2002))

As we stated before many process frameworks could be characterized in relation to the oldest ones. This is the case of PRINCE risk management approach which presents a very similar structure to PRAM. It is divided in two main parts:

- Risk analysis which consists of:
  - Risk identification. This step identifies the potential risks (or opportunities) facing the project. It lists various categories of risk that make a useful start point for risk identification.
  - Evaluation. Risk evaluation is concerned with assessing probability and impact of individual risks, taking into account any interdependencies or other factors outside the immediate scope under investigation.
  - Identify suitable responses to risk. Contemplated strategies are prevention, reduction, transference, acceptance and contingency.
  - Selection. The risk response process should involve identifying and evaluating a range of options for treating risks and preparing and implementing risk management plans. It is important that the control action put in place is proportional to the risk and cost-effective.
- Risk management
  - Planning and resourcing. a) Planning, which, for the countermeasure actions, itemised during the risk evaluation activities. b) Resourcing,

which will identify and assign the actual resources to be used to conduct the work involved in carrying through the actions;

– Monitoring and reporting. Checking for execution, warning signs, modelling trends, etc.

2.3.7 SAFE

SAFE (Safe Activities For Enhancement) is a risk management method to understand, reduce, and accept project risk supplementing a number of different public domain approaches, such as PRM body of knowledge from Project Management Institute, CTC from the Software Engineering Institute, the Euromethod strategy model, those described by McFarlan (1982), Archibald (1994), and others. Although the SAFE method originated in the field of information and communication technology, it may easily be extended to other domains of application (Meli, 1998).

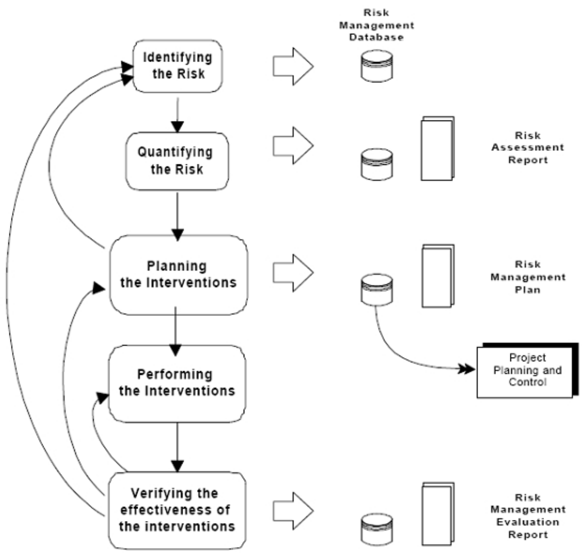


Figure 2.11: SAFE framework, Source: (Meli, 1998)

In SAFE, the first risk management activity (Figure 2.11) is Identifying the Risk (RA1), in which all the major sources of risk are identified, listed, and entered into the Risk Management Database (RMD) containing all the needed information to apply this method. This is followed by Quantifying the Risk (RA2), which makes it possible to obtain a view of the instinctive perceptions of the project riskiness. Hence, a report may be drafted on the nature and degree of risk to which the project is exposed (Risk Assessment Report - RAR).

After the diagnosis phase, the next step is to identify general and particular strategies to reduce the risk factors, both in their probability of occurring and in their possible effects. This is done by Planning the Interventions (RA3), which makes it possible to formulate a Risk Management Plan (RMP) containing both the general indications for properly setting up the project, as well as a section identifying a set of actions to prevent, monitor, and combat each risk factor. The purpose of the RMP is to reduce the Unconditioned Risk associated with the project to a Residual Risk that has a level of acceptability explicitly defined and documented in the Risk Assessment Report. At this point, by comparing the Unconditioned Risk and the Residual Risk, it will be possible to assign the RMP level of estimated effectiveness in removing the risk, measured using an appropriate index.

Management intervention planning will be followed by the activity of Performing the Interventions (RA4), putting into practice all the prevention initiatives provided for by the RMP, activating all the "sensors" designed for the early detection of the occurrence of a risk event, and lastly adopting all the countermeasures needed to combat the risks, that may have been transformed into problems to be neutralized, or at least mitigated.

The final activity is Verifying the Effectiveness of the Interventions (RA5). This is needed in order to confirm or dispute the validity of the RMP, in order to plan new prevention, monitoring, or combating interventions more effective than those adopted to that point. The results of this activity take concrete shape in a document called the Risk Management Evaluation Report (RMER), containing evaluations of those events that have occurred, the effectiveness of the prevention performed, and the reactions adopted. This phase may once again trigger the diagnosis phase (RA1 and RA2) and/or the planning phase (RA3).

The SAFE method illustrated in this work also suggests the techniques and tools supporting the different stages of the analysis as the cognitive map of the territory, the force field analysis, the cause/effect grid, the context diagram and risk matrix for risk identification and quantification, the Delphi or Shang method, the self-determination index, the index of effectiveness in removing risk, weighted analysis techniques and more. For more details see SAFE by Meli (1998).

2.4 Quantitative vs Qualitative Risk Management

Risk analysis and management may be undertaken to varying degrees of details depending on the risk, the purpose of the analysis, and the information, data and resources available (Australian Standard). Analysis may be qualitative, semi-quantitative, quantitative or a combination of both, depending on the circumstances. Some Risk Management Processes in literature focus on qualitative analysis, some others on quantitative analysis, and some else use both. We think that both should be used varying at different stages in the Project Life Cycle (PLC) and at different points in the RMP.

When we speak about Qualitative or Quantitative Risk Management, we primarily refer to the approach taken in the Risk Assessment phase (which includes identification, analysis and evaluation). Risk Assessment (RA) is a process for systematically guiding risk management activities. Outcomes are based on collecting and evaluating (qualitative or quantitative) data on severity of a risk effect linked to a risk factor (event) and the probability of occurrence of that risk factor. A wide dispute about this concern exists in Risk Management literature between those who emphasize formal quantitative assessment of the probable consequences caused by the recommended actions, and comparison to the probable consequences of alternatives, and people who instead emphasizes perceived urgency (qualitative expert judgments) or severity of the situation motivating recommended interventions. Till now it is not clear if Qualitative Risk Assessment better performs than (or as well as) the Quantitative in identifying risk management interventions, but there are strong empirical and theoretical reasons to expect that judgment-based risk management in response to concerns, conducted without a formal QRA, may lead to worse decisions and outcomes than would more quantitative models and methods (Cox, 2007).

What is important for the present purposes is understanding that an effective RMP will necessarily be a largely qualitative identifying-and-structuring process early on and a more quantitative choosing-and-evaluating process later on. The effectiveness and efficiency of quantitative analysis is driven to an important extent by the quality of the qualitative analysis and the joint interpretation of both. Many of the key motives for formal risk analysis may seem to be directly driven by quantitative risk analysis, but the underlying role of the qualitative analysis should never be forgotten, and some of the key corporate learning motives are met by the qualitative aspects of the process.

The Australian Standard (AS/NZS 4360, 1999) distinguishes the types of analysis as follow:

1. *Qualitative analysis*
   Qualitative analysis uses words to describe the magnitude of potential consequences and the likelihood those consequences will occur. Qualitative analysis may be used:

   - as an initial screening activity to identify risks which require more detailed analysis;
   - where this kind of analysis is appropriate for decisions;
   - where the numerical data or resources are inadequate for a quantitative analysis.

   Identification, for example, can be achieved: interviewing key members of the project Team; organising brainstorming meetings with all the interested parties; using the personal experience of the risk analyst; reviewing past corporate experience if appraisal records are kept.

2. *Semi-quantitative analysis*
   In semi-quantitative analysis, qualitative scales are given values. The objective is to produce a more expanded ranking scale than is usually achieved in qualitative analysis, not to suggest realistic values for risk such as is attempted in quantitative analysis. However, since the value allocated to each description may not bear an accurate relationship to the actual magnitude of consequences or likelihood, the numbers should only be combined using a formula that recognizes the limitations of the kinds of scales used.
   Care must be taken with the use of semi-quantitative analysis because the chosen numbers may not properly reflect relativities and this can lead to inconsistent, anomalous or inappropriate outcomes. Semi-quantitative analysis may not properly differentiate between risks, particularly when either consequences or likelihood are extreme.

3. *Quantitative analysis*
   Quantitative analysis uses numerical values (rather than the descriptive scales used in qualitative and semi-quantitative analysis) for both consequences and likelihood using data from a variety of sources. The quality of the analysis depends on the accuracy and completeness of the numerical values and the validity of the models used. Sometimes once all risks have been identified, during the qualitative analysis, it may be appropriate to enter into a detailed quantitative analysis.
   The way in which consequences and likelihood are expressed and the ways in which they are combined to provide a level of risk will vary according to the type of risk and the purpose for which the risk assessment output is to be used. The uncertainty and variability of both consequences and likelihood should be considered in the analysis and communicated effectively.

> Several techniques have been developed to analyse the effect of risks on the final cost and time-scale of projects. However, such techniques do not always readily apply themselves to the analysis of performance objectives.

2.5 Risk Management in IT projects

2.5.1 Introduction

IT (or IS) projects such as other kinds of complex projects may be considered an interesting area for action and potential development of risk management practise.

Risk management is a relatively new trend in this field (Sauer, 1999; Ropponen and Lyytinen, 2000), and, with the growing complexity of systems (Avison and Fitzgerald, 1999; Church and Te Braake, 2001) and the fast pace of technology change (Currie and Glover, 1999; Lopes and Morais, 2002; Stump et al., 2002; Levacov, 2000), rethinking the software process is always needed.

Software projects are high risk activities, generating variable performance outcomes (Charette, 2005). The complexity of the IS field is very significant. IT projects, in fact, often involve the provision of a service to implement systems and solutions, including a variety of hardware and software products (Howard, 2001) and have a high rate of failure (Whittaker 1999; McGrew and Bilotta, 2000).

The IS concept has a variety of definitions in literature. IS are (i) systems that record, handle, transmit, retrieve and display information used in business processes (Alter, 1996); (ii) interrelated elements, based on computer technology or not, that collect, process, record and display data and information (Stair, 1998); (iii) interrelated components that collect, process, record, retrieve and distribute information needed for control and decision support in organizations (Laudon and Laudon, 2000); (iv) information technology (IT) particularly instantiated (Lee, 1999b); (v) human-activity or microsocial systems not necessarily based on computers (Clarke and Lehaney, 2000); or (vi) meaning-building systems in which people select and process data in order to connect them to contextual purpose and support human action, not exclusively involving the processing of data (Checkland, 1999). Moreover, the human factor is integral to an IS (Metersky, 1993) or at least it is closely related to the success of such systems (Marchand and Davenport, 2004), due to the complex intra and interpersonal elements involved (Bednar, 2000). Therefore, IS research is multidimensional in nature.

We can see the software as a product (Nidumolu and Knotts, 1998) due to artifacts like the source code, the documentation and the interfaces (Palvia et al., 2001), notwithstanding its intangible nature (Smith and Keil, 2003) and some service-like attributes (Palvia et al., 2001). But an enterprise information system (IS) includes a software component (Stamelos et al., 2003) which is central to a company's business processes (Chan et al., 1997; Sabherwal and Chan, 2001). Then, when IS assumes strategic organizational functions, its planning should foresee and combine technical, organizational and business factors (Alter, 1996), in the search for a systemic appraisal of all the relevant processes. The fit between the strategic orientation of business and the strategic orientation of IS becomes one of the dominant challenges executives face (Brodbeck, 2001; Chan et al., 1997).

Hence, it is assumed that IS development or implementation have an impact on organizations. In a broad sense, implementation refers to all that must be done by a specific organization for it to be able to harness the capabilities of a particular information technology as envisioned (Sarker, 2000). Implementation essentially refers to anticipating and strategically managing the impacts of the change of the technology component (Robey, 1987) so that the IS becomes "organizationally valid" (Schultz and Slevin, 1975; Markus and Robey, 1983) as the organization comes to a post-implementation steady-state.

A review of the outcome of many information technology (IT) projects reveals that they often fail to meet the pre-specified project objectives of scope, time and budget. In one study, it was found that a third of all software projects were terminated before completion while more than 50% of the projects cost approximately double the estimate (Whittaker 1999) and other similar examples are available in literature. According to another estimation of the Standish Group International, 90% SAP R/3 ERP projects run late (Baki and Cakar, 2005); while a SGI study on 7400 IT project confirms that 34% were late or over budget, 31% were abandoned, scaled or modified, and only 24% were completed on time and on budget. Examples of high profile IT project failures reported in the literature include the American airlines Corporation AMR Information Services (AMRIS), London Ambulance System, the Wessex Health Service RISP (Regional Information Systems Plan, London Stock Exchange's Transfer and Automated Registration of Uncertified Stock (TAURUS) system, FoxMeyer Drug Co., Mandata Human Resource System and the Californian State Automated Child System (SACSS) (Sauer, 1993; Beynon-Davis, 1995; Remenyi, 1999; Willcocks and Graeser, 2001).

Evidences suggest that this is a global issue (KPMG, 2005), impacting private and public sector organizations alike (Sauer and Cuthbertson, 2003). Moreover they indicate that risks in IT projects are not effectively managed and, as a result, their lack of identification and management during a project life-cycle can contribute to their failure (Willcocks and Griffiths, 1997; Hedelin and Allwood, 2002).

Practitioners surveyed by Whittaker (1999) affirmed that IT project failure was most commonly attributed to a lack of top management involvement, a weak business case and n inadequate risk management. Neither less one of the highest ranked factor for project failure was risk management (Whittaker, 1999; Aloini et al., 2007). Despite well established and accepted project risk management processes being available, including PMI 2000, Prince 2 or PRAM, project managers commonly perceive them as not effective for managing project uncertainties (Whittaker, 1999; Pender, 2001). This failure may be well attributed to the inadequate application of those risk management processes (Kutsch and Hall, 2005).

In particular, the OTR Group (1992) found that only 30% of organisations applied risk analysis in their IT investment and project management processes. Likewise, Willcocks (1996) found organisations undertook little formal risk analysis, except when undertaking financial calculations. In this perspective, it is prudent for organisations to improve their ability to manage their IT risks so that projects can be successfully delivered (Gobeli et al., 1998; Willcocks and Graeser, 2001; Jiang and Klein, 2001; Hartman and Ashrafi, 2002).

Kutsch and Hall (2005) stated that in pursuing risk management using the approach derived from expected utility theory (EUT), risk managers and other project stakeholders could expect the benefits of improved certainty in the outcomes of the project with the additional benefits of improved budget setting and reductions in political and financial tension arising from surprises. However, they failed to avail themselves of these benefits because other issues became paramount - what might be called “barriers to preventative action”. These barriers have been called intervening conditions and have been found to manifest themselves as conditions of denial, avoidance, delay and ignorance of uncertainty.

There are many risk events that affect a particular IS/IT project. In these project a formal Risk Management enhances corporate control in terms of allocating resources in a more effective way, improve the ability to look out and utilize opportunities, and also internal or external factors that may affect the organizational success.
According to literature (Ward and Chapman, 2004), risk management can lead to a range of project and organizational benefits including:

- identification of favourable alternative courses of action;
- increasing confidence in achieving project objectives;
- improving chances of success;
- reducing surprises;
- more precise estimates (through reduced uncertainty);
- reducing duplication of effort (through team awareness of risk control actions).

2.5.2 Success in IT projects

Before investigating risk causes and effects of an IT project, we therefore have to give our definition of success in this field. “Risk Factors”, “Critical Success Factors” and “Uncertainty Factors”, sometimes used to convey the same concept, in fact, exist only in relation to a specific definition of project success/failure.

Introducing new IT systems into an organization necessitates integrated change, concurrently attending to technical, human and organizational aspects of IT, while simultaneously accommodating the diverse interests of multiple stakeholder groups. Project success/failure definitely depends on how and by whom it is determined (Wallace, 2004). When we speak of IT project success, it is therefore important to ask: “From whose perspective - the project manager, the user or some other stakeholder?” Schmidt et al. (2001) suggest this is an important area for research.

The project management literature has linked project success to general cost, time and quality of product (Brooks, 1987; Shenhar and Levy, 1997; Atkinson, 1999). In this view, IT (or IS) projects as other kind of complex projects are considered to have failed when expected scope, cost and time targets are not met, expected benefits are not realised, or a stakeholder is dissatisfied with an aspect of the process or outcome.

In Whittaker (1999), for example, IT project failure was defined as meaning:

- the project budget was overrun by 30 per cent or more; and/or
- the project schedule was overrun by 30 per cent or more; and/or
- the project was cancelled or deferred due to its inability to demonstrate or deliver the planned benefits

Wateridge (1998) when surveying the success of IS/IT projects, stated that the participants associated the project success either with meeting requirements; thus the “users” wanted “happiness” while the project managers were interested in being within budget and on time.

Linberg (1999) observed that the success of a completed project was linked to the quality of the product, while a cancelled project had one positive result: the organizational learning.

Agarwal and Rathod (2006) identified two different perspectives of success: an internal perspective linked to time, cost and scope that underlined the value of project monitoring and control processes and an external perspective focused on customer satisfaction and system quality.

Procaccino and Verner (2006) in contrast with the traditional definition of project success (Baccarini, 1999; Boehm, 1981), found that project managers saw success in the delivery of a system that met customer/user requirements at work (resulting in improved quality and personal achievement).

Our IT project failure definition follows Lyytinen and Hirschheim (1987) classification. They categorized IT project success by assessing the resulting system against the planned objectives, user expectations, project budgets and goals by obtaining user’s consensus on the differences. So IT failure is one of four levels:

- *Process failure*, when the project is not completed within the time and budget.
- *Expectation failure*, when the IT systems do not match user expectations.
- *Interaction failure*, when users attitudes towards IT are negative.
- *Correspondence failure*, when there is no match between IT systems and the planned objectives.

2.5.3 Critical issues in IT/IS implementation projects

It is clear that IS/IT projects are very composite and multidisciplinary items, and addressing the success in this kind of projects is a difficult task. Different scholars have tried to address the problem of implementation in different ways, thus deriving different insights and prescriptions for successful implementation. Sarker (2000) provides a deep and effective review of literature dealing with IS implementation success; we report some extracts below.

Churchman and Schainblatt (1965), viewed implementation as "the problem of determining what activities of the scientist (i.e., the IS professional) and the manager (i.e., the user) are most appropriate to bring about an effective relationship between the two". While Churchman and Schainblatt's approach was a novel and useful way of framing implementation, it had at least three serious limitations: first, the approach completely ignored the system (technology) that was to be implemented; second, it provided almost no guidance on how to achieve the state of mutual understanding; and third, the approach did not incorporate the fact that "scientists" and "managers" do not (and cannot) operate isolated from the context of implementation.

The next wave of research (Lucas, 1975; Schultz, Ginzberg and Lucas, 1984; DeSanctis, 1984; Leonard-Barton, 1988) thus focused on identifying a broad range of factors that affected the implementation outcome (Figure 2.12). Factors identified are classified as:

- individual variables: such as needs, cognitive style, personality, demographics, decision-style, and expectancy contributions;
- organizational variables: such as differentiation / integration, extent of centralization, autonomy of unit, culture, group norms, reward systems, and power distributions;
- situational variables: such as user involvement, nature of analyst-user communication, organizational validity, and the existence of critical mass; and
- technological variables: which include the type of technology (MIS, TPS, CASE tools, EMS, etc.), and characteristics of technology such as transferability, implementation complexity, divisibility, and cultural content.

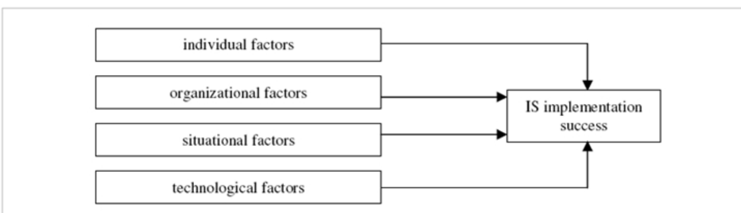


Figure 2.12: Factors perspective on IS implementation, Source: (Sarker, 2000, p. 196)

However the realization that implementation was not a static phenomenon as implicitly assumed by those conducting factors research, and implementation would be better understood as a process mediated by certain conditions such as project management, presence of a champion and top management support (Figure 2.13). While some scholars adopting the "process view" saw implementation as diffusion of innovation, most viewed it as a process of changing the institutionalized way of doing things within an organization (Ginzberg, 1978; Galbraith, 1979), and thus, existing process models of organization change (e.g. Lewin/Schein model, Kolb/Frohman model) were often used to conceptualize the implementation of information systems.

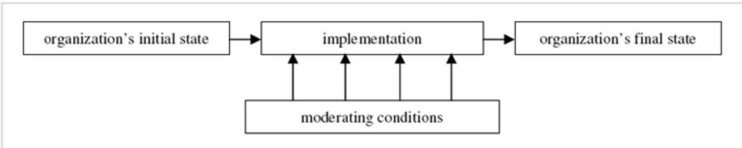


Figure 2.13: Process perspective on IS implementation, Source: (Sarker, 2000, p. 196)

The process view of implementation was further developed by scholars influenced by the "socio-technical" school of thought (e.g., Bostrom and Heinen, 1977; Markus, 1983; Robey, 1987), and this "interactionist" approach arguably remained the dominant one for the study of implementation of IS in organizations (see Figure 1d). Within this perspective, the organization was implicitly conceptualized as a "diamond," a model originally proposed by Leavitt (1965), consisting of interacting components: people, tasks, technology, and structure. Introduction of an IS involves changing the organization's technology component which automatically triggers changes in the other components of the organization (figure 2.14).

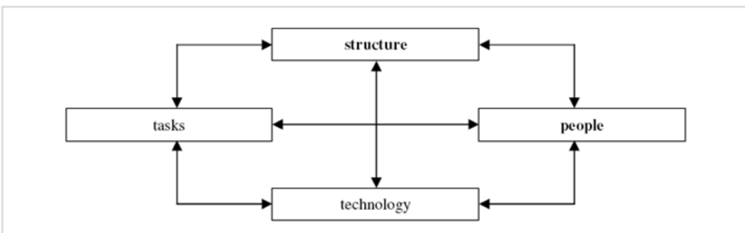


Figure 2.14: The diamond model, Source: (Sarker, 2000, p. 196)

Unfortunately, the diamond model, which appears to be the foundation for much of the current understanding of IS implementation, fails to sufficiently reflect the political underpinnings of implementation (Keen, 1981; Markus, 1983) and institutional realities such as symbols (Hirschheim and Newman, 1991) and frames

(Orlikowski, 1992). Sarker (2000) argued that such issues cannot be satisfactorily addressed without taking into consideration the “subjective realities” that exist in the minds of the actors. Hence, a number of prominent operations research/management science (OR/MS) and information systems (IS) researchers have recognized that behavioural issues rather than technological issues seem to be at the root of problems related to implementation (Schultz and Slevin, 1975; Ginzberg, 1978; Lyytinen and Hirschheim, 1987; etc.). Consequently, much of the research on implementation in the fields of OR/MS and IS has focused on the related human aspects (Bellini, 2008).

Concluding it could be argued that different factors, concerning different categories of problems, impact on the successful implementation of IS according to several distinct but complementary perspective of analysis. Studies dealing with risk factors in IS projects have described issues of organizational fit, skill mix, management structure and strategy, software systems design, user involvement and training, technology planning, project management and social commitment.

In order to find the underlying causes for the challenges facing the software field, Shaw (2003) proposes that perceived and actual problems may differ. Figure 2.15, based on Maslow’s hierarchy of needs, shows that factors influencing the software process are in reverse order to their implementation priority in practice. This means that the most important factors (higher in the hierarchy) are seldom implemented, which is an explanation for why most projects fail, as well as why technological issues (appearing at the bottom) are the first - and sometimes the only - concern in projects. Sarker (2000) conceived a similar model with the above mentioned factor perspectives , but with no hierarchical assumptions.

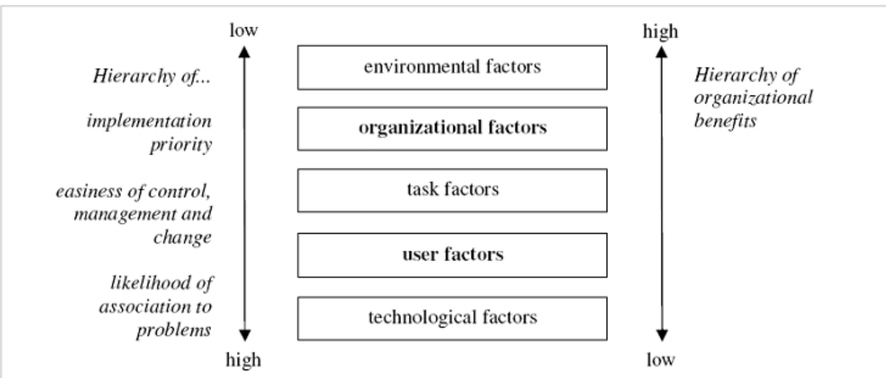


Figure 2.15: Implementation and organizational benefit in IS projects, Source: (Bellini et al., 2004, p. 18) and adapted from (Shaw, 2003)

2.5.4 Uniqueness of risk management in IT (and ERP) projects

At the project level, software projects have long been recognized as high-risk ventures prone to failure (Brooks, 1975; Abe et al., 1979). Boehm and Ross (1989) argue there are two classes of software project risks: generic risks common to all projects, and project-specific risks. Some of these risks are easy to identify and manage. Others are less obvious or it is more difficult to predict their likelihood and/or impact.

This is complicated by multiple project dimensions including size, structure, complexity, composition, context, novelty, long planning and execution horizons, and volatile change (Ward and Chapman, 2004; Willcocks and Griffiths, 1997). Therefore, risk management in software projects is important to help in avoiding disasters, avoiding rework, focus and balance efforts; and stimulate win-win situations (Boehm, 1989).

The general notion as used today in software projects is to reduce the likelihood of an adverse project outcome, all potential risk factors should be identified at the beginning of the project. The risk exposure for each factor is then estimated (using the formula mentioned above) and the exposures are prioritized to identify the risks representing the greatest threat to the project. Attention is then focused on the high risk factors to minimize the likelihood of their occurrence and/or the magnitude of impact if they are realized, through control measures such as mitigation strategies and/or contingency plans. Risk factors are progressively monitored to detect, as early as possible, when they materialize or if the threat changes (in likelihood or impact). A progressive status of identified risk factors is maintained and periodically updated. The realization of a risk is often recognized throughout the onset of a predefined risk trigger or the reaching of a predetermined risk threshold, or the predefined time contingency plans are activated to minimize the impact (Bannerman, 2008).

Some observations should be done about the proposed approach compared with the current managerial practise and peculiarity of IS project:

First of all, this approach does not match the actual managerial behavior. It was found that, in practice, the likelihood of outcomes and their impacts tend independently to enter into managers' calculations of risk, rather than as their products (March and Shapira, 1987). Managers see risk in less precise way. First, they tend to be more concerned with the magnitude of the potential loss than the probability it will occur. They also tend to prefer verbal characterizations of risk than probabilistic representations because they are sceptical that the broad dimensionality of risk can be reduced to a single number. Finally, managers tend not to accept risk estimates given to them because they see risk as a subject to control. They believe that risks can be reduced or dissolved by using their managerial skills to control the dangers. That is, "managers look for alternatives that can be managed to meet targets, rather than assess or accept risks" (March and Shapira, 1987, p. 1414).

A second aspect is that it is very difficult in practice to estimate the probability of impact of many risk factors, especially in software projects. Probabilities can only be meaningfully determined for activities that are repeated many times, under controlled circumstances. The one-off nature of many software project activities mitigates against accurately estimating probabilities. In classical decision theory, this problem was handled by conceiving risk as variation in a distribution of probable outcomes, not a probable outcome. These issues reflect an unresolved question about whether the management of risk is a science, an art, or some combination of both (Bernstein, 1996). Are the best decisions based on quantification and numbers, determined by the patterns of the past, or are they better based on more subjective assessments of the uncertain future? We cannot quantify future with any certainty, but we have learned how to extrapolate from the past through mathematics and probability. However, since software projects are about enabling change through new applications using new technologies in dynamic environments, the degree to which past patterns are relevant to the future is fundamentally uncertain in these projects.

While it may be possible to generate metrics of low-level software engineering processes that enable probabilistic quantification of some important risk factors, there is likely to be many other critical software project risk factors that cannot be probabilistically assessed.

Research found that risk management is not always well-applied in practice (Ibbs and Kwak, 2000; Morris, 1996; Pfleeger, 2000; Ropponen, 1999; Ropponen and Lyytinen, 1997). For example, in a multi-industry study of project management maturity based on PMI's knowledge areas, Ibbs and Kwak (2000) found that the risk knowledge area had the lowest maturity of all knowledge areas in the IS industry, and the risk maturity level of the IS industry was the lowest of the four industries in the study.

Also, Ropponen found that 75% of project managers did not follow any detailed risk management approach, and only vaguely understood the software risk concept and its managerial implications. However, most reported use some type of risk management method (Ropponen, 1999; Ropponen and Lyytinen, 1997).

Based on an extended review, Bannerman (2008) concludes that: first, the notion of risk is relevant to software projects, and there is a need and potential for risk management to contribute to project outcomes; second; the development of risk and risk management in the research and practice literature lags the requirements of the threat phenomenon in practice, and; third, the adoption of risk and risk management concepts and methods in practice lags the understanding and prescriptions found in literature.

Given the potential cost and losses from failed software projects, researchers and practitioners must continue learning from each other to reduce project failures and developing practices that consistently generate better project outcomes. Better risk management, as a project and organizational capability, is critical to achieve these objectives.

In sum, there is a need of a better risk management in research and practice. This thesis focuses in particular on Risk management in a specific kind of IS project: the introduction of an Enterprise Resource Planning (ERP) System.

2.5.5 Focusing on ERP systems

Enterprise-wide/ERP projects are among the most critical IS project and pose new opportunities and significant challenges in risk management field. In the past few years many organizations have initiated enterprise-wide/ERP (Enterprise Resource Planning) projects using such packages as SAP, Peoplesoft and Oracle. These projects often represent the single largest investment in an information systems (IS) project in the histories of these companies and, in many cases, the largest single investment in any corporate wide project.

Without question, effective management of these large IT projects is a new and unique challenge which requires the use of project management and control methods that have not been extensively used in the past. The sheer size of these projects requires centralized control, strict discipline and extensive monitoring of project outcomes.

The accounting profession recognizes the need of evaluating risks associated with current and emerging information systems such as ERP solutions. For instance, the Information Systems Audit and Control Foundation (1998, 3) formulated the Control Objectives for Information and Related Technology (CobiT) framework as a guide for management, users, and auditors to help bridge the gaps between business risks, control needs, and technical issues. The CobiT framework gives explicit consideration to the need of identifying risks in computerized environments.

The Committee of Sponsoring Organizations (COSO) report (1992) provides a framework for the consideration of risks that is relevant to business, accounting, and auditing and assurance. COSO stipulates that measures have to be taken to ensure organizational effectiveness and efficiency, including identification and assessment of business risks, developing an information system to track performance, and monitoring compliance.

Risk management, in this field should be more than a process or methodology but a real-time threat management capability that is developed within an organization, through learning, practice, and other mechanisms, over a long period of time. It is not just about identifying and assessing risks, and putting in place mitigation and contingency strategies. It is also about being able to quickly and effectively respond to realized threats as they arise. That because these threats may or may not have been foreseen, but they have the potential to significantly impacts the project and its outcomes.

Several research issues include conducting an assessment of the relative criticality of each of these risk factors and contrasting the risk factors which in large versus occur small ERP projects. Sumner (2000) addresses the question of what peculiarities of ERP projects are and what inherent risks can be found in enterprise-wide/ERP projects that are not present in non-ERP projects. Revealed factors dealing with organizational fit, skill mix, software systems design and technology integration.

ERP systems, in fact, do not just represent enhanced software and hardware; they also affect the interdependencies among business processes. Process reengineering and/or customization of the ERP system to achieve desired business functionality leads to heightened risks of potential financial statement misstatements, misclassifications, and defalcations (Wright and Wright, 2000).

Prior research has examined risk from a software-development perspective. For instance, Barki et al. (1993) and Jiang and Klein (1999), in order to maximize the probability of success of a software development project (e.g., ERP customization), suggested that the risks associated with the business task or application must be understood and minimized. The same rationale holds for the success of an ERP system. It is reasonable to posit that the success of a given ERP system, from a system reliability perspective, is linked to adequate considerations of the impact of business-process reengineering and customization. Business process reengineering may create significant risks due to the scope of the change and potential lack of knowledge of or attention to the need of reliance by the implementation team.

Since these evidences, definitely, in order to be effective and realistic, Risk Management approaches for ERP system must embrace both the software and the business-process and the project management dimensions.

2.6 Conclusion

The chapter clarifies the meaning of uncertainty, risk and risk management, setting definitions and terminology in this field. It focuses on project risk management and provides readers with the current state of the art, reporting an excursus of the several existent approaches. Then, it gives the rational for the use of risk management in IT project, in particular the attention moves on the peculiarities of ERP introduction projects.

CHAPTER 3

Enterprise Resource Planning

This chapter moves the focus of attention towards a specific class of IS enterprise projects: the introduction of Enterprise Resource Planning (ERP) systems. ERP are sets of integrated applications that can provide a total solution to an organisation information system needs by addressing a large proportion of business functions including financial, accounting, human resources, supply chain and customer information. However, the ERP systems have an impact on the entire organization, implementation is not merely a "computer project", it is strategic and must be approached as such.

In the first part of the chapter, a brief history of the Enterprise Resource Planning systems mainly drawn by Jacobs and Weston (2007) and by Shehab et al. (2004) is presented, showing the main features, diffusion and relationships with its predecessors MRP and MRP II.
The next sections deal with the implementation problems focusing on the life cycle of the introduction project and on the critical success factors. After that an extended literature review on the key articles discussing ERP implementation is proposed. The different approaches are compared from a risk management point of view in order to address and analyze the potential risk factors and their relevance during the project life cycle. Finally, the review focuses on the Risk Management of ERP projects, reporting a number of specific contributions both from academic and practitioner world. Lastly gaps and shortcomings in this field are discussed. As a result, the main outlines of the chapter are:

- Introduction and adoption of ERP systems
- ERP system history
- The ERP's introduction process
- The referential literature about ERP systems
- Academic and practitioner approaches to Risk Management for ERP projects
- Critics to past approaches

3.1 Introduction

ERP systems are accepted to be one of the most important developments in the world of Information Technology (IT) and are also the most popular standard business software of the last decade (Davenport, 1998; Robey, Ross and Boudreau, 2002).

The Eleventh Edition of the APICS Dictionary (Blackstone and Cox, 2005, page 38) defines ERP (Enterprise Resource Planning) as a "framework for organizing, defining, and standardizing the business processes necessary to effectively plan and control an organization so that the organization can use its internal knowledge to seek external advantages". This definition highlights the broad scope of applications that fit under the ERP framework. Manufacturing planning and control (MPC) systems are our primary focus but the full system is intended to serve business processes housed within the other functional areas - finance and accounting, human resources, payroll, and sales/marketing, etc.

3.1.1 Diffusion of ERP systems: some numbers

According to a study by Coffey et al. (2000), more than 70 per cent of Fortune 1000 companies have begun the implementation of an ERP system or are planning to do it in the next few years. A survey by Themistocleous et al. (2001) predicted that the spending on ERP will reach 66 billion dollars in 2003.

Through the years 2000 and 2004, the global ERP market increased of 3-13% per year. In 2005, AMR Research (2005) reported that the market for ERP software surprisingly grew by 14% in 2004 and became a 23.6 billion dollars business. This number was 5.5% in 2001. Moreover, With ERP penetration at 67%, the ERP market was the largest segment of a company's applications budget (34%) in 2004. AMR Research expects an annual growth rate from 6% to 7% compound between the years 2006 and 2009.

Traditionally applied in capital-intensive industries such as manufacturing, construction, aerospace and defence, ERP systems have been recently expanded beyond manufacturing and introduced in finance, health care, hotel chains, education, insurance, retail and telecommunications sectors (Shehab et al., 2004). Another positive aspect for its diffusion is that smaller firms that are very dependent on large companies are going to be forced into ERP packages to stay compliant with larger ERP system organisations.

Without a doubt this numbers evidence that the ERP software market has become one of today's largest IT investments worldwide.

3.1.2 Reasons and difficulties for the adoption

Studies have illustrated that an ERP system is not just a pure software package to be tailored to an organisation but an organizational infrastructure that affects how people work and "imposes its own logic on a company's strategy, organisation, and culture" (Davenport, 1998; Lee and Lee, 2000).

The potential benefits from ERP adoption include drastic declines in inventory, breakthrough reductions in working capital, abundant information about customer wants and needs, along with the ability to view and manage the extended enterprise of suppliers, alliances and customers as an integrated whole (Chen, 2001).

Since ERP packages touch many aspects of a company's internal and external operations and because of the scale of business process re-engineering (BPR) and the customisation tasks involved in the software implementation, ERP projects are large, costly and difficult to perform. The investment is in both software itself and in related services such as consulting, training and system integration. Consequently, successful deployment and use of ERP systems are critical to organizational performance and survival (Markus et al., 2000b).

The relative invisibility of the implementation process is another major cause of ERP implementation failures (Griffith et al., 1999). Markus and Robey (1988) attributed such invisibility to the unpredictably complex social interaction of IT and organization on the one hand, and, to the mutual adaptation between the IT and user environment (Volkoff, 1999) on the other hand.

3.2 History and evolution of ERP

ERP system traces its roots starting from standard inventory control packages to Material Requirements Planning (MRP), and manufacturing resource planning (MRP II) (Shehab et al., 2004). The move beyond MRP occurring in the late 1970s and early 1980s was driven by the need for stronger integration among the functional enterprise silos that dominated firms throughout this period (Jacobs and Weston, 2007), but the early application appeared in the 60s.

In the 1960s the primary competitive thrust was cost, which resulted in product-focused manufacturing strategies based on high-volume production, cost minimization, and assuming stable economic conditions. The introduction of newly computerized Reorder Point (ROP) systems - including economic order quantity and economic reorder point - satisfied basic manufacturing planning and control (MPC) needs of these firms (for example, IBM's "PICS" - production and inventory control system).

MRP system - the predecessor to and backbone of MRP II and ERP - was born in the late 1960s through a joint effort between J.I. Case, a manufacturer of tractors and other construction machinery, in partnership with IBM. At that time, the early MRP application software was the state-of-the-art method for planning and scheduling materials for complex manufactured products. At its core, MRP was a time phased order release system that schedules and releases manufacturing work orders and purchase orders, so that sub-assemblies and components arrived at the assembly station just as they are required (Shehab et al., 2004).

However, the initial MRP solutions were big, clumsy and expensive. They required a large technical staff to support the mainframe computers - at first the IBM7094, for example, and later IBM's 360s and 370s. The development of ever faster and higher capacity disk (random access) storage was a major enabling technology for the development of more integrated business information systems.

In the late 1970s MRP fairly quickly became established as the fundamental parts and materials planning concept used in production management and control due to a best integration between forecasting, master scheduling, procurement, plus shop floor control. This era also saw the introduction of IBM's COPICS (communications oriented production information and control system). The movement towards what would be called MRP II - manufacturing resource planning - was underway (Figure 3.1).

From a commercial viewpoint, the mid-1970s saw the birth of major software companies that would later become key ERP vendors. SAP started in 1972

Figure 3.1: Evolution of ERP, Source: (Rashid et al., 2002)

in Germany, Lawson Software was founded in 1975, J.D. Edwards and Oracle Corporation were established in 1977. In 1978 Jan Baan began its activity in the Netherlands and so on.

In 1975 IBM offered its Manufacturing Management and Account System (MMAS) which Bill Robinson from IBM considers a true precursor to ERP.
In 1978 the IBM System 34 - a mini-computer smaller and less expensive than earlier mainframes - was released as was a new integrated suite of applications called manufacturing, accounting and production information and control system (MAPICS).
In 1979 the first commercial SQL (Structured Query Language) relational database management system was offered by Oracle.

Developments in hardware and software, as well the new competitive pressures, made the earliest MRP systems seem obsolete, even crude. With constantly improving hardware available at a reasonable price, and software development keeping pace, it was possible to add functions, which could access a centralized database. The new technologies, in fact, allowed for system expansion to support increasing numbers of functions while offering the advantage of integration.

In 1978 SAP released a more highly integrated version of its software, called the SAP R/2 system, taking full advantage from the current mainframe computer technology, allowing for interactivity between modules as well as additional capabilities such as order tracking.

During the 1980s, the way towards MRP II started. J.D. Edwards began to focus on writing software for the IBM System/38 and the term MRP began to be applied to other functions, leading to the use of the phrase manufacturing resource planning rather than material requirements planning. The term MRP-II was coined to identify the newer systems capabilities.

A major purpose of MRPII was to integrate primary functions (i.e. production, marketing and finance) and other functions such as personnel, engineering and purchasing into the planning process to improve the efficiency of the manufacturing enterprise (Chen, 2001; Chung and Snyder, 2000; Mabert et al., 2001). The idea of an integrated software package where sales, inventory and purchasing transactions updated both inventory and accounting information was an innovation: this was designed to replace the several stand-alone systems which many companies used at the time.

In 1987, the software company PeopleSoft was founded and in 1988 it offered an innovative Human Resource Management System (HRMS). With the addition of PeopleSoft, all of the major ERP software companies were now in place.

At the end of the 1980s IBM came out with an update to their COPICS software that introduced the new acronym CIM for Computer Integrated Manufacturing. This newer CIM framework offered a "comprehensive strategy to help integrate information in a consistent, effective manner across the enterprise", supporting Marketing, Engineering and Research, Production Planning, Plant Operations, Physical Distribution, and Business Management.

With the reference to "across the enterprise", the migration path from early MRP to MRPII to CIM to ERP had now been laid (IBM, 1989; Robinson, 2006).

The Gartner Group of Stamford, CT, USA, coined the term ERP in the 90s (Wylie, 1990) to describe the business software system that is the latest enhancement of an MRPII system (encompasses all MRPII modules). A key difference between MRPII and ERP is that while MRPII has traditionally focused on the planning and scheduling of internal resources, ERP strives to plan and schedule supplier resources as well, based on the dynamic customer demands and schedules (Chen, 2001).

The year 1992 marked the release of SAP's R/3 product. The main feature that distinguished R/3 from previous ERP systems was its use of client-server hardware architecture and was also designed with an open architecture approach, allowing third-party companies to develop softwares that would integrate with SAP R/3.

The evolution of extended-ERP systems has further expanded in recent years to include more "front-office" functions, such as sales force and marketing automation, electronic commerce and supply chain management systems.

The proliferation of the Internet has shown tremendous impact on each aspect of the IT sector including ERP systems becoming more and more "Internet-enabled" (Lawton, 2000). This environment of accessing systems resources from anywhere anytime has helped ERP vendors extending their legacy ERP systems to integrate with newer external business modules such as supply chain management, customer relationship management, sales force automation (SFA), advanced planning and scheduling (APS), business intelligence (BI), and e-business capabilities.

Today the world is moving towards ERP II which expands from the resource optimization and transaction processing of traditional ERP to leveraging the information involving those resources in the enterprise efforts to collaborate with other enterprises, not just to conduct e-commerce buying and selling (Figure 3.2), including non-manufacturing industries (Gartner, 2000).

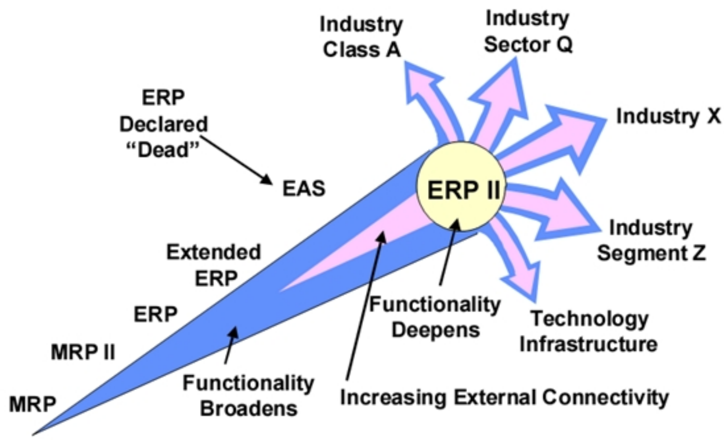


Figure 3.2: Evolution of ERP systems, Source: (GartnerGroup, 2000)

From a market viewpoint, definitely by the 1999, the dominance of IBM in the 1980s had slipped as J.D. Edwards, Oracle, PeopleSoft, Baan and SAP controlled much of the ERP software market. One major factor in the dramatic growth of ERP software and systems during this period was the year 2000 (or Y2K) problem that was anticipated as a major turn-of-the-century issue. Fortune 1000 as well as small-to medium-sized enterprises (SMEs) quickly adopted the new ERP offerings as one way of addressing needed fixes to a legacy system software that was not Y2K compliant.

A deeper description of the technological evolution of ERP from MRP has been presented by Chen (2001) and Chung and Snyder (2000).

3.3 ERP system features

ERP systems realize the Dearden's dream. In 1972 he stated:

"The notion that a company can and ought to have an expert (or a group of experts) create for it a single, completely integrated supersystem - an "MIS" - to help it govern every aspect of its activity is absurd."

(Dearden, 1972, p. 101)

ERP allows companies to integrate various departmental information. Many users consider an ERP as a "do it all" system performing everything from entry of sales orders to customer service (Shehab et al., 2004).

The traditional application systems, which organisations generally employ, treat each transaction separately. They are built around the strong boundaries of specific functions that a specific application is meant to cater for. Untill the 80s, in fact, organizations created "islands of automation" (McKenney and McFarlan, 1982). When companies identified a new application for IT, they programmed a discrete new information system.

ERP stops treating these transactions separately as stand alone activities and considers them to be a part of interlinked processes that make up the business (Gupta, 2000). Enterprise systems, in this sense, are clearly a phenomenon in the IT marketplace. They represent a nearly complete re-architecting of an organization's portfolio of transactions processing applications systems to achieve integration of business processes, systems, and information.

A typical ERP system integrates all the principal company functions (Figure 3.3) by allowing its modules to share and transfer information by freely centralising information in a single database accessible by all modules (Chen, 2001).

The various modules of ERP include engineering data control (bill of materials, process plan and work centre data); sales, purchase and inventory (sales and distribution, inventory and purchase); material requirement planning (MRP); resource flow management (production scheduling, finance and human resources management); works documentation (work order, shop order release, material issue release and route cards for parts and assemblies); shopfloor control and management and others like costing, maintenance management, logistics management and MIS. The model of ERP also includes areas such as finance (financial accounting, treasury management, enterprise control and asset management), logistics (production planning, materials management, plant main-

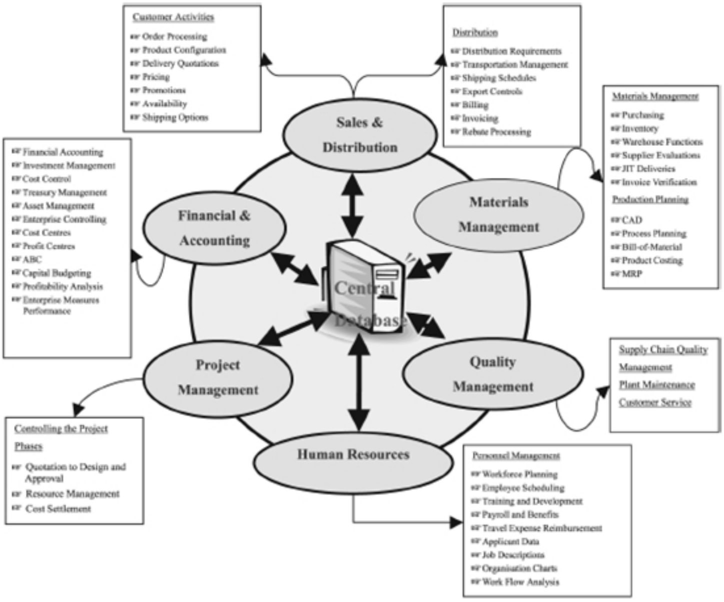


Figure 3.3: Modules of an ERP system, Source: (Shehab et al., 2004)

tenance, quality management, project systems, sales and distribution), human resources (personnel management, training and development and skills inventory) and workflow (integrates the entire enterprise with flexible assignment of tasks and responsibilities to locations, positions, jobs, groups or individuals) (Siriginidi, 2000).

Markus and Tanis (2000) argued that Enterprise systems have several characteristics, each one with important implications for the organizations adopting them:

Integration. Enterprise systems promise "seamless integration of all the information flowing through a company-financial and accounting information, human resource information, supply chain information, and customer information" (Davenport, 1998, p. 121). However, it is extremely important to note that achieving this integration depends on "configuring" (setting up) the system in particular ways.

Packages. Enterprise systems are commercial packages; that is, they are purchased or leased from software vendors rather than being developed in-house from scratch. This has two important implications for the organizations adopting them: first the IS life cycle is different, so the adopters of an enterprise system often adjust the organization ways of working to fit the package; second, organizations that purchase an enterprise system enter into long term relationships with software vendors.

Best Practices. Since they are designed to fit the needs of many organizations, enterprise systems are built to support generic business processes that may quite substantially differ from the way any particular organization does business. The vendors of enterprise systems have crafted what they claim to be "best practices".

Some Assembly Required. At one level, the claim of enterprise systems to be "integrated" is wildly overstated. What is integrated is the software, not the computing platform on which it runs. Empirically, enterprise system-adopting companies have had great difficulty integrating their enterprise software with a package of hardware, operating systems, database management systems software, and telecommunications suited to their particular organizational size, structure, and geographic distribution. As for example to interface the package to the company's own proprietary "legacy" systems, for which the enterprise system does not provide an adequate replacement.

Evolving. Finally, like all of IT, enterprise systems are rapidly changing. First, they are changing architecturally (from mainframe to client-server architecture, to web-enable systems), but the functionality (module and functions supported) of enterprise systems is also evolving. Service arrangements are also changing. Some services firms offer packaged implementation services; others (often called application service providers) are offering ongoing enterprise software functionality on an outsourced basis. Enterprise systems terminology will undoubtedly change, too.

3.4 ERP introduction/implementation project

3.4.1 Motivations and troubles of the adoption

Given the richness of enterprise systems in terms of functionality and potential benefits to adopting organizations, it should not be surprising that companies are adopting these systems for many different reasons: some for technical and other for business reasons (Ross, 1999).

Markus and Tanis (2000) present a general review of these motivations in the following figure (Figure 3.4. Among the reasons for non-adoption of Enterprise

	Small Companies/ Simple Structures	Large Companies/ Complex Structures
Technical reasons	• Solve Y2K and similar problems • Integrate applications cross-functionally • Replace hard-to-maintain interfaces • Reduce software maintenance burden through outsourcing • Eliminate redundant data entry and concomitant errors and difficulty analyzing data • Improve IT architecture • Ease technology capacity constraints • Decrease computer operating costs	Most small/simple company reasons plus • Consolidate multiple different systems of the same type (e.g., general ledger packages)
Business reasons	• Accommodate business growth • Acquire multilanguage and multicurrency IT support • Improve informal and/or inefficient business processes • Clean up data and records through standardization • Reduce business operating and administrative expenses • Reduce inventory carrying costs and stockouts • Eliminate delays and errors in filling customers' orders for merged businesses	Most small/simple company reasons plus • Provide integrated IT support • Standardize different numbering, naming, and coding schemes • Standardize procedures across different locations • Present a single face to the customer • Acquire worldwide "available to promise" capability • Streamline financial consolidations • Improve companywide decision support

Figure 3.4: Reasons for adopting Enterprise Systems, Source: (Markus and Tanis, 2000)

System, they report the lack of "feature function fit" between the company's needs and the packages available in the marketplace. A second major motivation concerns company growth, strategic flexibility, and decentralized decision-making style. Finally a third factor is the availability of alternatives for increasing the level of systems integration. Another alternative to enterprise systems involves re-architecting in-house systems around a layer of middleware that isolates application systems from stores of "master data."

Despite the importance and popularity of ERPs, in fact, implementing these systems in the organizations of different sectors is hard to achieve as the way organizations make business is not standard. Markus and Tanis (2000) described ERP implementation as a complex exercise in technology innovation and organizational change management.

From a managerial perspective, the nature of the ERP implementation problems includes strategic, organisation and technical dimensions. Therefore, ERP implementation involves a mix of business process change (BPC) and software configuration to align the software with the business processes (Holland and Light, 1999). An ERP implementation often entails transferring the business knowledge incorporated in the basic architecture of the software package into the adopting organisation.

Since this complexity, ERP projects require reliance on many different types of expertise often sourced outside the organisation. Consultants often advise managers to undertake some degree of re-engineering of key processes before acquiring ERP systems (Bancroft et al., 1998).

ERP implementation should involve the analysis of current business processes and the chance of re-engineering, rather than designing an application system that makes only the best of bad processes; this adds to the complexity and political character of the projects (Adam and O'doherty, 2000).

In short, the enterprise system phenomenon has strong conceptual links with just about every major area of information system research. Markus and Tanis (2000) identify 5 important topics of IS research in ERP implementation:

- *Financial Costs and Risks.* Installing an enterprise system is an expensive and risky venture. Large companies have been spending on the order of hundreds of millions of dollars to make the technical and business changes associated with enterprise systems. This area includes studying the payoffs from investment in information technology, IS project success and failure, and IS implementation process and change management (training, user involvement, communication, etc.)

- *Technical Issues.* Enterprise systems are technically challenging. The technical areas of research include: "development" life cycle for enterprise system packages; software selection approaches; enterprise modelling and software configuration tools and techniques; "reference models" for particular industry segments, systems integration strategies, and systems and software architectures; and data quality, reporting, and decision support for enterprise systems.

- *Managerial Issues.* Enterprise system projects involve parties from many different organizations and cut across the political structures of the organization and have implications on how companies should organize and manage their information systems functions. Interesting challenging areas of research include: IT project management; IT project sponsorship and user involvement; IS-business relationships, vendor management, structuring the IS function and IT management more generally, and IS personnel management.

- *IT Adoption, Use, and Impacts.* ERP systems have large potential impacts at all levels of analysis: individual and societal (employment, occupational structure, skills required, and quality of work), work system (cooperation, business process efficiency), organizational (competitive advantage, business results), and interorganizational (impact on supply chain, industry structure). To know how widely these technologies have been assimilated (Fichman and Kemerer, 1997) in organizations, for example, how extensively they are used within the organization, how faithfully and how effectively they are used are important topics.

- *Integration.* Finally, enterprise systems suggest some unique research questions about: extents that enterprise systems are binding up in a complete restructuring of organizations and industries around the capabilities of information technologies; structural change in the provision of IT services (from in house to outsourced services); the emerging role of the so-called system integrators, etc.

3.4.2 ERP project life cycle

An organization's experience with an enterprise system can be described as moving through several phases, characterized by key players, typical activities, characteristic problems, appropriate performance metrics, and a range of possible outcomes.

Each enterprise system experience is unique, and experiences may considerably differ, depending, for example, on whether the adoption of the enterprise system is initiated by IS specialists or by businesspeople, whether involves external consultants or is done largely in-house, follows a process of strategic IT business planning or business process reengineering or does not follow such a process, and so forth.

Researchers have described ERP life cycle using different, sometimes incomplete or overlapping models according to the target application, sometimes with a few general stages, like the three of Deloitte Consulting's (1998) (pre-implementation, implementation and post-implementation), while others are more analytic having five or more phases, such as Markus and Tanis (2001) (four stages model), Ross and Vitale (2000) (five stages model) or Rajagopal (2002) (six stages model). Markus and Tanis (2000) developed a four-phase model of ERP implementation including: chartering, project, shake-down and onwards and upwards. The life cycle phases they described are presented in Figure 3.5.

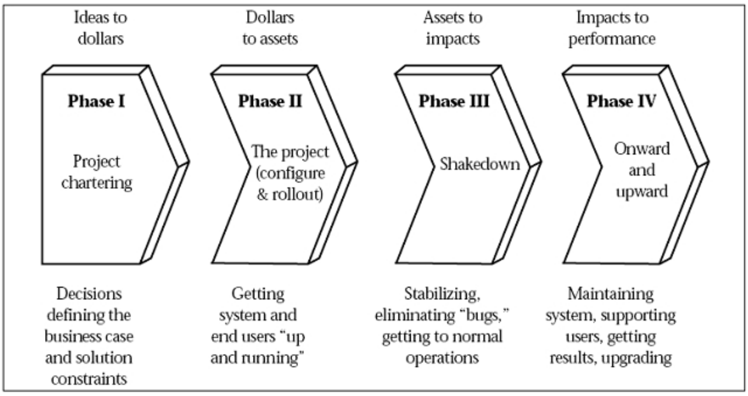


Figure 3.5: Enterprise System Experience Cycle, Source: (Markus and Tanis, 2000)

- The chartering phase comprises decisions leading up to the funding of an enterprise system. Key players in this phase include vendors, consultants, company executives, and IT specialists, although the precise constellation of players may vary. Key activities include building a business case for enterprise systems, selecting a software package (though this decision may be deferred until the project phase), identifying a project manager, and approving a budget and schedule.

- The project phase comprises activities intended to get the system up and running in one or more organizational units. Key players include the project manager, project team members (often nontechnical members of various business units and functional areas), internal IT specialists, vendors, and consultants. As mentioned above, the constellation will vary, depending on the decision to do the project in-house, with outside assistance, or on an outsourced basis. Key activities include software configuration, system integration, testing, data conversion, training, and rollout.

- The shakedown phase is the organization's coming to grips with the enterprise system. The phase can be said to end when "normal operations" have been achieved (or the organization gives up, uninstalling the system). The project (or consulting) team may continue its involvement or may pass control to operational managers and end users and whatever technical support it can muster. Activities include bug fixing and rework, system performance tuning, retraining, and staffing up to handle temporary inefficiencies.

- The onward and upward phases continue from normal operation until the system is replaced with an upgrade or a different system. It is during this phase that the organization is finally able to ascertain the benefits (if any) of its investment. Key players include operational managers, end users, and IT personnel support (internal or external). Vendor personnel and consultants may also be involved, particularly when deliberations about upgrades are concerned. Characteristic activities of this phase include continuous business improvement, additional user skill building, and post implementation benefit assessment; however, these "typical" activities are often not performed.

Ross and Vitale's (2000) stages in the ERP journey are: (1) design, (2) implementation, (3) stabilization, (4) continuous improvement, and (5) transformation.

- Design. In the planning stage, firms made two important design decisions, one about process change and the other about process standardization.
- Implementation. While most firms carefully planned for implementation, deploying implementation teams that trained users on the new system and, to some extent, on new processes, most found that "going live" tended to be highly disruptive, because the new system tended to be linked to new processes.
- Stabilization. Stage during which the firm attempted to clean up its processes and data, and adjust to the new environment. The typical activities during stabilization included cleaning up data and parameters (sometimes referred to as business rules), providing additional training to new users, particularly on business processes, and working with vendors and consultants to resolve bugs in the software.
- Continuous improvement. During this stage, firms were primarily focused on continuous improvement, but they were also starting to engage in process redesign to implement new structures and roles to leverage the system. Following stabilization, firms entered a stage in which they were adding functionality through new modules or bolt-ons from third-party vendors (implementing EDI, bar-coding, sales automation, warehousing and transportation capabilities, and sales forecasting).
- Transformation would involve changing organizational boundaries, particularly with regard to systems. It means leverage organizational visibility to gain increased agility.

Kwon and Zmud (1987) proposed that IT implementation follows six-stages or phases: initiation, adoption, adaptation, acceptance, routinization and infusion.

Cooper and Zmud (1990) applied this six-stage model to examine the implementation of MRP systems. Rajagopal (2002) extends the model to the analysis of ERP systems 3.6.

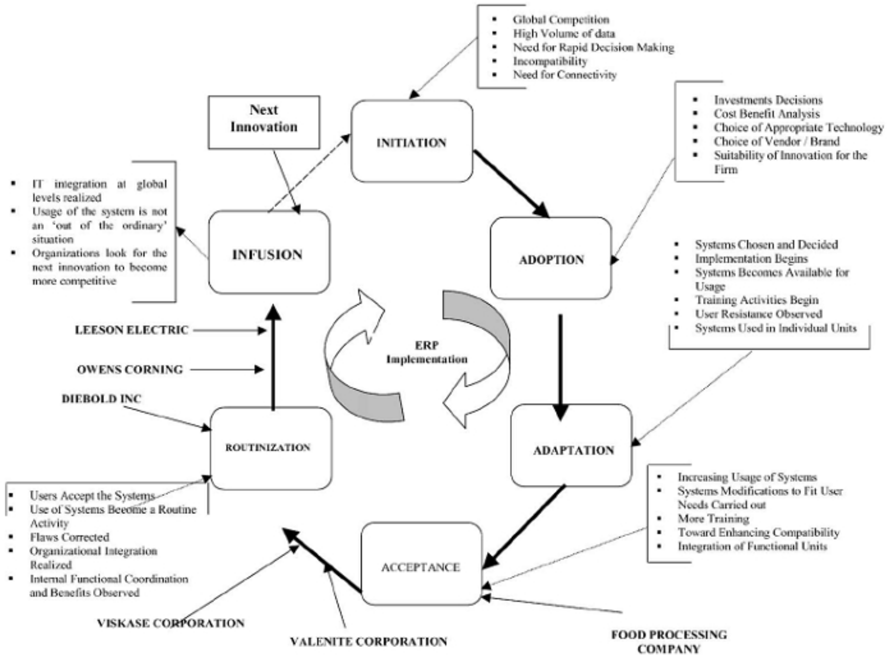


Figure 3.6: Kwon and Zmud's ERP implementation model, Source: (Rajagopal, 2002)

Kwon and Zmud (1987) identified the following stages:

- Initiation. The first or the initiation stage is characterized by the various exo- and endogenous factors that influenced the organizations to implement an integrated system like an ERP system.
- Adoption. Investment decisions and cost-benefit analysis related to implementation of ERP systems and choice of brand or vendor are carried out during the second or adoption stage
- Adaptation. The implementation of the ERP system requires changes in the way business is conducted, and the interviewed companies carried out BPR before implementing an ERP system. They do a "self-discovery" process where they analyze the details of the various business processes

and look for improvements or to redesign the same. This adaptation stage corresponds to the planning and design phase in the Preece's model (1991).

- Acceptance. The systems become increasingly available for use in the organization. The systems are modified in order to solve the problems reported by the end-users. Continuous improvements are made to make the system easy to use and to solve various problems. The integration of various functional units is realized during this acceptance phase. The acceptance stage is similar to the Installation stage proposed by Preece (1991).

- Routinization. The users accept the system. Preece (1991) terms this stage operationalization stage.

- Infusion. The system is used to enhance the performance of the organization. If there are some problems in a production facility, the production could be easily diverted to another facility to utilize its idle capacity, easily since such information is readily available to the decision-makers.

In our analysis, the previous project life cycle models were analyzed and re-adapted to our needs trying to homogenize the discrepancies. The models were finally aggregated into a two layer project life cycle consisting of three principal phases and six sub-stages, as shown in Figure 3.7.

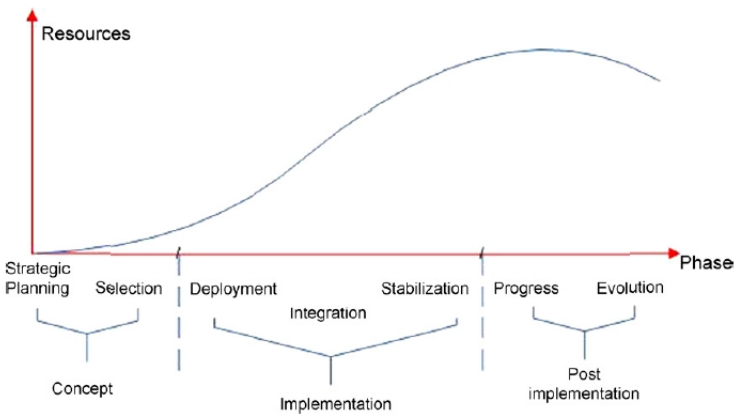


Figure 3.7: ERP Life cycle, Source: (Aloini et al., 2007)

The new model we will use in the next sections of the thesis includes three main phases at the first level: Concept, Implementation and Post-Implementation.

In this section, the model is compared and integrated with the five-phase Implementation roadmap of SAP ERP (Figure 3.8). The phase definitions here provided will be used interchangeably in the rest of the thesis.

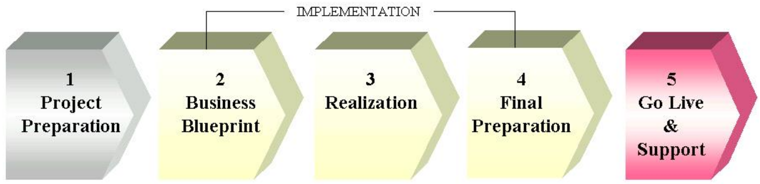


Figure 3.8: SAP Implementation Roadmap, source: Adapted from (Monk and Wagner, 2006)

1. The "**Concept**" phase which corresponds to the "**Project Preparation**" phase in the SAP model refers to the activities of ERP introduction from "*Strategic planning*" of requirements to software package "*Selection*".
   In these phases main decisions regard the strategic role of the project inside the IT strategy of the company, the project approval and funding. Goals, objectives and scope (what the ERP is to accomplish) of the project must be carefully defined. Typical tasks, after the strategic agreement, include organizing the project team, selecting the package - hardware and database vendors, identifying e prioritizing the business process to support, communicating to the personal objectives and impacts of the new system, evaluating financially the investment and fixing the budget.
   Key actors are IT specialists, line of business managers (cross-functional competences are required), ERP systems vendor and integrators, consultants.

2. The "**Implementation**" phase includes activities from the system deployment, software installation to parameterization, integration, testing, and stabilization.

   - The "*Deployment*" phase, or also "*Business Blueprint*" has the objective to develop a detailed documentation of how the business processes have to be managed and supported by the enterprise system. This documentation, sometimes called "Business Transformation Master Plan" defines specifications to configure and eventually customize the system in the next phase.
     Typical tasks include the development of a detailed project plan, definition of Key Users (KUs), KUs / project team education and

acquisition of supportive skills, detailed process mapping (AS IS) and definition of process reengineering needs (TO BE according to the procedures incorporated in the system, gap analysis and action plan to solve variances), identification of the legacy systems treatment (elimination, integration, method of data retrieval, clean up and transfer to the ERP database) and definition of software requisites.
Key actors are organizational cross-functional members, project team, vendor / consultants / system integrator business analysts.

- The "Realization" phase, or also "Integration" phase, covers the core activities to get the system up and running, through its configuration and hardware - network connection, actual reengineering of processes, execution of change management plan (if any).
Typical tasks, besides configuration/parameterization, are system integration, data clean up and conversion, education of KUs - IT staff - executive, development of standard prototype without detailed interfaces and reports.
Key actors are the same of the previous phase plus end users that begin their training.
- The "Final Preparation" phase, or "Stabilization" encompasses critical tasks as testing the ERP in critical processes, prototype completion with reports and interfaces, users enablement and final training, Help Desk implementation, bugs - fixing, final tuning/optimization of data and parameters, ending the data migration from legacy systems, setting the Go Live date.
Key actors are the same of the previous phase.

3. The "Post-implementation" phase also called "Go Live Support" includes Progress and Evolution activities: from the help to the users after the go live, upgrading, to the new-releases management, and evolution maintenance.
This phase starts from Go Live and continues during the "normal operations" when processes are fully supported and no external support is necessary. Most of end users problems arise during the first few weeks; so monitoring of the system is critical in order to quickly arrange changes if the performance are not satisfactory. Typical tasks are to support the Help Desk by project team skills, final bug fixing and rework, monitoring of operative performances of the new system, upgrades, adding capacity or new functions.
In this phase we may observe the effects, problems related to a bad management of the project: under-use/no use of the system modules, data input errors, excessive dependence on Key Users and external parties, retraining, difficulty in diagnosis and solving software problems, over-length of the same phase.

Key actors are IT specialists and members of the project team staffed to Help Desk, operations managers, external technical support personal.

3.5 ERP: literature review

The difficulties of ERP implementations have been widely cited in literature (Appleton, 1997; Davenport, 1998). Many papers were written over the past 20 years on peculiarity of ERP selection, implementation, risk assessment and more general on ERP project in organization. Problems and potential approaches to ERP implementation have been discussed from several and complementary perspectives, several reviews were written about the ERP critical success factors, but none was made integrating the CSF view with a risk management approach.

Al-Mashari (2003) illustrated a possible taxonomy of ERP research that is believed to cover the major issues in the fields (Figure 3.9). They argue that much research is still needed to better understand the ERP phenomena form a balanced perspective. Our aim is adding valuable information especially from a Risk Management perspective and demonstrating this assumption in the following review.

In particular this section presents a comprehensive review of the recent research works about ERP systems, investigating the most relevant risk factor in ERP life cycle and their distribution in research fields.

In this part of the work we collected and analyzed a number of key articles discussing ERP implementation. The different approaches found in literature were compared from a risk management point of view to highlight the key risk factors and their impact on the project success. Literature was further classified in order to address and analyze each risk factor and its relevance during the stages of the ERP project life cycle. After that contributions dealing with risk management approaches for ERP projects were carefully analyzed and compared.

In particular, starting from an extensive analysis of literature, we classified project risk factors focusing on the question of how they weigh on the best use of a company's limited resources. Therefore the main purposes of this work are:

- to review and analyze key articles on ERP project from a risk management point of view;
- to identify risk factors and risk approaches taken, their relations and differences in terms of their impact on the organization;

Figure 3.9: ERP research taxonomy, Source: (Al-Mashari, 2003)

- to describe and classify important contributions to ERP risk management identifying their differences, advantages, and disadvantages;
- to clarify at which stage of the ERP life cycle it is critic to manage risks; and
- to identify the areas needing ERP risk management deployment.

3.5.1 Literature review: research design

We decided only to search peer-reviewed papers having more than two pages in order to eliminate editorials, book-reviews, and viewpoints. Moreover, in recent years the number of papers has substantially increased (Botta-Genoulaz et al., 2005). Therefore we used only published literature since 1999. The adopted method followed the criteria listed below:

- Main research lines were carefully explored. Bibliographic databases were used extensively.
- Web search facilities were used and articles concerning ERP critical success

factors, selection, implementation, risk management during the ERP life cycle were collected and analyzed.

- Papers without these foci were eliminated.
- Papers were classified depending on their research objective.
- Papers were analyzed to determine their main message.

Literature contributions were primarily of articles from:

- Emerald, which publishes a wide range of management titles and library-and-information services titles by publishers world-wide. Subjects covered included management, HRM, Marketing, Librarianship, Mechanical engineering, electronic and electrical engineering. Emerald contains 42,000 searchable articles from over 100 of its journals.
- Science Direct (Elsevier), the electronic collection of science, technology, and medicine full text and bibliographic information.
- Springer, the specialist publisher of the Science, Technology, Medicine (STM) sector and integrated Business-to-Business publishing houses in German-speaking and Eastern European countries.
- IEEE-Xplore, providing online delivery systems with full text access to high quality technical literature in electrical engineering, computer science, and electronics.

After extracting from these databases, the papers of interest were reviewed in order to identify the relevant risk factors and data was then organized to produce a classification from several perspectives, taking into account (Figure 3.10):

1. Research aim and sector.
2. Research type and methodology.
3. Risk factor (highlighted).
4. ERP life cycle (stadium).

To determine the research methodology, articles were classified using two "double" axis dimensions. In the first dimension, papers were reviewed, analyzed, and classified according to their "aim and sector", then a procedure suggested

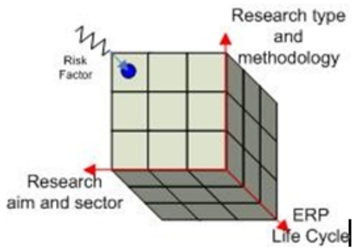


Figure 3.10: Dimension of analysis

by Williams and Oumlil (1987), the methodology outlined by Hunt (1989) was adapted for our research.

The "Aim" of the research was defined by examining the following key factors:

1. *System selection* - including papers about the package selection process, which involved activities from **as is** and **to be** to requirements analysis, use of structured selection techniques for system selection, consulting, software testing and evaluation, vendor selection, and global cost evaluation.

2. *System implementation* - implementation processes from the end of the selection to system testing and post implementation. It involves contributions to identify critical issues and their impact on implementation, development of a structured technique, implementation strategies, business case, BPR, and change management.

3. *System/IT Risk management* - presenting specific problems related to risk management as part of a general and structured project management technique; including activities from context analysis to risk treatment, review and control, with direct reference to the ERP project or more generally with pertinence to any complex IT project.

4. *General IT/System project* - with general considerations of ERP and complex IT projects - their impact on the organization (those not be specifically classified in other classes). In particular this collected contributions related to the impact of introduction of the ERP, its critical success factors, success and failure drivers, both from an engineering point of view as well as sociological and managerial ones, also this contained specific case studies.

The "Sector" depended on contributions linked to sector scope and company size. In particular the defined variables were:

1. *Multiple Sector (MS)* contributions that involve empirical articles of interest to more than one sector or conceptual ones with general applicability.

2. *Sector specific* contributions are articles which are referenced in a specific business sector. The specificity of research and the impact of corporate scope on problem settings make a size-differentiation essential. So we distinguished between:

   - *Small and medium enterprises (S-SMEs).*
   - *Large corporate-enterprises (S-LC).*

The article's *research type and methodology* was classified as either *empirical, conceptual/ theoretical or conceptual/theoretical and empirical.*
Empirical articles included surveys, case studies, interviews or anecdotal information. Case studies analyzed ERP projects in specific industries or life cycle phases; these articles were typically narrow and in-depth, providing a thoroughly examination of a limited area. Anecdotal studies give 'examples' of practices, without exploring practice in any rigorous or in-depth manner. Papers in the *conceptual/theoretical* group had their primary focus on the development of models, concepts, or ideas. They pointed out literature reviews, development of conceptual models, concepts or propositions. The articles classified as both *conceptual and empirical* typically developed a number of hypotheses and tested them empirically.
For "methodology", the papers were classified as either *positive/descriptive* or *normative/prescriptive.* Articles in the *positive/descriptive* category attempted to describe, explain, predict, and understand processes, activities, and phenomena that actually existed. The articles in the *normative/prescriptive* category sought to prescribe the activities in which organizations and individuals should be engaged. The *prescriptive/descriptive* dimension was really a continuum, because some of the articles were primarily descriptive but give some managerial implications. In order to simplify the classification and create comparable groups, articles were only divided in prescriptive and descriptive categories based on their major focus. Bi-dimensional matching of variables was a functional requisite to our research approach. The scheme in 3.11 shows the interpretative criteria that we followed to determine evidence of research trends and interests in recent literature.

After this first "characterization of context" to identify the research approach, the review concluded with an output list of the most critical risk factors prioritized by frequency presented in the literature reviewed. Finally risk factors were determined in a life cycle interpretative framework to highlight the important relation with the ERP introduction and development processes. Therefore, a dimension was added to show which phase of the ERP project was considered.

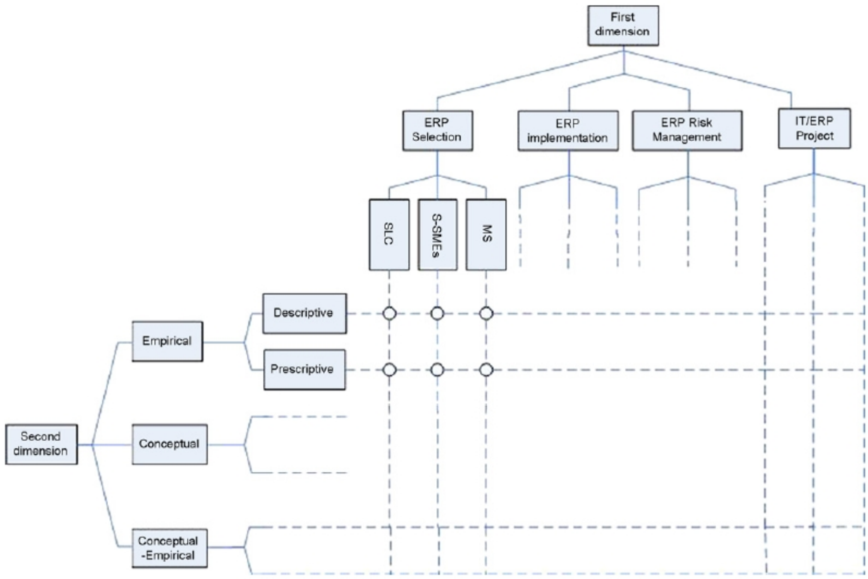


Figure 3.11: Multidimensional matching - research approach

3.5.2 ERP Risk identification

As stated in Chapter 2, a project success/failure depends on how and by whom it is determined. Identifying ERP risks, in fact, can be considered as a challenge for managers, especially because risks can be described and categorized in different ways (Baccarini and Salm, 2004). Often "risk factors", "Critical Success Factors" and "Uncertainty factors" are used to convey also the same concept. So we homogenized factors presented in literature and grouped them into or similar factors according to the Lyytinen and Hirschheim (1987) categorization. They classified the IT failure as the first of four different levels:

(a) **Process failure**, when the project is not completed within the time and budget set.

(b) **Expectation failure**, when the IT systems do not match users expectations.

(c) **Interaction failure**, when users attitudes towards IT are negative.

(d) **Correspondence failure**, when there is no match between IT systems and the planned objectives.

Starting from this general classification of global failure causes, we defined the bottom-up principal risk effects on the project and the relative risk factors, analyzed them from a life cycle view according to the article proposal. Among the principal risk effects identified there are: budged exceed, time exceed, project stop, poor business performances, inadequate system reliability and stability, low organizational process fitting, low user friendliness, low degree of integration and flexibility, low strategic goals fitting and bad financial/economic performances. Then literature researches were explored to identify and homogenize bottom up relevant risk factors, as shown in Figure 3.12.

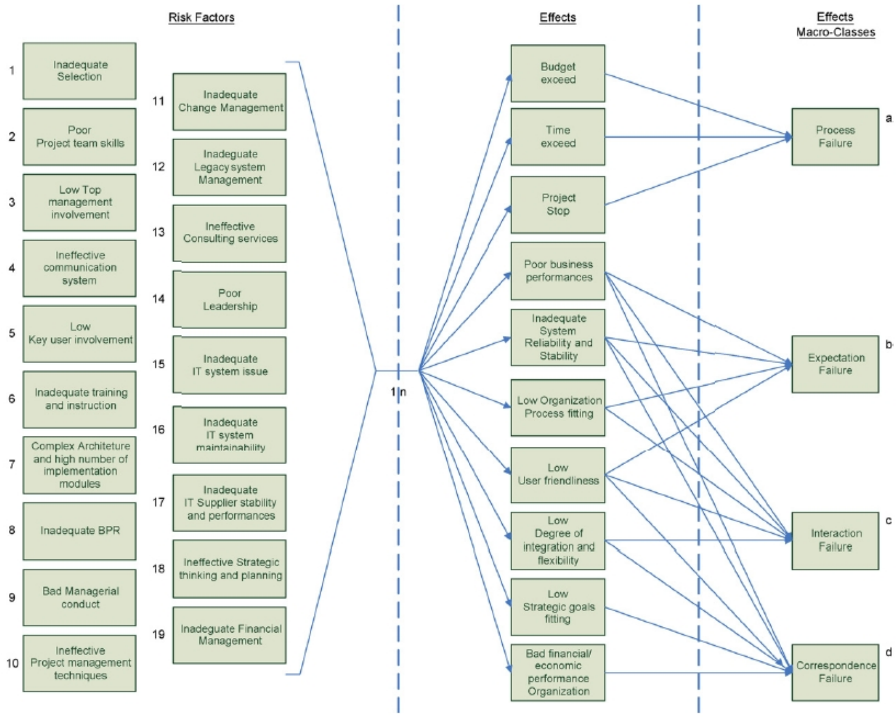


Figure 3.12: Risk factors, effects and project failure

3.5.3 Data collection

Data was collected by an extended review of more than 130 articles, collected using web facilities. After the elimination of older and less technical materials, the final sample was of about 75 articles. A team of three researchers was involved in the review. Two of them analyzed and classified, separately and independently, all the papers. Each researcher completed a classification/coding table, and discrepancies were resolved in an open discussion with the third researcher and a common table was then compiled. The literature was divided into four groups: ERP selection, ERP implementation, ERP risk management, and general ERP projects. Each paper was then analyzed and its contributions mapped in Figures 3.13-3.16 (A classification table is also reported in 3.17).

N°	Research type and methodology	Research aim and sector	Research contents	Risk factors	Reference source
1.	Conceptual and Empirical Prescriptive	Risk-Management MS	Risk identification and treatment in IT: Literature review + Interview	1, 2, 4, 5, 6, 10, 11, 13, 14, 15, 16, 17	[17]
2.	Empirical Descriptive	Risk Management MS	Identification by Delphi method, Prioritization by AHP framework	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18	[63]
3.	Conceptual and Empirical Prescriptive	Risk Management S-LC	Literature review + Case study	1, 3, 4, 5, 6, 9, 10, 11, 12, 15, 16, 17, 18	[88]
4.	Conceptual Prescriptive	Risk Management MS	RM Tool development	10	[174]
5.	Conceptual and Empirical Prescriptive	ERP selection S-LC	AHP model + Case Study	1	[160]
6.	Conceptual and Empirical Prescriptive	ERP selection S-LC	Fuzzy AHP + Case Study	1	[161]
7.	Conceptual and Empirical Prescriptive	ERP implementation S-LC	OPM + Case study	1, 8, 13	[132]
8.	Conceptual and Empirical Prescriptive	ERP implementation MS	Literature analysis + Survey	1, 2, 3, 4, 5, 6, 8, 9, 10 , 11, 12, 13, 15, 16, 17, 18	[137]
9.	Conceptual and Empirical Prescriptive	ERP selection MS	Criteria in selection + AHP	1	[145]
10.	Empirical Descriptive	ERP selection MS	Buying process a+ Case Study	1	[152]
11.	Conceptual and Empirical Prescriptive	ERP implementation MS	Team skills	2	[153]
12.	Conceptual Prescriptive	ERP selection MS	0-1 goal programming and Analytic Network process + example	1	[81]
13.	Conceptual and Empirical Prescriptive	ERP selection S-LC	Factor identification + survey	1	[19]
14.	Empirical Descriptive	ERP selection MS	Selection processes in middle and large companies	1	[23]
15.	Empirical Descriptive	ERP selection S-LC	Case study	1	[154]
16.	Empirical Descriptive	ERP selection MS	Survey	1	[49]
17.	Conceptual Prescrittive	ERP selection MS	Selection factor	1	[113]
18.	Conceptual and Empirical Prescriptive	ERP selection MS	Literature review + questionnaires	1	[29]
19.	Conceptual Prescriptive	ERP selection MS	Strategic selection factors	1, 18	[123]
20.	Conceptual Descriptive	IT/ERP project MS	Literature Review on ERP system	1, 2, 3, 4, 5, 6, 10, 14, 15, 16, 18	[52]
21.	Conceptual and Empirical Prescriptive	ERP implementation MS	BPR + Case Study	8	[75]

Figure 3.13: Articles and risk factors analysis - 1
Reference number and relative sources are reported in Appendix A)

22.	Conceptual and Empirical Descriptive	ERP implementation S-LC	Impact of culture on ERP implementation	9, 11, 14	[76]
23.	Conceptual Prescriptive	ERP implementation MS	Misalignment	2, 3, 4, 5, 8, 10, 11, 12, 14, 15, 16, 18	[134]
24.	Conceptual Prescriptive	ERP implementation MS	CSF + Case Study	7	[91]
25.	Conceptual and Empirical Prescriptive	ERP implementation MS	Cultural dimension of ERP	5, 9, 11, 14, 18	[26]
26.	Conceptual Prescriptive	ERP implementation MS	CSF + Case Study	7	[50]
27.	Conceptual and Empirical Prescriptive	ERP implementation MS	CSF + Case Study	2, 4, 14	[122]
28.	Conceptual Prescriptive	ERP implementation S-SMEs	Agent model to manage ERP development	10	[65]
29.	Conceptual and Empirical Prescriptive	ERP implementation MS	SAP R/3 implementation	2, 4, 8, 9, 10, 11, 15, 16, 18	[4]
30.	Conceptual Descriptive	IT/ERP project MS	Strategic advantage	18	[21]
31.	Conceptual and Empirical Descriptive	IT/ERP project MS	ERP role	3, 5, 6, 7, 11	[156]
32.	Conceptual and Empirical Prescriptive	ERP implementation MS	CSF + Case Study	1, 2, 3, 6, 7, 9, 10, 11, 12, 14, 18	[151]
33.	Conceptual and Empirical Prescriptive	ERP implementation MS	CSF + Survey	1, 8	[62]
34.	Empirical Descriptive	ERP implementation MS	CSF + Survey	1, 3, 6, 8, 10, 13, 15, 16, 18	[46]
35.	Empirical Prescriptive	ERP implementation S-LC	CSF + Stakeholders analysis	3, 5, 9	[27]
36.	Empirical Prescriptive	ERP implementation S-LC	Deployment + Case Study	1, 2, 5, 6, 9, 15	[22]
37.	Empirical Prescriptive	ERP implementation MS	CSF + Case Study	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 15, 16, 18	[97]
38.	Conceptual and Empirical Prescriptive	ERP implementation S-LC	CSF + Case Study	2, 3, 5, 6, 7, 8, 9, 11, 13, 15, 17, 18	[172]

Figure 3.14: Articles and risk factors analysis - 2

39.	Conceptual Prescriptive	ERP implementation MS	Training planning	6	[37]
40.	Conceptual Descriptive	ERP implementation MS	CSF taxonomy	1, 3, 4, 6, 8, 9, 10, 11, 12, 14, 18	[6]
41.	Conceptual Prescriptive	IT/ERP project MS	Business modelling + Case Study	1, 8	[126]
42.	Conceptual and Empirical Prescriptive	ERP implementation S-SMEs	ERP SME vendor perspective	1, 8, 18	[83]
43.	Conceptual Prescriptive	ERP implementation MS	Strategy and context analysis	1, 18	[44]
44.	Conceptual Prescriptive	ERP selection MS	CSF	1, 18	[31]
45.	Empirical Descriptive	ERP implementation MS	CSF + Case Study	1, 2, 3, 4, 6, 8, 10, 18	[98]
46.	Conceptual and Empirical Prescriptive	IT/ERP project MS	Survey	9,10	[3]
47.	Conceptual Prescriptive	ERP implementation MS	CSF	2, 3, 4, 5, 8, 9, 10, 11, 12, 15, 18	[99]
48.	Empirical Descriptive	IT/ERP project MS	ERP Strategy	18	[64]
49.	Empirical Descriptive	IT/ERP project MS	IT in Global Supply Chain	18	[95]
50.	Conceptual Prescriptive	ERP implementation MS	Legacy System management	12, 18	[164]
51.	Empirical Prescriptive	Risk Management S-LC	FMEA application on ERP	10	[170]
52.	Conceptual Prescriptive	ERP implementation MS	Change management	11	[2]
53.	Conceptual and Empirical Descriptive	IT/ERP project MS	CAD CAM and ERP integration	1, 3, 4, 5, 6	[135]
54.	Empirical Descriptive	ERP implementation S-LC	CSF	3, 4, 6, 15, 18	[56]
55.	Conceptual and Empirical Descriptive	ERP implementation MS	CSF + Case Study	1, 2, 3, 5, 6, 8, 9, 11, 13, 15, 16	[69]
56.	Conceptual and Empirical Descriptive	ERP implementation S-SMEs	CSF	1, 15, 16, 18	[115]
57.	Empirical Descriptive	ERP implementation MS	Structured Implementation approach	10	[104]

Figure 3.15: Articles and risk factors analysis - 3

39.	Conceptual Prescriptive	ERP implementation MS	Training planning	6	[37]
40.	Conceptual Descriptive	ERP implementation MS	CSF taxonomy	1, 3, 4, 6, 8, 9, 10, 11, 12, 14, 18	[6]
41.	Conceptual Prescriptive	IT/ERP project MS	Business modelling + Case Study	1, 8	[126]
42.	Conceptual and Empirical Prescriptive	ERP implementation S-SMEs	ERP SME vendor perspective	1, 8, 18	[83]
43.	Conceptual Prescriptive	ERP implementation MS	Strategy and context analysis	1, 18	[44]
44.	Conceptual Prescriptive	ERP selection MS	CSF	1, 18	[31]
45.	Empirical Descriptive	ERP implementation MS	CSF + Case Study	1, 2, 3, 4, 6, 8, 10, 18	[98]
46.	Conceptual and Empirical Prescriptive	IT/ERP project MS	Survey	9,10	[3]
47.	Conceptual Prescriptive	ERP implementation MS	CSF	2, 3, 4, 5, 8, 9, 10, 11, 12, 15, 18	[99]
48.	Empirical Descriptive	IT/ERP project MS	ERP Strategy	18	[64]
49.	Empirical Descriptive	IT/ERP project MS	IT in Global Supply Chain	18	[95]
50.	Conceptual Prescriptive	ERP implementation MS	Legacy System management	12, 18	[164]
51.	Empirical Prescriptive	Risk Management S-LC	FMEA application on ERP	10	[170]
52.	Conceptual Prescriptive	ERP implementation MS	Change management	11	[2]
53.	Conceptual and Empirical Descriptive	IT/ERP project MS	CAD CAM and ERP integration	1, 3, 4, 5, 6	[135]
54.	Empirical Descriptive	ERP implementation S-LC	CSF	3, 4, 6, 15, 18	[56]
55.	Conceptual and Empirical Descriptive	ERP implementation MS	CSF + Case Study	1, 2, 3, 5, 6, 8, 9, 11, 13, 15, 16	[69]
56.	Conceptual and Empirical Descriptive	ERP implementation S-SMEs	CSF	1, 15, 16, 18	[115]
57.	Empirical Descriptive	ERP implementation MS	Structured Implementation approach	10	[104]

Figure 3.16: Articles and risk factors analysis - 4

Research type	Research methodology	Research aim / Sector / ID	ERP selection: SLC 1	ERP selection: SSMEs 2	ERP selection: MS 3	ERP implementation: SLC 4	ERP implementation: SSMEs 5	ERP implementation: MS 6	ERP/IT Risk management: SLC 7	ERP/IT Risk management: SSMEs 8	ERP/IT Risk management: MS 9	General ERP/IT project: SLC 10	General ERP/IT project: SSMEs 11	General ERP/IT project: MS 12
Empirical	Positive/Descriptive	A	(15)		(10)(14)(16)	(54)	(59)(74)	(34)(45)(57)(60)			(2)(70)			
	Prescriptive/Normative	B	L-P		H-P	(35)(36)	M-	(37) H-P	L-P		(51)			H-P
Conceptual/theoretical	Positive/Descriptive	C						(40)(62)			(4)(30)			(20)(64)
	Prescriptive/Normative	D			(12)(17)(19)(44)		(28)	(23)(24)(26)(39)(47)(50)(52)(43)						(41)(48)(49)
Conceptual/theoretical and empirical	Positive/Descriptive	E				(22)	(56)	(55)(58)(61)(65)(72)(73)						(31)(53)
	Prescriptive/Normative	F	(5)(6)(13)		(9) (18)	(7)(38)(63)(67)	(42)	(8)(11)(21)(25)(27)(29)(32)(33)(68)(69)	(3)(71)(75)	H-P	(1)*			(46)(66)

Figure 3.17: Classification and positioning of articles
Article ID (See: Figures 3.13-3.16); L-P: Low populated, M-P: Medium populated, item H-P: Highly populated

3.5.4 Evidences from the literature

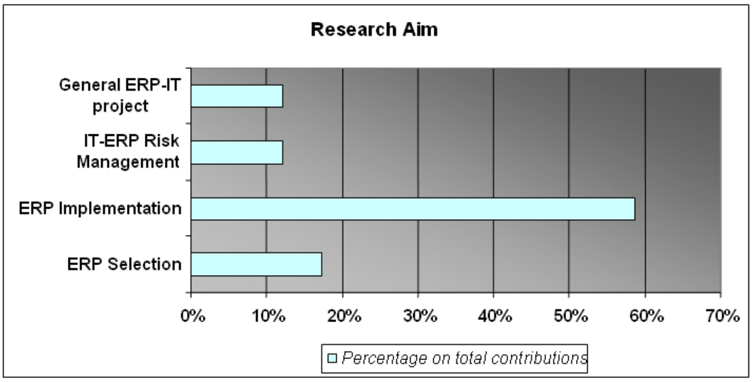


Figure 3.18: Research Aim - Analysis of contributions

As shown in Figure 3.18, ERP selection and implementation, about 75% of the contributions, was the largest part. ERP research interest has increased in the recent years following the natural progress of implementation of ERP systems in companies. Most research is related to the periphery of ERP and not on the systems themselves: implementation methods, organizational impact or comment on case studies are typical objects of study.

3.5.4.1 Research fields description and gap analysis: First dimension - aim and sector

Considering articles from the first analysis and going into each identified group, the review revealed the follow characteristics of the research fields.

a) ERP selection.

A number of articles described the management of the package selection process (Verville and Halingten, 2003; Baki and Cakar, 2005; Buonanno et al., 2005). These have been divided in two groups: one dealt with identification of selection criteria, while the other concerned the design or extension of specific ranking techniques. The various selection criteria were well documented by Bernroider and Koch (2001), Chen (2001), Everdingen et al. (2000), Rao (2000); Sprott (2000); Verville and Halingten (2003). Bernroider and Koch discussed the results from an empirical study of Austrian companies concerning differences in the characteristics of the ERP system selection process between small or medium and large sized organisations. Verville and Halingten (2003) investigated the decision process for selecting an ERP system through a case study. They reported that the three distinct types of an ERP system evaluation were vendor, functional and technical. Specific frameworks for selecting suitable ERP system were presented by Wei et al. (2005) and by Wei and Wang (2004). They tested their models for ranking based on AHP and fuzzy-AHP theory. Several other contributions were recognized, for example Lee and Kim proposed an 0-1 goal programming algorithm for selection.

- Contributions of both groups were homogeneously distributed among the Research Types: conceptual, conceptual and empirical, and empirical.
- Little attention has been given to SMEs except for work dealing with multi-sector analysis, which was mainly a case study analysis, hard to conceptualize and generalize.
- In recent years, most ERP system suppliers have increased their focus on SMEs but contributions, especially for small enterprises, are still limited.
- Smaller firms that are very dependent on large companies, sill be forced to using ERP packages to stay compatible with larger organisation supply chains (Coffey et al., 2000).

b) ERP implementation.
Another section of the ERP literature deals with the implementation field (Krumbholz and Maiden, 2000; Marsh, 2000). The approaches can be divided in three arts: identification of critical success/un-success factors, design of structured implementation standard procedures and techniques, and analysis of a specific CSF and deployment of resolving actions. T. M. Somers and K. G. Nelson (2004), using an information theory approach, presented problems related to identification of key players and critical activities during ERP project life cycle. Al-Mashari, Al-Mudimich and Zairi (2003) presented a taxonomy of the critical success factors in the implementation process based on a literature review. Al-Mashari et al. (2003), Markus et al and Parr and Shanks (2000) proposed models of ERP implementation in order to gain a deeper understanding of the process and provide guidelines for successful implementation. Al-Mashari and Zairi (2000), for example, suggested an integrative framework for SAP R/3 implementation. Their framework was based on the premise that effective deployment of SAP R/3 was primarily determined by the extent to which certain key elements, such as the business case, implementation strategy, change management, and BPR, were considered and fully integrated. Sarker and Lee (2003) examined, using a case study approach, the role of three key social enablers: strong and committed leadership, open and honest communication, and a balanced and empowered implementation

team. Koch (2001) discussed the role of BRP in ERP implementation, while Willis and Willis-Brown (2002) considered legacy system management and Aladwani (2001) discussed change management impact on success. This is a complex area, however most contributions are related to CSF identification, they generally belong to a multi sector perspective and rarely distinguish context specific models or problem solving approaches, especially for small enterprises.

c) Risk management and general ERP project section.
Contributions are limited and concerning with organizational and business ERP impact or risk assessment models from a multi sector perspective. ERP project contributions are mostly linked to discussion of strategic meanings and impact of ERP systems on business, SCM design, organization and IT strategy. Beard and Sumner (2004), for example, explored strategic advantages viewing ERP system from the resource based perspective, Wang and Chen (2004) investigated the relationships between various governance mechanisms and their capacity in reducing project risk. In risk management, Huang et al. (2004) used a Delphi method to identify potential ERP project risk factors and an AHP-based framework to prioritize them; while Zafiropoulos, et al. (2005) presented a risk management application for modelling, optimal adaptation and implementation of an ERP system. Articles proposing specific risk treatment strategies and techniques were very limited (we will propose a deeper review in the next section), and there were no contributions on SMEs. With an exception for specific approaches for SLC implemented by big vendors, a lack of contributions identified causal connection between risk factors.

3.5.4.2 Research fields description and gap analysis: Second dimension - type and methodology

Analyzing data from a typology and methodology point of view, we showed that each field was characterized by a mix of conceptual and empirical approaches with a general orientation on a multi sector analysis and prescriptive aim (Figure 3.19). The smaller number of articles in other classes was probably linked to the tendency of researchers to develop a conceptual model and follow it up with empirical testing using a survey methodology, business case, interview, simulation, etc.

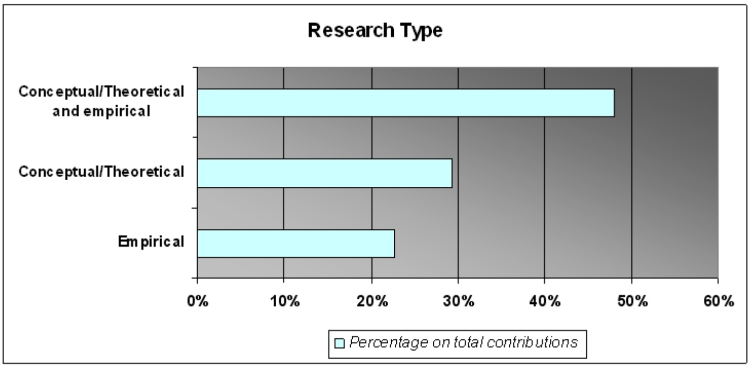


Figure 3.19: Research Type - Analysis of contributions

3.5.4.3 Risk factors analysis - life cycle

In order to complete a multiple perspective classification, risk factors identified in literature were analyzed and homogenized, trying to systematize the different views and interpretations of various authors. The total number of recurrences of the risk factors was computed (Figure 3.20) to provide their rank by total frequency rate. In Figure 3.21 a top ten card with the most frequent risk factors is given.
According to literature, the most researched (top 5) risk factors were: inadequate ERP selection, ineffective strategic thinking and planning, ineffective project management techniques, bad managerial conduction, and inadequate change management. Among these factors, the selection process and strategic organization fitting is marginally linked to the technological dimension, while the other factors are more related to managerial aspects. It appears that the first and second risk factors have been keenly studied. The ERP selection area is largely populated with "strategic thinking and planning" presented in almost 40 percent of the papers analyzed. Moreover, it is important to note that despite the great importance reserved to factors linked to project management and change management areas (R10, R11 are respectively the 3rd and 5th risk factor), only a few articles dealt with them.

Finally the top ten risk factors were analyzed in order to provide a scheme showing their use in the ERP life cycle (Figure 3.23 and 3.24). A general scheme of risk factor impact was developed to show the priority and importance of risk identification and treatment in the introduction process. Except for R6 and R11, risk factors early occur and have a pervasive impact during all the ERP project life cycle.

ID[1] Class / ID Risk factor	A1	A3	A4	A5	A6	A9	B4	B6	B9	C6	C9	C12	D3	D5	D6	D12	E4	E5	E6	E12	F1	F3	F4	F5	F6	F7	F9	F12	Tot	Freq. Rate
R1	1	3		1	2	1	1	1		2		1	4		1	1		1	2	1	3	2	1	1	4	1	1		**36**	✓✓✓
R2				2	2	1	1	1		1		1			1				3				2		7		1		**23**	✓✓
R3			1	1	3	1	1	1		1		1			1				3	2			1		2	1			**20**	✓✓
R4			1	1	1	1		1		2		1			1				1	1			1		4	1	1		**18**	✓✓
R5						1	2	1		1		2			1				4	2			1		2	1	1		**19**	✓✓
R6			1	1	2	1	1	1		1		1			1				4	2			3		3	1	1		**24**	✓✓
R7															2				1	1			1		1				**6**	✓
R8				1	3	1		1		1					2	1			3				3	1	5				**22**	✓✓
R9				1		1	2	1		1					1		1		4				3		6	1		2	**24**	✓✓
R10					4	1		1	1	2	1	1		1	2				4				1		4	2	1	1	**27**	✓✓
R11				2	1	1		1		2					3		1		2	1			3		5	1	1		**24**	✓✓
R12					1	1				1					2				1				2		2	1			**11**	✓
R13					2	1		1											2				2		1		1		**10**	✓
R14										1		1					1								5		1	1	**10**	✓
R15			1		1	1	1	1				1			2			1	3				1		2	2	1		**18**	✓✓
R16					1	1		1				1			1			1	3						2	2	1		**14**	✓
R17						1													2				1		2	1	1		**8**	✓
R18			1	1	3	2		1		1	1	1	2		4	2		1	2				2	1	5	1			**31**	✓✓✓
R19																			1										**1**	✓

Figure 3.20: Risk factor frequency for each researched area
ID Class: Each column matches lines and columns of Table 1 (Ex. Column A1 of Table II matches line A and column 1 of table 1)

Risk ID	Risk factor	Frequency Rate
R1	Inadequate ERP selection	✓✓✓
R2	Poor project team skills	✓✓
R3	Low top management involvement	✓✓
R4	Ineffective communication system	✓✓
R5	Low key user involvement	✓✓
R6	Inadequate training and instruction	✓✓
R7	Complex architecture and high number of implementation modules	✓
R8	Inadequate BPR	✓✓
R9	Bad managerial conduction	✓✓
R10	Ineffective project management techniques	✓✓
R11	Inadequate change management	✓✓
R12	Inadequate legacy system management	✓
R13	Ineffective consulting services experiences	✓
R14	Poor leadership	✓
R15	Inadequate IT system issues	✓✓
R16	Inadequate IT system manutenibility	✓
R17	Inadequate IT Supplier stability and performances	✓
R18	Ineffective strategic thinking and planning Strategic	✓✓✓
R19	Inadequate financial management	✓

Figure 3.21: Risk factors identification and rate

ID	Rate degree	Value
✓	**Low**	**<15**
✓✓	**Medium**	**>15 and <30**
✓✓✓	**High**	**>30**

Figure 3.22: Rating

Risk ID	Risk factor	Total number of recurrences[2]	Frequency Rate[3]	Manifestation Life cycle phase
R1	Inadequate ERP selection	36	✓✓✓	Concept/Selection
R18	Ineffective strategic thinking and planning Strategic	31	✓✓✓	Concept/Strategic Planning
R10	Ineffective project management techniques	27	✓✓	Implementation/Deployment
R9	Bad managerial conduction	24	✓✓	Concept/Strategic Planning
R11	Inadequate change management	24	✓✓	Implementation/Integration
R6	Inadequate training and instruction	24	✓✓	Implementation/Integration
R2	Poor project team skills	23	✓✓	Concept/Selection
R8	Inadequate BPR	22	✓✓	Concept/Strategic Planning
R3	Low top management involvement	20	✓✓	Concept/Strategic Planning
R5	Low key user involvement	19	✓✓	Concept/Selection

Figure 3.23: Top ten risk factors in the project life cycle

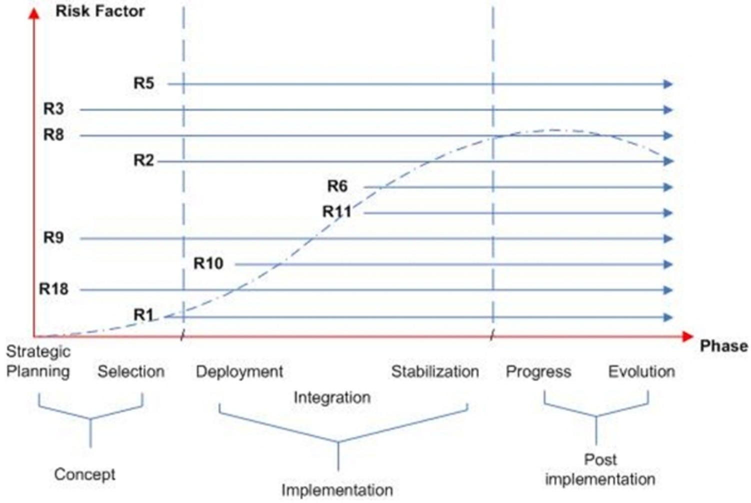


Figure 3.24: Risk factors impact during ERP life cycle

3.6 Literature review: focusing on the ERP risk management field

After the general review in the ERP field we focused the analysis on the ERP project risk management area in order to provide a complete and deeper overview of the risk management approach proposed in this field (and particularly on the works related to the introduction and implementation project of ERP systems in the company). With this aim, we extended the reviewed literature also including contributions previously kept out from the general selection criteria since they were: a) out of the selected timeline; b) no peer-reviewed or c) not presented in the web facilities by selected list of editors. We tried to identify and analyse all the works in literature which explicitly dealt with this risk topics, including both academic and practitioners initiatives.

Works approaching ERP field from a risk management point of view are very few in scientific literature and a minority of them present structured process and methodologies for ERP risk management.

Poba-Nzaou et al. (2008) analyzed enterprise resource planning (ERP) implementation in small- to medium-sized enterprises (SMEs) to explore what can be done to minimize the risk of ERP system implementation. They allowed the identification and understanding of the risk of ERP from a managerial/practical standpoint, the results show that highly formalized management is not necessary to minimize ERP implementation risk in the context of SMEs.

Hunton et al. (2004) examined the extent to which financial auditors recognize heightened risks associated with an enterprise resource planning (ERP) system, as compared to a non-ERP (legacy) system. The research findings indicate that financial auditors may not be fully aware of the greater risk exposure associated with an ERP system, as compared to a non-ERP system environment when security controls are relatively weak.

3.6.1 Academic literature

In Figure 3.25 we report the main academic contributions analyzing them in relation to the phases of the risk management process they support (more details about the classification of the different phases will be provided in Chapter 4). Most of the contributions are concentrated on the identification and analysis phases, while just few of them suggest operative models to support the global quantification phase or the selection of appropriate treatment strategies. Finally only one of them provides a computer-assisted tool supporting the different stages of the process.

	General approach to IT risk management	Risk Assessment			Risk treatment	Risk Control	
		Identification	Quantification			Monitoring and Review	Communication and Consulting
			Analysis	Evaluation			
Bandyopadhyay et al. (1999)	**						
Sumner (2000)	*	***			*		
Wright and Wright (2001)		**					
Scott and Vessey (2002)		**	*				
Tatsiopoulos et al. (2003)		*	*	*			
Huang et al. (2004)		**	*				
Zafiropoulos et al. (2005)		**	*	*	**	*	*
Leopoulos et al. 2005		**					
Yang et al. (2006)		*	*	**		*	*

Nota: * low, ** middle, ***high degree.

Figure 3.25: Classification of articles

In the following sub-sections we report a critic overview of the works.

3.6.1.1 A framework for integrated risk management in information technology

Bandyopadhyay et al. (1999) proposed a general framework for IT integrated risk management and sponsored additional researches in this area. They argued that business organizations annually invest hundreds of billions of dollars in information technology (IT); so they are increasingly becoming technology-dependent, and consequently, highly vulnerable to the risks of IT failure. The framework should provide IT managers with a comprehensive view of their overall risk management situation and does not emphasize any particular component of the risk management process but concentrates on the sequential linkage of the four components to make up the entire system of IT risk management. It includes the four major components of risk-management (Figure 3.26):

1. Risk identification. Authors decline risk identification in the IT environment according to the following three levels: the application level, the organizational level, and the inter-organizational level (see figure). The application level concentrates on the risks of technical or implementation failure of IT applications, since risks may arise from both internal and external sources. At the organizational level, the focus is on the impact of IT throughout all the functional areas of the organization rather than on any isolated application. At the inter-organizational level, the focus is on the IT risks of organizations operating in a networked environment.

2. Risk analysis. Authors have not digressed into a detailed explanation of all the risk analysis methodologies but they assert that a combination of qualitative and quantitative methodologies is more effective than any single method because of its flexibility in considering a wide variety of IT assets, possible threats, and vulnerabilities.

3. Risk-reducing measures. The measures for reducing IT risks are summarized according to five main classes: Natural disasters; Data security risks; Computer viruses; Strategic risks; and Legal risks.

4. Risk monitoring. The monitoring phase not only evaluates the performance of risk-reducing measures but also serves as a continuing audit function.

The suggested approach finally encourage managers trough three major steps: first, to recognize the concept of risk at all three level applications, organizational, and inter-organizational; second, to undergo training in decision theory approaches to risk management; and third, to actively participate in the estimation of their organization overall IT risk. Even if it does not emphasize any

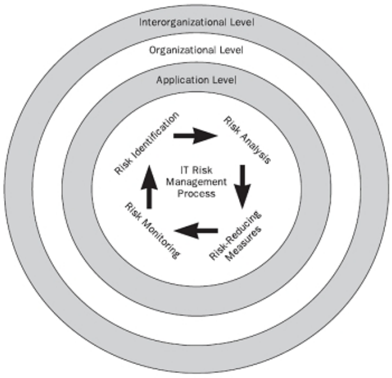


Figure 3.26: A framework for integrated IT risk management, source: (Bandyopadhyay et al., 1999)

one of these main risk management phases in a ERP project environment, it leads the research through several important directions.

3.6.1.2 Risk factors in enterprise-wide/ERP projects

Sumner (2000), using case studies from experiences of several companies which had implemented enterprise-wide information management systems such as SAP, Peoplesoft, and Oracle, held an investigation to a better understanding of the major risk factors associated with enterprise-wide/ERP projects. In particular, she described the risk factors associated with enterprise-wide/ERP (enterprise resource planning) projects and identified the risk factors in ERP projects which are unique to these projects.

At the beginning of the work author present a summary (form literature) of the risk factors in IS projects (Figure 3.27) and then they examine these risk factors describing seven case studies developed using in-depth structured interviews with the senior project managers responsible for planning and implementing enterprise-wide/ERP systems within their respective organizations.

The findings report the project justification and risk factors identified by the project managers, then the risk factors uniquely associated with ERP systems implementation mentioned by senior project leaders are identified according to six main categories (Figure 3.28). After that, risk factors are organized within the context of the stages of an ERP project together with responsible individuals (Figure 3.29) and general strategies for controlling risk factors in

Risk factor	Issue
Organizational fit	Organizational environment (resource insufficiency and extent of changes) (Block, 1983; Borki *et al.*, 1983)
	Changing scope and objectives (Keil *et al.*, 1998)
Skill mix	Lack of technical expertise (Ewusi-Mensah, 1997)
	Lack of application knowledge (Barki, *et al.*, 1993; Ewusi-Mensah, 1997)
	Inappropriate staffing and personnel shortfalls (Block, 1983; Boehm, 1991; Keil *et al.*, 1998)
Management structure and strategy	Lack of agreement on project goals (Block, 1983; Ewusi-Mensah, 1997)
	Lack of senior management involvement (Ewusi-Mensah, 1997; Keil *et al.*, 1998)
Software systems design	Misunderstanding requirements and changes in requirements (Block, 1983; Boehm, 1991; Cash *et al.*, 1992; Keil *et al.*, 1998)
	Lack of an effective methodology, poor estimation and failure to perform the activities needed (Block, 1983; Keil *et al.*, 1998)
User involvement and training	Lack of user commitment and ineffective communications with users (Block, 1983; Keil *et al.*, 1988)
	Conflicts between user departments (Keil *et al.*, 1998)
Technology planning	Lack of adequate technology infrastructure (Ewusi-Mensah, 1997)
	Technological newness, strained technical capabilities and failure of technology to meet specifications (Block, 1983; Boehm, 1991; Cash *et al.*, 1992; Barki *et al.*, 1993)
	Application complexity (technical complexity) (Barki *et al.*, 1993)
Project management	Unrealistic schedules and budgets (Boehm, 1991)
	People and personality failures, lack of effort, antagonistic attitudes and people clashes (Block, 1983)
	Lack of measurement system for controlling risk and inadequate project management and tracking (Block, 1983; Ewusi-Mensah, 1997)
Social commitment	Inability to recognize problems. a tendency to keep pouring resources into a failed project and unrealistic expectations (Ginzberg, 1981; Willcocks and Margetts, 1994; Keil and Montealegre, 2000)

Figure 3.27: Risk categories, source: (Sumner, 2000)

enterprise-wide/ERP projects are summarized (Figure 3.30).

The Sumner's strategy is among the first contributions in ERP risk management fields and provides a useful guide especially for the identification phase of risk management process. In fact the list of risks is quite complete and the risk factors are well defined and discussed. Despite this some improvements should still occur in term of considering financial management, some technical issues such as the legacy system management, and other relevant risk factor categories. The others risk management phases are in a quite embryonic stage; nothing is done about the risk quantification while suggestions and advices proposed to treat the risks are general and not prioritized.

3.6.1.3 Information System Assurance for ERP Systems: Unique Risk Considerations

Wright and Wright (2002) present an initial exploratory study of the nature of ERP risks. They collected detailed information about the risk perception of project participants and client experiences by a semi-structured interview study with 30 experienced information systems auditors (from three of the five big

Risk category	Risk factor	Unique to ERP
Organizational fit	Failure to redesign business processes	Yes
	Failure to follow an enterprise-wide design which supports data integration	Yes
Skill mix	Insufficient training and reskilling	Yes
	Insufficient internal expertise	Yes
	Lack of business analysts with business and technology knowledge	Yes
	Failure to mix internal and external expertise effectively	Yes
	Lack of ability to recruit and retain qualified ERP systems developers	
Management structure and strategy	Lack of senior management support	
	Lack of proper management control structure	
	Lack of a champion	
	Ineffective communications	
Software systems design	Failure to adhere to standardized specifications which the software supports	Yes
	Lack of integration	Yes
User involvement and training	Insufficient training of end-users	
	Ineffective communications	
	Lack of full-time commitment of customers to project management and project activities	
	Lack of sensitivity to user resistance	
	Failure to emphasize reporting	
Technology planning/integration	Inability to avoid technological bottlenecks	
	Attempting to build bridges to legacy applications	Yes

Figure 3.28: Risk factors, source: (Sumner, 2000)

Type of risk	Strategies for minimizing risk
Organizational fit	Commitment to redesigning business processes Top management commitment to restructuring and following an enterprise-wide design which supports data integration
Skill mix	Effective use of strategies for recruiting and retaining specialized technical personnel Effective reskilling of the existing IT workforce Obtaining 'business analysts' with knowledge of application-specific modules Effective use of external consultants on project teams
Management structure and strategy	Obtaining top management support Establishing a centralized project management structure Assigning a 'champion'
Software systems design	Commitment to using project management methodology and 'best practices' specified by vendor Adherence with software specifications
User involvement and training	Effective user training Full-time commitment of users to project management roles Effective communications
Technology planning/integration	Acquiring technical expertise Acquiring vendor support for capacity planning and upgrading Planning for client–server implementation including client workstations

Figure 3.29: Strategies for minimizing risks, source: (Sumner, 2000)

Project phase	Responsibility	Risk factor to be addressed
Planning	User management IT management	Lack of top management support Lack of a proper management structure for the project Lack of a champion
Requirements analysis	User management IT management Business analysts	Failure to redesign business processes Failure to follow an enterprise-wide design that supports data integration
Systems design	User management IT management IT designers	Lack of 'business' analysts Failure to adhere to standardized specifications which the software supports Lack of data integration
Systems implementation/ maintenance	IT management	Insufficient training and reskilling of the IT workforce in new technology Insufficient 'internal' expertise Failure to mix internal and external expertise effectively
Technology integration and implementation	IT management User management	Unsuccessful attempts to integrate ERP with legacy applications

Figure 3.30: Risk responsabilities, source: (Sumner, 2000)

firms specialized in assessing risks for ERP systems).

The study identifies pervasive ERP implementation and operating risks (Figure 3.31), examining ERP risks by application (e.g., payroll, supply-chain management, business intelligence) and by vendor (e.g., SAP, PeopleSoft, Oracle). Authors argue that differences in risk by application may lead to variations in financial statement risk and that risk may also be impacted by the history of the major ERP vendors. The research findings confirm the hypotheses and indicate that ERP implementation teams may not adequately consider the impact of business-process reengineering and ERP customization on system reliability. Furthermore, results suggest risk may be significantly greater when ERP modules are integrated with existing legacy systems or systems from other vendors, referred to as bolt-ons. Finally, the results suggest the major firms use process audit techniques, as opposed to validation testing (i.e., they do not rely on tests of outputs) when hired to provide assurance on the risks for an ERP system and for assurance providers to be aware of these unique risks associated with ERP systems in planning and executing an assurance engagement.

Since this is an initial exploratory study of the nature of ERP risks, authors did not engage in a full risk identification process, that is a limit but it equally provides a first tentative to identify critical factors for ERP risk management. Authors propose additional research to corroborate and extend the findings, leading to create a taxonomy of risks and the way they affect the information systems reliability.

	Reported Frequency (%)
Users were not adequately involved in the design of the ERP system.	68.2
Users were not adequately trained to use the ERP system.	40.9
Process reengineering was required.	40.9
The ERP system initially lacked adequate controls.	31.8
The ERP system was poorly designed; it did not adequately mirror required processes.	22.7
Systems implementation was poorly executed.	22.7
The ERP system as designed did not provide information needed to do the task (task-technology fit).	18.2
Data conversion was poorly executed.	18.2

Figure 3.31: Risk factors' frequency, source: (Wright and Wright, 2002)

3.6.1.4 Managing risks in enterprise systems implementations

Scott and Vessey (2002a) evaluated the utility of a model (Scott and Vessey, 2002b) for risk factor identification in ERP implementation, applying it to SAP R/3 projects of two big corporations (Dow Corning Incorporated and FoxMeyer Drug Corporation). One of them survived while the other failed after installing an enterprise system (ES), SAP R/3. Both the Dow Corning and FoxMeyer implementations involved the same software; they took place at similar times (1994-1996) with similar package capabilities and ES knowledge; and both companies were suffering significant industry pressures.

Authors asserted that no one risk, on its own, might be responsible for a system failure, but that certain risks could be overcome if other certain risks were particularly well treated. They distinguished 4 levels (external business context, organizational context, information system context and enterprise system context) in which they placed the several risk factors trying also to investigate the interrelationships among the levels (Figure 3.32).

The Model-based Analysis of Dow Corning and FoxMeyer Ability first outlined the similarities in the two implementations followed by the differences. Then they used the model to explain the differences in reacting and withstanding the Environmental Change (Figure 3.33 and 3.34).

Even if the authors analyzed the two case studies from a risk management perspective, providing interesting contributions to the identification of common and critical risk factors suggesting a general scheme for risk factor classification and analysis, they did not explicitly deal with any structured risk management methodology useful for this scope.

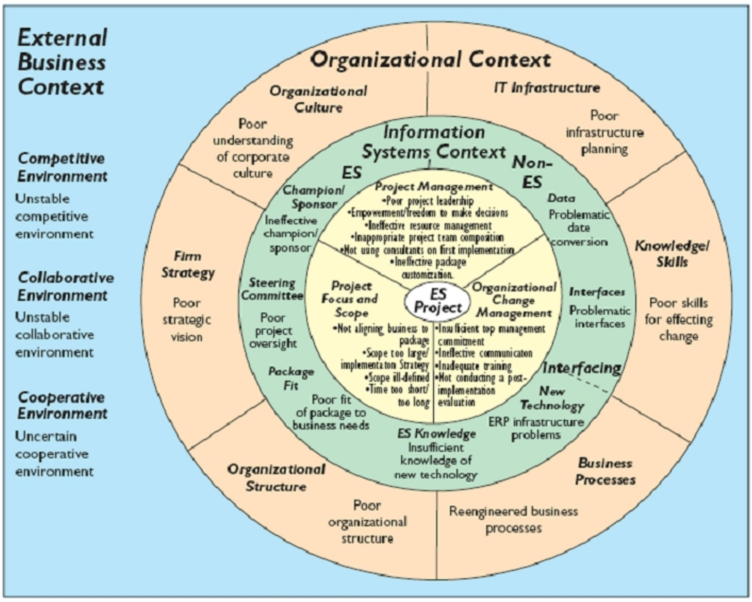


Figure 3.32: Scott and Vessey's framework, source: (Scott and Vessey, 2002a)

Risk Factors	Dow Corning	FoxMeyer
External Business Context Characteristics		
Competitive Environment	Threatened by breast implant lawsuits; competitive pressures	Unstable; cut throat competition; acquisitions and mergers
Collaborative Environment	Relatively stable	Unstable; lost major customer (Phar-Mor). Signed a replacement customer (UHC) during implementation. (Did not react appropriately; see Project Characteristics)
Cooperative Environment	Relatively stable	Relatively stable
Organizational Context Characteristics		
IT Infrastructure	Radical change required	Radical change required
Knowledge/Skills	Lacked needed skills; training on R/2 inappropriate, inadequate; established PRIDE academy	Lacked needed skills
Business Processes	Originally planned to reengineer; in the end, accepted R/3 processes	Originally planned to reengineer; in the end, accepted R/3 processes
Organizational Structure	Centralized prior to R/3 decision; still needed process-oriented approach	Centralized prior to R/3 decision; still needed process-oriented approach
Firm Strategy	High-growth strategy	High-growth strategy
Organizational culture	Established firm; certain changes under way prior to R/3 decision open culture invited communication; loyalty	Established firm; certain changes under way prior to R/3 decision; less open culture; inadequate communication; lack of loyalty; turnover problems

Figure 3.33: Comparing Dow Corning and FoxMeyer (a), source: (Scott and Vessey, 2002a)

Risk Factors	Dow Corning	FoxMeyer
Information Systems Characteristics ES		
Champion/Sponsor	Charlie Lacefield: VP and Executive Director of Business Processes and Information Technology (BPIT) realistic expectations of technology; move forward gradually; small wins	Thomas Anderson: Chief Operating Officer; unrealistic expectations of technology
Steering Committee	Process and Information Technology Board (PITB) responsible for setting strategic directions for global IT	If in place, did not play a strong leadership role
Package fit	Concerns with processing large numbers of global users	Attempted to assess transaction volume; in the end, proved to be inadequate
ES Knowledge/Skills	Lacking; minimal use of consultants	Lacking in both FoxMeyer and implementation partner, Andersen Consulting
New Technology	Not used previously for such a large number of global users	Not used previously for distribution; large volumes of transactions
Non-ES		
Data		Conversion problematic; numerous data errors (large $ losses)
Interfaces	Omitted bolt-ons, for example, to bar scanners, and so forth, to meet project deadlines	Problematic; numerous data errors (large $ losses)
ES Project Characteristics		
Project Focus and Scope	Reduced scope when needed	Inappropriate reaction to new customer; compressed schedule; did not test adequately
Project Management	Strong project leadership	Who was in charge? Project leadership inadequate
Organizational Change Management	Formed "think tanks" to determine future processes, aid in change management	Had some exposure to change; needed improvement

Figure 3.34: Comparing Dow Corning and FoxMeyer (b), source: (Scott and Vessey, 2002a)

3.6.1.5 Risk Management as a Strategic Issue for the Implementation of ERP Systems: A Case Study From the Oil Industry

Tatsiopoulos et al. (2003) propose a structured risk management approach for the successful implementation of ERP systems. The application of the proposed methodology is demonstrated in a case study concerning a European company operating in the Petroleum sector. Tasks and the tools that can be used are organised into discrete phases in order to provide a coherent and structured approach. Authors propose an identification phase based on the interviews and questionnaires, which are used as a tool of the risk management team.

Although they identify three of the most important risk areas, this methodology concerns primarily the strategic level ad does not extend to the operational level. The risk analysis is performed by the use of a qualitative methodology for the assessment of the probability of occurrence and impact, while risk control phase is achieved by the use of a risk matrix as suggested by PMI book (2000). Further analyses on the risk factors were performed by "Riskman Professional" using montecarlo simulations. This work is one of the first contributions of applying a structured risk management process on a real ERP implementation. However some shortcomings are identified. Firstly identification of risks should continue at a lower operational level to achieve control and provision of the necessary feedback. Attention should be addressed to the connection of the low-level risks with the strategic ones and to the inter-dependences between risk factors. Quantitative evaluations of risks are very difficult to be accomplished in this kind of models and no support is given for the risk treatment phase.

3.6.1.6 Assessing risk in ERP projects: identify and prioritize the factors

Huang et al. (2004) suggested a concern-driven (i.e. perception based) assessment of risk factors using a Delphi method. Authors selected and contextualized the main ERP project risk factors using Delphi method which started from those identified in literature mainly from Sumner (2000) and Wright and Wright (2001). Then they used AHP (Satty, 1990) to analyse and prioritize them. The research invited seven experts, all experienced and well performed in ERP projects, to participate in this study; After obtaining consensus from Delphi method, authors extracted 28 proper risk factors and then categorized them basing on their attributes: organization fit, skill mix, project management and control, and software system design user involvement, technology planning. Risk factors were used to construct the framework of the risk assessment (Figure 3.35).

The AHP was used as a flexible and easily understandable way of analyzing project risks since allows subjective as well as objective factors to be considered in project risk analysis. After constructing the hierarchy, the elements for each level are pair-wise compared in respect of their importance trying to fit subjective experience and knowledge from decision-makers. 26 on 198 of invited members of a Chinese Enterprise Resource Planning Society (CERPS) participated the research.

This study takes some steps to answer the following needs: what the actual risks of ERP projects are and which of these risks managers perceive to be more deserving their attention. Outcomes establish an AHP-based framework to assess risks and, starting from a list of 28 risk factors, prioritize them in to a top ten list (Figure 3.36).

The results also demonstrated there are discernible differences in the identification and perceived importance of certain risk factors. However, authors did not perform a formal risk quantification of effect severity or occurrence probability of risk factors but just ranks them according to a managers' global perception of risky, that is a weakness of the model. Assessing in the same time perceived impact and probability of occurrence into a general risk perception, concern-driven risk management permits emotional and psychological motives (drivers of concern) distinct from quantified cause-and-effect relations and this could

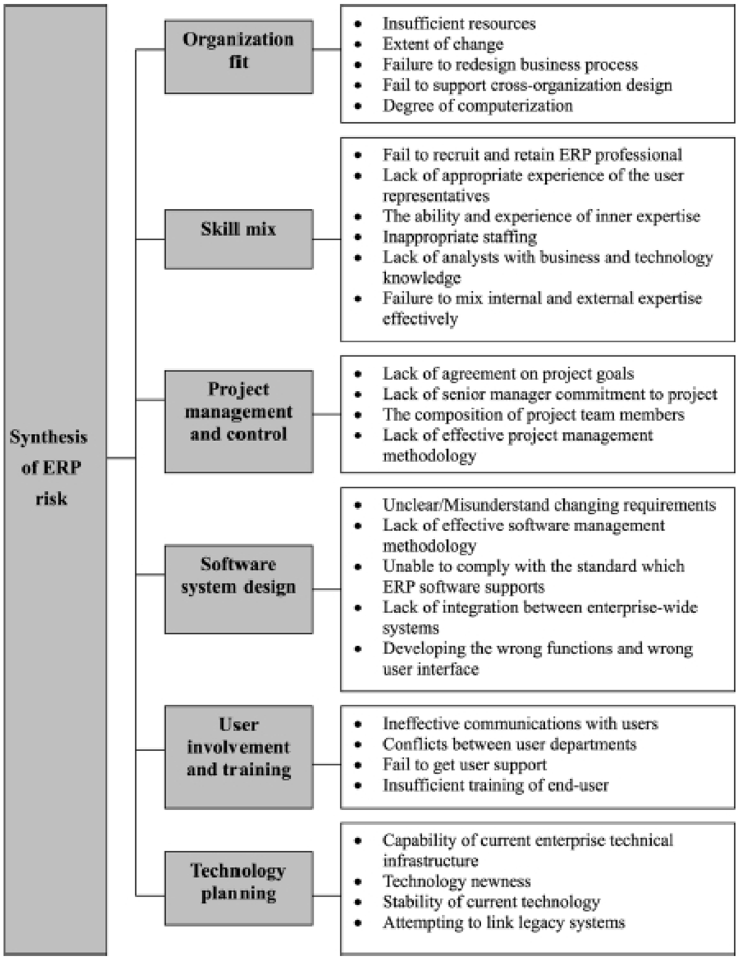


Figure 3.35: Risk assessment (AHP hierarchy), source: (Huang et al., 2004)

Name	Loading	Priority
Lack of senior manager commitment to project	0.11	1
Ineffective communications with users	0.073	2
Insufficient training of end-user	0.066	3
Fail to get user support	0.052	4
Lack of effective project management methodology	0.049	5
Attempting to build bridges to legacy applications	0.043	6
Conflicts between user departments	0.043	7
The composition of project team member	0.041	8
Fail to redesign business process	0.037	9
Unclear/Misunderstanding changing requirements	0.036	10

Figure 3.36: Top ten risk factors of ERP projects, source: (Huang et al., 2004)

affect the effectiveness of the risk assessment processes.

3.6.1.7 Dynamic risk management system for the modeling, optimal adaptation and implementation of an ERP system.

Zafiropoulos, et al. (2005) presented a qualitative risk management application for modelling, optimal adaptation and implementation of a generic ERP system in small or medium-sized enterprises. The tool supports project managers in identifying, assessing the importance and evaluating potential impact of risk factors, moreover it actively supports the communication and reporting activities during the project life cycle and suggests some risk treatment strategies.

The system uses ASP pages and Microsoft Access 2000 so that the application is dynamic and accessible via network and supports three groups of users: project manager, consultants and system administrator. It consists of three sub-systems:

1. The risk management system has the following functionalities:

    - Risk assessment. In which different categories of risk are assessed by questions to managers. The questions are generic and the user has the capability of not to choose an answer, if this is not suitable for the specific project. Each category has sub-categories and each sub-category has one question with three possible answers.
    - Risk calculation. After having answered to various questions (on each category), the system calculates the resulting risk. Each question has a value, which range is between 0-10. The value depends on two elements: the importance the project manager and the consultants

give to this subcategory and the possibility of risk appearance (Figure 3.37).

RISK SCORING

	Scored Risk	Maximum Risk	Risk %
PROJECT DEFINITION	150	260	57,69%
PROJECT MANAGEMENT STRUCTURE	155	350	44,29%
PROJECT SIZE	110	210	52,38%
SOFTWARE PACKAGE SELECTION	145	250	58,00%
SPONSORSHIP AND COMMITMENT	180	320	56,25%
STAFFING	320	530	60,38%
TECHNOLOGY	180	290	62,07%
USER ORGANIZATION	115	230	50,00%
Total	1355	2440	55,53%

Figure 3.37: Risk Scoring, source: (Zafiropoulos et al., 2005)

- Graphical presentation of risk percentage.
- Risk impact and mitigation strategy. A form analyzes each possible risk and the system dynamically presents the possible impacts and mitigation strategies according to the identified risks. It also presents methods for the mitigation of the risk sub-categories.

2. Data management system. An application with which users could manage the risk data is provided in the system.
3. The database system which contains the following fields in order to support the different stages of the risk management process: Category, Questions, Answers and Results.

Definitively, the authors achieved a structured procedure to manage risk within the implementation of the system, a knowledge repository on managing risk, through the dynamic structure of the application and provide systems for an immediate communication for the team members through the web of the appropriate migration strategy. Despite this, some gaps still occur:

- They did not explicit any risk effect on the project or explain how the tool proceed in risk evaluation. It seems that the evaluation assessed the risky of each risk category by itself without taking in consideration the probability of occurrence or the entity of the impact on the project goals.

- The system does not support the process of risk monitoring and control.
- The proposed mitigation strategies are "standard", i.e. they are unique for each sub-category. They are not differentiated according to the type of risk treatment strategy (avoidance, mitigation, transference and acceptation) and are not phased in the project life cycle. In my opinion, other relevant variables should be considered for the right choice of the most effective solution, as for example controllability, detect-ability of a risk factor.

3.6.1.8 ERP systems as a component of the electronic supply chain: Classification of implementation risks

Leopoulos et al. (2005) evaluated the utility of a structured model of risk factors in ERP implementations and create a Risk Breakdown Structure (RBS) of five categories and eight classes. The paper was focused on the first step of risk management process (risk identification). Risks have been identified through published risk catalogues and return from experience related to ERP installations, concerning three companies in an ongoing project in the (para)pharmaceutical industry. The innovative outcome is the Risk Breakdown Structure specifically for implementation projects of ERP systems with e-commerce modules.

Figure 3.38: Risk breakdown structure, Source: Leopoulos et al. 2005

The risk breakdown structure classified in a quite detailed way the ERP implementation risks in the following categories (Figure 3.38): Technical, Financial, Managerial, Legal and Strategic. Technical risks are related to the technology concerning the implementation of the ERP systems (both hardware and software) and associated with the critical questions of the system performance. The managerial risks can be divided in three classes: Project risks, Consultant/ Provider related risks and Human Resources risks. Financial risks mostly concern the senior management since ERP systems are major investments and companies often experience a low Return-On-Investment. Legal risks are associated with the contract of the project and the general matters of law.

Finally strategic risks, which mostly concern the senior management, are related to the chance that the costly ERP system will not pay off, in terms of business effectiveness, the implementing company. Shortcoming mainly includes the lack of standardization of the risk categories defined here and the absence of support for the other risk management steps such as risk analysis and control.

3.6.1.9 A study on applying FMEA to improving ERP introduction

Yang et al. (2006) suggest a systematic assessment of project risks in ERP introduction by the use of FMEA and its application to support performance measurement during the implementation process. They introduce a standardized model to prioritize risk factors starting from risk factors severity, occurrence probability and detection difficulty. FMEA is a preventive technology for reliability design and analysis by applying structured systematic procedures and methods to locate the potential failure modes of products at an early stage.

Authors suggest a performance evaluation matrix integrated with FMEA in order to select the strategies for improvement in each performance zone (increase resources to enhance satisfaction, decrease resources to reduce the cost of introducing the system, and maintain the present situation). A standardized system based on the performance evaluation matrix is established in accordance with the locations of the three RPN indices Severity (S), Occurrence (O) and Detection (D), in the PEM. Performance levels will be assessed and the performance improvement strategy introduced by the system will be formulated. Finally, falling items within the non-appropriate performance zone will be specified through the Quality Function Development (QFD) method. All that the management needs to do is to correspond to the positions of these RPN indices of implementation items on the performance matrix for the assessment of performance.

The data of risk priority number (RPN) are based on risk assessment. The multiplied risk factor indices refer to Severity (S), the outcome of a failure, Occurrence (O), the chance of a failure and Detection (D), the chance of a failure is not detected by customers or the difficulty level of detection. A scale of ten points is served to be a comparison table for the level and grade of these three factors. RPN is the outcome of multiplying occurrence, detection and severity and can be represented as Formula 1. For the decision factor number of RPN, different decision factors and grade judgment principles can be formulated in accordance with FMEA applications.

$$RPN = S \times O \times D$$

Accordingly to these three indices, three performance matrices in this article are formed and critical factors placed (Figure 3.39). The management only complies with the items located outside the control lines for improvement, which not only reduces time and cost but also serves to be an extremely useful tool. If a factor falls in Zone A outside the performance matrix boundary, resources have to be increased to reduce the occurrence of system failures and a positive area weight is resulted. If it lands in Zone B outside the performance matrix boundary, resources invested need to be decreased and a negative area weight is given.

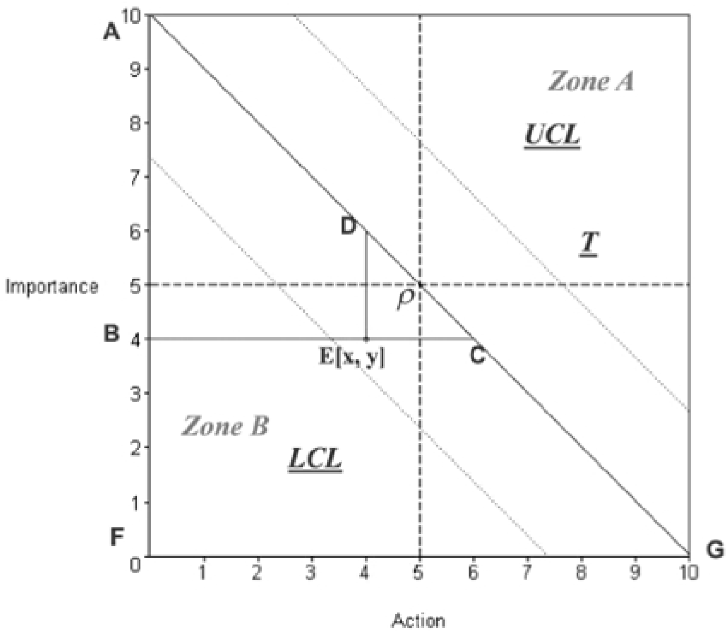


Figure 3.39: Performance matrix, Source: Yang et al. (2006)

In addition to locate areas of abnormal coordinates through the performance matrix, a strategic improvement in crucial items needs to be made. The located abnormal areas would work with QFD for the development of the related matrixes to define the priority of critical improvement items as well as representing a reference for the enterprises.

Main issues addressed by the research are concerning with the risk quantification:

- An objective and convenient performance matrix to facilitate the evaluation of overall performance of implementing ERP.
- The utilization of three indices of FMEA to judge ERP performance level, including performance of implementing each ERP module.
- The use of QFD to determine critical ERP implementation items in addition to evaluating the strengths and weaknesses while establishing ERP objectives.
- Follow-up improvements in ERP introduction projects.

In the same time some observations should be moved especially referring to the risk identification and treatment stages. No support is in fact provided for risk identification, except in the case study where nonetheless identified risk factors are not exhaustive and sometime overlapping. The risk evaluation phase is formally well defined but risk analysis remains more general and nothing is done to consider the inter-dependences among risk factors. Risk effects are not formalized and project success is not well defined. Finally the suggested risk management strategies (treatment actions) are very limitative and only concern with resources allocation. Neither suitable strategies or actions are proposed nor support to the choice of the most appropriate strategy according to the risk factor profile.

3.6.2 Practitioner initiatives (from Vendor or Business Integrators)

Contributions from practitioners are difficult to recover and available documentation is very fragmented and low detailed. This often happens because proprietary solutions are covered by patents and rarely disseminated, other times since their sectorial and ad hoc nature which limits the audience interest towards these approaches. However, we know that relevant practitioners' initiatives, some more general and some other specific for the ERP implementation process, exist.
In 1998, the IT Governance Institute (ITGITM) (www.itgi.org), established to advance international thinking and standards in directing and controlling an enterprise's information technology, has designed and created COBIT® 4.1 as an educational resource for chief information officers (CIOs), senior management, IT management and professional controls.

COBIT supports IT governance (Figure 3.40) by providing a framework to ensure that, among the other goals, IT risks are appropriately managed. A risk

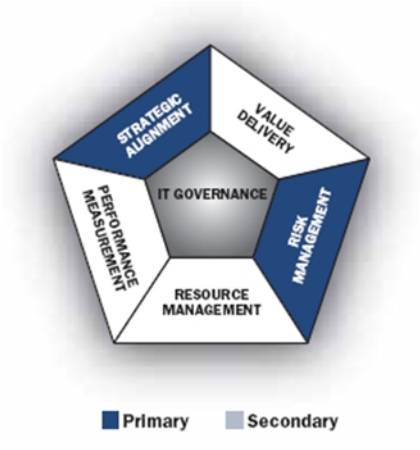


Figure 3.40: IT governance and risk management, Source: Cobit 4.1 framework (2007)

management framework is created and maintained. The framework documents a common and agreed-upon level of IT risks, mitigation strategies and residual risks. Any potential impact on the goals of the organisation caused by an unplanned event should be identified, analysed and assessed. Risk mitigation strategies should be adopted to minimise residual risk to an accepted level. The result of the assessment is understandable to the stakeholders and expressed in financial terms, to enable stakeholders to align risk to an acceptable level of tolerance and measured by a set of indicators (i.e. percent of critical IT objectives covered by risk assessment; identified critical IT risks with action plans developed; risk management action plans approved for implementation). However, the framework does not extend to the operational level; neither suggests any tool or support to this phase.

Also some ERP vendors such as SAP and Baan have tried to provide certain methodologies and applications as to conduct successful risk management. Specifically, SAP has a risk assessment application. The purpose of the application is to provide an objective measure of the degree to which the organization believes the R/3 implementation is credible and profitable for itself and for individuals. In addition, this application shows the change team how it could strengthen the credibility and perceived benefits of the R/3 implementation. This intelligence will be used to drive the change management initiative (SAP White Paper, 2003).
Baan provides a risk manager with which the project manager can conduct a risk assessment. In response, the system calculates the risks that may appear and provides mitigation strategies. With the support of such systems, the

project manager makes a more realistic estimation of costs and time, defining in a more accurate way the goals and the desired outcomes and avoiding the possible future problems, which may end in unwanted results.

3.7 Shortcomings and gaps in past ERP Risk Management Approaches

Chapman and Ward (2002, chap. 5) illustrate some shortcomings in terms of potential cause of failure in risk management which fit quite well also with the ERP case, including:

1. *Over-attention to Activities.* A define phase that is too detailed in terms of activities and fails to address the other aspects of risk management as the link with the Project Life Cycle (PLC).
2. *Motivation.* Unclear motivation for the RMP in relation to the various interested parties, or the links between motives for analysis and the selected models.
3. *Wrong or superficial risk analysis.* It fails to provide a useful structure for sources of uncertainty, associated risk, and responses.
4. *Forgetting interdependence.* Absence of a structure phase, with little evidence of robustness testing or effective structuring decisions, including the lack of a significant search for common responses and a failure of identifying significant linkages and interdependences between issues.
5. *Contracts.* Lack of contractual arrangements for motivating parties to manage uncertainty, including inappropriate use of simple contracts.
6. *Efficiency.* An estimate phase that is costly but not cost-effective, resulting in biased estimates that are usually highly conditional on scope and other assumptions that are lost sight of.
7. *Evaluation.* An evaluate phase that combines different sources of uncertainty without capturing crucial dependence or without providing the insight to clarify how revisiting to earlier analysis can clarify uncertainty, develop effective responses, facilitate crucial or demonstrate the robustness of those choices.
8. *Iteration.* Absence of a phase, to manage the transition from an iterative shaping process to the detailed planning necessary for managing implementation of the project plan.

The literature review evidences that quite all the analyzed contributions in scientific literature present pretty qualitative and not integrated approaches to risk assessment. Authors frequently suggest general frameworks or global approaches to risk management in the ERP fields often derived from IT and Risk Management literature but rarely propose methodologies and tools for the specific ERP case which could drive or support the different stages of RM process in a real project. They often challenge one of this phases as a stand alone activity while on the contrary it should be deeply interconnected with the other phases.

Concern-driven risk management (Cox, 2007), in which qualitative experts' judgments about risk management interventions are used in preference to quantitative risk assessment (QRA), emphasizes perceived urgency and severity of the situation and does not use formal and analytical quantification or comparison of probable consequences for alternative decisions. Even if concern-driven risk management has some potential political or communicational advantages over more analytic QRA's approach and it is recommended by critics of QRA in several areas of applied risk management especially when "data", "facts" and "causal-effect relationships" are not available or difficult to quantify, it could be easily affected by misperceptions and its effectiveness remains to be assessed.

QRA in fact, separating "facts or beliefs" about the "consequences" from the "values" assigned and "consequences" form "actions", provides a logical framework with more analytic and systematic procedures for organizing and applying scientific and engineering knowledge to improve "rational" (consequence driven) decision making in uncertainty conditions. Using explicitly documented assumptions, knowledge, facts and available data (encapsulated in risk models) to assess risk and potential alternatives, it has many benefits in improving risk management process, because it makes possible to identify the specific areas of disagreement and either to resolve them or note which assumptions affect the result. So moving towards QRA and generally to more analytic and formal approaches is highly desirable, also in ERP projects; combining quantitative and qualitative approach in a formal ERP risk management framework can be a relevant step in this direction.

Looking at the review from a risk management perspective and analyzing the phases supported by the previous works, it appears that most of the contributions focus on the identification phase. Quite all the authors propose a more or less complete risk list in which risk factors are defined and discussed, however a lack of standardization is still evident. In the quantification phase, most of them provide useful advices for the analysis of the risk factors, their potential impact and interesting suggestions for risk factor classification (risk analysis). By the way, no one explicitly deals with the problem of the risk factors interdependence and their relationships with the effects or with any structured risk management methodology useful to this scope. Some contributions as for example Huang et al. (2004), Zafiropoulos et al. (2005) represent tentative of risk factor prioritization (risk evaluation). A common gap is they assess in the same time perceived impact and probability of occurrence into a general risk perception. Yang et al. (2006) avoid this problem by the use of a FMEA approach which is nevertheless less suitable from a practical point of view.

The risk treatment phase evidences a clear gap in literature. The proposed mitigation strategies are "standard", neither differentiated according to the type of risk treatment strategy (avoidance, mitigation, transference and acceptation) nor phased in the project life cycle (Zafiropoulos et al., 2005). Often they only concern with resource allocation (Yang et al., 2006).

Finally transversal phase as context analysis, risk monitoring and communication are scarcely supported and often contributions remand to more general risk management approaches (see Chapter 2).

As for practitioner initiatives, SAP and Baan, along with other ERP vendors, which have certain methodologies, have designed proprietary applications for the needs of their own ERP systems. These risk management applications are not generic and thus cannot be used at the implementation of any ERP system. Moreover they adopt more a technical perspective than an organizational one. So the risk is seen from the vendor or business integrator point of view more than from the company's one. Despite these approaches could help in project resource planning, allocation and time forecasting, especially since they benefit of the large experience of these subjects, they fail to address other important dimensions of project success, such as the organizational one. For this reason, and for some other desired functionalities such as network access and dynamic content, the development of a more dynamic and generic risk management application is necessary (Zafiropoulos et al., 2005).

Concluding, currently formal RA methods are rarely applied for risk management in complex projects like ERP introduction. Several generally accepted approaches to risk management exist in literature. Activities and main stages which authors divide risk management process are often inhomogeneous and overlapping, moreover numerous shortcoming were identified in proposed approaches. Our attempt is to address these shortcomings in order to achieve an effective risk management for ERP introduction projects.

3.8 Conclusion

This chapter introduced the ERP field, setting main definitions and illustrating the characteristics of ERP introduction process. An extended literature review was presented in order to clarify from a risk management point of view which approaches were used in ERP research field. This provided evidences of a lack of contributions explicitly dealing with risk management in ERP introduction projects. The few existent ones were deeply analyzed and shortcoming discussed.

Section 2

In our voyage, this section represents the hypothesized cartography and would draw the way to the destination seaport, planning the most important stages and milestones.

Chapter 4 and 5 follow a general risk management model in order to develop a specific risk management approach for ERP introduction projects, suggesting innovative methodologies and techniques for the different risk management phases or adapting the existing ones to the ERP context.

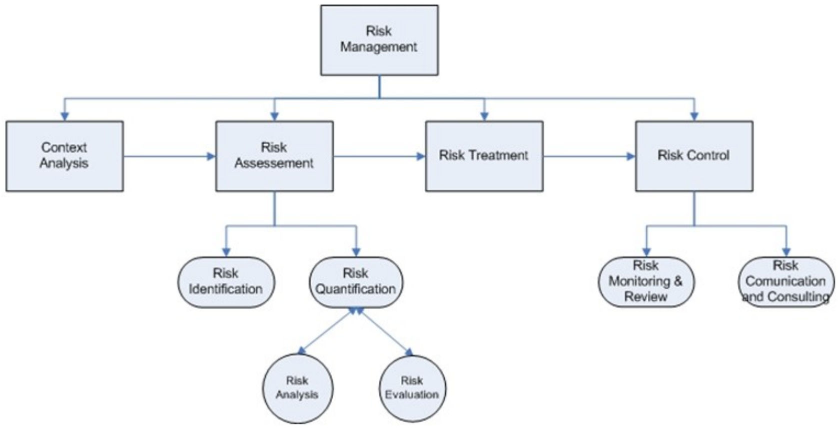
Here we present the adopted risk management framework which tries to homogenize discrepancies revealed in the existing literature. As follows, we first propose all our definitions of *Risk, Risk assessment* and *Risk management* which will clarify the approach we suggest in dealing with risk during the introduction of enterprise resource planning systems.

Definition 1: *Risk* is an uncertain event or condition that, if occurs, has a positive or negative effect on a project objectives (PMI, 2001).

Definition 2: *Risk assessment* is the process of quantitatively or qualitatively assessing risks. It involves an estimation of both the uncertainty of risk and its impact.

Definition 3: *Risk management* is the practice of using risk assessment to devise management strategies and deal with risk in an effective and efficient way.

According to this perspective, a general risk management framework can be drawn for ERP projects. It consists of several activities (7 basic activities and 4 main stages), as shown in figure.



1. *Context analysis* - which aims to define the boundaries of the risk management processes: processes which have to be analyzed, desired outputs, level of performance etc., in order to support the definition of the correct risk model approach;

2. *Risk assessment* - is a core step of the risk management processes and includes:

   - *Risk identification* - which allows organization to early determine the potential threats (internal and external risk factors) and their impact (effects) on the project success;
   - *Risk quantification* - which aims to prioritize the risk factors according to their risk levels and consists of two principal phases:

     a) *Risk analysis (or estimation)* - provides inputs for the final quantification to the risk evaluation phases. The typical inputs are: the probability of occurrence of a risk factor, the links (weight) with potential effects, the severity of these effects and eventually the detection's difficulty.

     b) *Risk evaluation* - which defines risk classes. It selects an appropriate and effective risk aggregation algorithm and synthesizes the risk level for each identified risk factor.

3. *Risk treatment* - targets to the selection of an effective strategy to manage the risks related to the different risk classes identified. Risk management

strategies consist of four classic approaches: the first aims to reduce the risky circumstances, the second deals with risk treatment after a risk factor appears, while the third and fourth deal to risk externalization or acceptation.

4. *Risk Control* - the final aim of risk management is managing project risk in order to perform a better control on the project and increase its probability of success. The principal issues of the risk control phase are:
   - *Monitoring and Review* - each step of risk management processes is a convenient milestone for reporting, reviewing and action taking.
   - *Communication and Consulting* - aims to effectively communicate hazard to project managers and people involved into the project in order to support the managerial actions.

Details about these phases in an ERP project will be explained in the following section of this thesis.

Chapter 4

Risk Assessment

This chapter deals with the context analysis and the assessment of risks for an ERP project. In particular, the main purpose is to provide a risk management (RM) methodology for ERP introduction projects.

The methodology deployment aims to develop a suitable and useful model for ERP risk management, suggesting innovative methodologies and techniques for the different phases of risk management or adapting the existing ones to the new ERP context. After the context analysis which focuses on setting boundaries within which risks must be managed, an extended literature review responds to the need of risk identification proposing a classification and taxonomy of the main risk factors. Then, adopting the Lyytinen and Hirschheim's (1987) definition of "failure" and "success" of IT projects, the main risk effects are identified and an overall framework, enumerating risk factors, effects and macro effects, is drawn.
As for Risk Quantification, existent techniques in Risk Analysis and Evaluation stages were analyzed from literature in Risk and Project Management, and Information System field. After that, an ISM-based (Interpretive Structural Modelling) (Sage, 1977) technique is proposed to model dependences and interconnections among risk factors and between risk factors and effects, in order to draw a risk event tree in risk analysis phase. Finally, a probabilistic network approach is suggested for Risk Evaluation to synthesize a final ranking of the risk factors.

The main outlines from this chapter are:

- Introduction to the context analysis
- Context analysis in a ERP project
- Introduction to risk assessment
- Risk assessment in a ERP project
  - Identification and taxonomy of risk factors an effects
  - Risk quantification (analysis of interdependences and evaluation)
- Conclusions

4.1 Introduction

The principle reason for managing risk in an organization is to protect the mission and the assets of the organization. Therefore, the risk management is a management function rather than a technical function. Managing risks to systems is of vital importance. Understanding risk, and in particular, understanding the specific risks of a system allows the owner to protect the information system commensurate with its value to the organization. The fact is that all the organizations have limited resources and risk can never be reduced to zero. So, understanding risk, especially the magnitude of the risk, allows organizations to prioritize scarce resources.

As Chapman and Ward (2003) affirm, the chess play is perhaps the most appropriate analogy for project RMPs. In a chess player's terms, we need to plan moves as far ahead as our capabilities allow, with a view to the next move, but even chess masters do not plan games to checkmate from the outset. Definitely, we need to identify potential moves and analyze them together (series of moves or play strategies), their relationships and interdependences, we need to identify the effects for our match and evaluate the risk to prevent or contrast the most risky ones. These activities well exemplify what is within the risk assessment process.

However, the risk management planning horizon needs to be limited according to the context. Until we see what happens, some aspects of detailed planning are an inhibiting waste of time. But anticipation in broad strategic terms needs to go beyond the next move or play. A key difference between chess masters and other chess players is the effectiveness of the way they anticipate what will happen without detailed analysis of all possible moves.

According to the Australian Standard for Risk Management (AS/NZS 4360:1999), the objective of the assessment is to provide guidance to enable public, private or community enterprises, groups and individuals to achieve in the following activities that we explained in the preface:

1. Establish the context;
2. Identify risks;
3. Analyze risks;
4. Evaluate risks.

This view of the relationship of Risk Management to Risk Assessment is depicted in Figure 4.1. Even if organizations tend to use a single method for Risk Management, multiple methods have typically been used in parallel for Risk Assessment. This happens because different Risk Assessment methods might be necessary, depending on the nature of the assessed system (e.g. structure, criticality, complexity, importance, etc.).

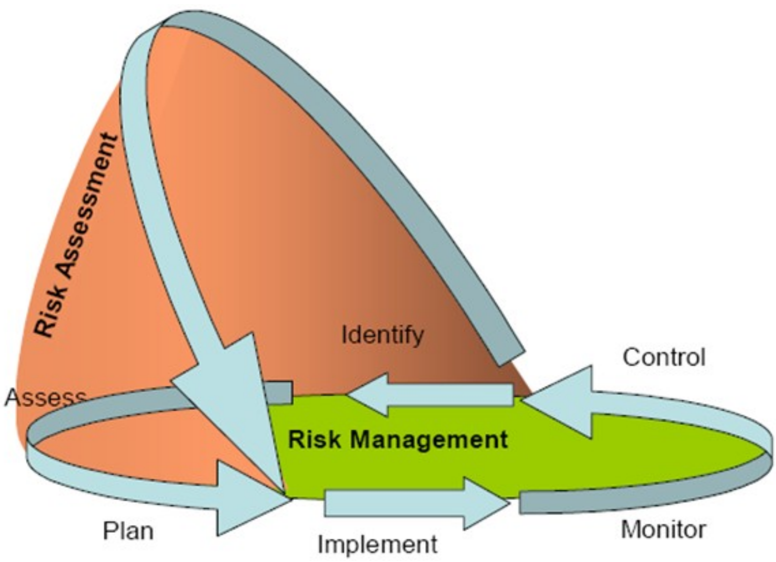


Figure 4.1: The relationship between Risk Management and Risk Assessment

Methodologies and techniques for risk assessment usually aims to provide:

- a more confident and rigorous basis for decision-making and planning;
- a better identification of opportunities and threats;
- a pro-active rather than re-active management;
- a more effective allocation and use of resources;
- a better corporate governance.

A more detailed analysis of these processes is presented in the next section of this chapter.

4.2 Context analysis

4.2.1 Introduction

The context analysis (Figure 4.2) is an important activity which should be preliminarily assessed in the risk management process. Establishing the context means setting boundaries within which risks must be managed and defining the scope, as well as the budget, for the following risk management activities.

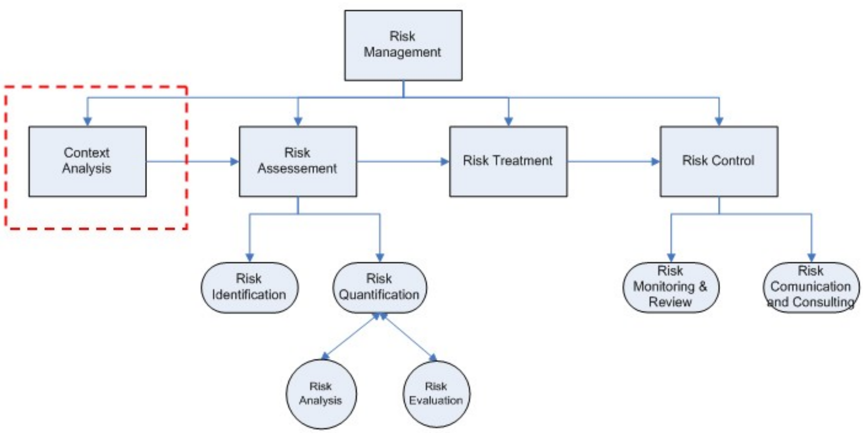


Figure 4.2: Context analysis phase

The context analysis is essential for the next steps of RMP and it is functional both to the assessment and the treatment phase, since it can enable a more complete identification, a better assessment and a more careful resource allocation and selection of suitable response strategies.

Context analysis pertains to both the process dimension and the Risk factor dimension.
Within the first, the context establishment in the risk management process involves representation of project units (functional, process, data, etc.) and their inter-relationships (Ahmed et al., 2003a, b). Before a risk management activity, at any level, is commenced, it is necessary to understand the project/organization. The key areas include:

- culture;
- internal stakeholders;
- structure;
- capabilities in terms of resources such as people, systems, processes, capital; and
- the goals, the objectives and the strategies put in place to achieve them.

This step defines the external environment in which the organization operates and defines the relationship with the business, social, regulatory, cultural, competitive, financial and political environment; the organization's strengths, weaknesses, opportunities and threats; external stakeholders; and key business drivers.

This enables in representing project status in several forms such as resource usage, equipment requirements, budget availability, stakeholder involvement, contract deliverables, strategic goals and schedules, depending on the desirable aspect of the project that is important for any particular purpose.
Project modeling tools and techniques are generally useful for this activity, such as project network diagrams, precedence diagramming method (PDM), generalized activity networks (GANs), design structure matrices (DSM), IDEF3 process modeling and IDEF0 functional modeling (Ahmed et al., 2007). These matrices are described in detail in the following paragraphs.

As for the Risk factor dimension instead, the attention is on the features of the risk factors which could influence the Risk Management Process, and on developing risk criteria.
Deciding the criteria against which risk has to be evaluated is essential in RMP.

Decisions concerning whether risk treatment is required may be based on operational, technical, financial, legal, social, environmental, humanitarian or other criteria. The criteria should reflect the context defined above. These criteria often depend on the internal policies, goals and objectives of an organization and on the interests of stakeholders. It is important for the appropriate criteria to be determined at the outset. The risk criteria must correspond to the type of risks and the way in which risk levels are expressed.

4.2.2 Tools and Techniques for the context analysis: literature review

Ahmed et al. (2007) present a very complete review of tools and techniques supporting the context analysis in respect of the process dimensions:

Project network diagrams
Project network diagramming is a graphical technique used to represent project tasks and precedence relationships (Webb, 1994; Russell and Taylor, 2000; Tavares, 2002). Project tasks or activities are modeled as arrows or nodes through two different methods - activity on node or activity on arrow. A project network diagram provides a simple visual display of tasks in a project, with difficulty in representing complex relationships. Alternative and overlapped activities are also not accommodated in project network diagrams.
Critical path method (CPM) and program evaluation and review technique (PERT) are then used for analysis of the critical path of the project, identification of critical tasks and estimation of the total project duration. Precedence diagramming method PDM is an extension of the project network diagramming technique where overlapped content between two dependent activities can be represented through lead-lag requirement relationships (Wiest, 1981; Badiru, 1993; Badiru, 1996).

Generalized activity networks
A GAN is a graphical representation of the probabilistic branching of activities (Dawson and Dawson, 1994, 1995, 1998). Uncertainty is represented as alternative paths with a connected probability; an illustration of the all possible paths or scenarios that can be described in a project, including loops is provided.

Design structure matrices
A design structure matrix (DSM) represents precedence relationships of project tasks on a square matrix, containing an equal number of rows and columns, representing the number of tasks. The existence of a precedence relationship between two tasks is represented through a binary code, with a mark "X". The absence of the mark means that no precedence relationship exists between

the two tasks. DSM depicts three different types of precedence relationships between tasks. A sequential relation indicates that the precedent task must be completed before the subsequent task commences. A parallel relationship indicates that two tasks are carried out independently, while a coupled or a circuit relationship indicates that the two tasks are interdependent, requiring input from each other (Steward, 1981; Kara et al., 1999; Eppinger et al., 2001). DSM provides a capability of representing task relationships in a complex system and lends itself to analysis through matrix manipulations leading to the isolation of group of coupled tasks. However, decision points are not represented into the DSM structure and alternative paths are not realized.

IDEF0 functional modeling

IDEF0 is a graphical representation of a system through a functional perspective. In IDEF0, a box represents an activity or a function while arrows represent inputs, outputs, controls and mechanisms operating on activities and on the project as a whole (Colquhoun et al., 1993; Sarkis and Lin, 1994; Malmstrom et al., 1999; Ang and Gay, 1993; Kusiak et al., 1994). An input is a requirement that a functional unit needs to perform, while an output is the outcome of that function or a combination of functions. Controls are constraints that dictate functions such as regulatory environment and budget, while mechanisms are supports that advocate performance of the function such as people, computer systems and machines. IDEF0 provides an overall view of the project at the top level and, successively deeper details inside subsequent levels. This provides a relevant model to all the functional levels in the organization.

IDEF3 process modeling

IDEF3 is a graphical method used for modeling sequence of tasks in a system through process or object-oriented perspectives. The process-centered view emphasizes the process flow and the relationships between tasks, while the object-centered view highlights change in states of objects as a process flow (Larson and Kusiak, 1996a, b; Mayer et al., 1995). In a system, tasks are defined as units of behaviour (UOB); relationships are represented as links and logical branching as junctions. Logical branches or junctions are usually decision points in the system and they could be of - AND, OR, or EXCLUSIVE OR types. IDEF3 allows greater flexibility in modeling alternatives in design processes, it is suited for the environment and lends itself as a foundation for further risk analysis (Kusiak and Zakarian, 1996). Since processes can be represented in layers with the top layer providing the overall view, an IDEF3 model could be as simple as it is desired to be or dig down into details in each subsequent lower layer.

Other tools and techniques supporting the risk factor dimension are available; in particular we remind the cognitive maps and the context diagram proposed by the SAFE methodology (Sage, 1997)

Cognitive map
A cognitive map is a sociogram that graphically and textually represents the project's various "project stakeholders" with their characterizing relationships. The lines of connection may be diversified based on their known or presumed critical nature. The sociogram offers the following advantages:

- there is no risk of neglecting subjects qualified for consideration "in the project";
- the analysis of the inter-dependencies makes it possible to highlight the so-called "dangerous relationships" that generate risk for the project. The cognitive map can help in applying force field analysis regarding the project objectives (forces in favour - forces against).

Context diagram
The context diagram (Fig. 3) is a circle-shaped graphic tool that stimulates the search for critical elements that may affect the project especially, but not exclusively, in its relationship with the external context - that is the environment in which the project must live as harmoniously as possible. The graph is divided into areas representing the intersection of two different ways of sectioning the circle - slices and concentric circles. Within the various areas, the critical elements are placed, and may be of two types: factors and subjects.
Factors are inanimate entities with no decision-making or action-taking powers. They may be events, circumstances, conditions, objects, configurations, information, and so on. They are marked by the fact that they can cause problems or damage (but also advantages if well managed) for the project. Subjects may be people, organizational units, or even information. The slices of the context diagram represent the classes in which the various critical elements may be sought. These are, for example, society, politics, laws/regulations, the economy, technology, logistics, geography, strategies, organization, and skills. The list is not comprehensive and new reference classes may be defined and used. Context diagrams are used to stimulate the imagination to seek possible critical elements using a verification list both during the early project assessment phase, in order to define all the relevant variables of the process, during the risk identification to stimulate the risk factor definition and also in the treatment phase, to chose the right strategy for each risk factor.
It is important to be able to assign to each identified critical element a degree of controllability deriving from the so-called project capacities. This is the third element in the context diagram: the concentric circles and it comprehends:

- *Control*: in this case, it is possible to successfully intervene on this critical element by modifying it.

- *Consideration*: the project exercises no control over the element, but is conditioned by it. We cannot act on the element, and we are therefore forced to act on the project itself.
- *Influence*: the project may exercise only indirect influence on the element, and with uncertain results.

4.2.3 Context analysis in ERP project

Performing the context analysis in ERP projects is not a simple task and standard models are difficult to draw. This is mainly due to the complexity of such projects and their high specificity, secondly for the lack of standardization of the implementation processes which companies undertake.
Regarding the implementation process dimension, it is assumed that IS implementation (the initiatives to put into effect the IT capabilities as planned - Sarker, 2000) has an impact on organizations, what supports the need for investigating how IS materializes, develops and perishes. When IS assumes strategic organizational functions, its planning should foresee and combine technical, organizational and business factors, in the search for a systemic appraisal of all relevant processes.
We think that Sarker (2000) offers a useful model (the socio-technical view that we already described in chapter 3) of the implementation process in order to understand the involved dimensions and key actors. It seems to be currently the most appropriate model for framing relevant variables in the process (Figure 4.3).

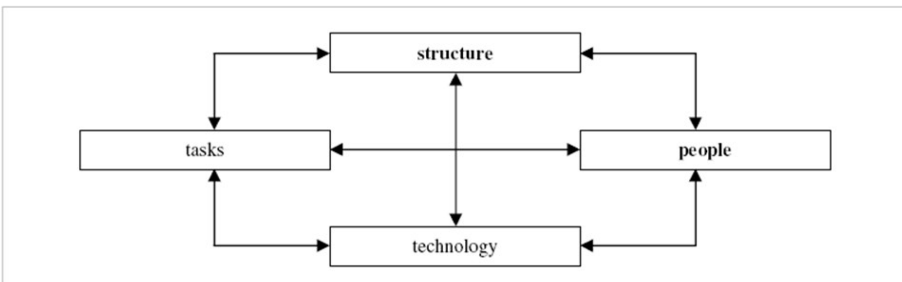


Figure 4.3: Socio-technical view, Source: (Sarker, 2000)

Other useful contributions to the comprehension of phases and roles in the implementation process, are given by the several schemes of the ERP project life cycle which are proposed in literature and by the Vendors or Business Integrator practices (see chapter 3 for more details).

As for the risk factor dimension, in our opinion, relevant attributes for factor classification and analysis in ERP projects are:

- Detect-ability of risk factors: easy or difficult detection of the occurrence of a risk factor.
- Responsibility of the actions: internal or external players.
- Project life cycle phases: the phases of the project in which the risk factor is enabled to occur.
- Controllability: the possibility of influencing the probability of occurrence of a risk factor.
- Dependence: dependence degree of a risk factor from the others.

Details about these variables will be provided in the next chapter.

In Figure 4.4, an example of the context diagram used by Scott and Vessey (2002a) in a number of case studies.

4.3 Risk Assessment

Each organization or project is continuously exposed to an endless number of new or changing threats and vulnerabilities that may affect its operation or the fulfillment of its objectives. Identification, analysis and evaluation of these threats and vulnerabilities are the only way to understand and measure the impact of the risk involved and hence to choose the appropriate measures and controls to manage them.

Risk assessment is the central phase of the risk management process. This phase allow us to understand the nature of risk in terms of which factors could impact on project success, the interactions, their probability of occurrence, detection difficulty and potential impact on the project, in order to quantify their risky and prioritize them. It consists of two principal issues (Figure 4.5): *Risk Identification* and *Risk Quantification*, which we will separately discuss.
These processes interact each other and with the other projects in the general framework; although they are here presented as discrete elements with well defined interfaces, in practice they may overlap.
Risk assessment is a complex undertaking, usually based on imperfect information. There are many methodologies aimed at allowing risk assessment to be

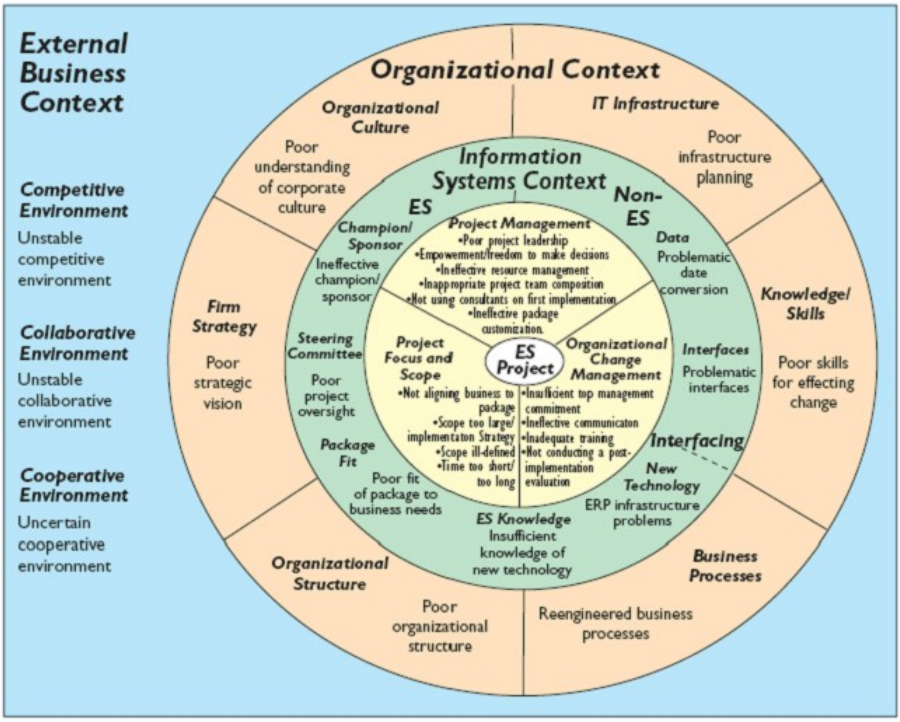


Figure 4.4: Context diagrem, Source: (Scott and Vessey, 2002a)

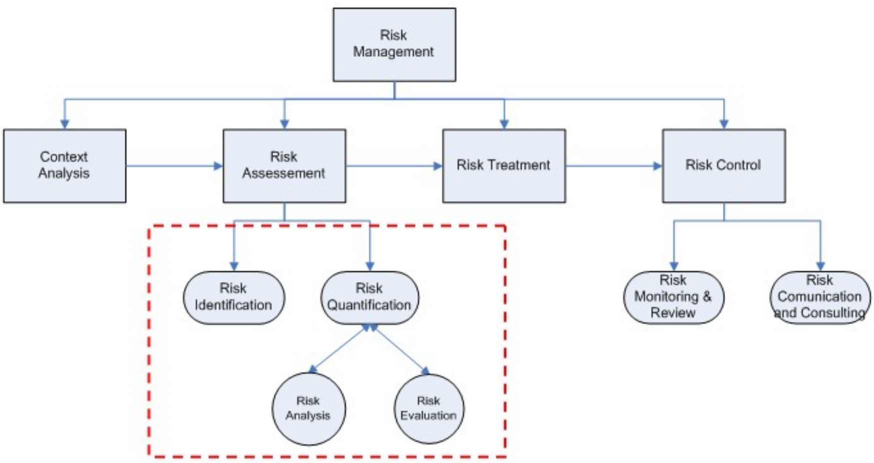


Figure 4.5: Risk assessment phase

repeatable and give consistent results. In the following chapter we investigate the identification and quantification phase with a particular focus on the objectives and supporting techniques in literature. Finally we propose our approach to each phase in the ERP context.

4.4 Risk identification

4.4.1 Introduction

Common Risk Management approaches emphasize the need of identifying "risks" early in the process. Chapman and Ward (2003) assert that a key deliverable for an effective risk management is a clear, common understanding of the sources of uncertainty facing the project and what can be done about them. The real sources of risk are the un-identified ones, so that the identification phase can be considered as an initial risk response action. Comprehensive identification using a well-structured systematic process is critical for the RMP, because a risk not identified at this stage may be excluded from further analysis (AS/NZS 4360:2004). Identifying issues involves two specific tasks:

- *Search* - for sources (and then responses), employing a range of techniques;
- *Classify* - to provide a suitable structure for defining sources (and then responses), aggregating or disaggregating particular issues as appropriate.

In terms of output and documentation, the identification phase involves the production of a list or register of sources. The identification of sources, effects and responses can be assessed in a variety of ways, by individual activity or involving other people, in order to stimulate imaginative thinking and draw on the experiences of different individuals. The approach depends on the nature of the activities under review, types of risk, the organizational context and the purpose of the analysis.
The idea is to structure formal procedures to systematically capture personal experience, so that group processes where a wide range of personnel are sought is particularly desirable in order to provide this comprehensive view and pooling the experiences.
These techniques include: interviewing individuals, interviewing groups or group processes such as brainstorming and decision conferencing, based on experience and records, flow charts, brainstorming, systems analysis, scenario analysis and systems engineering techniques (diagrams, cause-effects diagrams, event or fault trees, Quality Function Deployment QFD), checklists, judgments.

An obvious limitation of identification based on experience is that such experience may not be entirely applicable to future projects as for example in changing project environments and novel aspects of future projects. Therefore a call for creativity and imagination is necessary, for example in brainstorming or other kind of processes for stimulating the ideas generation, to provide more possible solutions and unusual approaches to a problem.

From literature (Chapman and Ward, 2003) it seems the simplest way to begin the identification phase is to adopt a simple ponder approach to the definition of what might be termed key criterion at level one. Key criterion issues at level one are sources and associated responses that directly impact on the most important or the central project performance criterion. It is then possible to iterate the process at a second or third level, considering the secondary performance criterion.
It is convenient to start with a focus on the performance issues, then generalize to consider other criteria from the key player's perspective, move on to other Ws (who, what, when, and wherewithal) and finally focus on the project life cycle stages. Considering the complete set of Ws first, then players and LC can reveal some key sources, associated responses, and in some cases secondary sources, with important interactions that require management. So this is essential in the aim of a complete identification. Many important sources are associated with the fundamental management processes that make up the PLC and a fair number of sources are implicitly acknowledged in lists of project management "key success factors". In Figure 4.6 the typical risks of a project are reported according to PLC stages.

Other more resource-intensive techniques exist but choosing between alternative identification techniques is a question of trading of different levels of analysis costs against effectiveness, a judgment that has to be made in relation to the importance of the uncertainty at all levels. It may require very different approaches in different areas.

The nature of the project success and performance is in fact multidimensional. In some circumstances the measurement of performance and success is very simple, more commonly, as for example in complex project such as ERP implementation, it does not happen. Project objectives might be viewed in terms of cost, time, or quality. Cost might be addressed in terms of capital cost or "whole life" cost and quality might be divided into technical specification, functionality, and appearance, each of which may be 'at risk' to different degrees (Chapman and Ward, 2003). So success and performance are primarily perceived in terms of dimensions that can be measured, such as time and cost or particular aspects of quality.

stage	*uncertainty management issues*
conceive the product	level of definition definition of appropriate performance objectives managing stakeholder expectations
design the product strategically	novelty of design and technology determining 'fixed' points in the design control of changes
plan the execution strategically	identifying and allowing for regulatory constraints concurrency of activities required capturing dependency relationships errors and omissions
allocate resources tactically	adequate accuracy of resource estimates estimating resources required defining responsibilities (number and scope of contracts) defining contractual terms and conditions selection of capable participants (tendering procedures and bid selection)
execute production	exercising adequate co-ordination and control determining the level and scope of control systems ensuring effective communication between participants provision of appropriate organizational arrangements ensuring effective leadership ensuring continuity in personnel and responsibilities responding effectively to sources that are realized
deliver the product	adequate testing adequate training managing stakeholder expectations obtaining licences to operate
review the process	capturing corporate knowledge learning key lessons understanding what success means
support the product	provision of appropriate organization arrangements identifying extent of liabilities managing stakeholder expectations

Figure 4.6: Sources of risk in each stage of the project life cycle (PLC), Source: (Chapman and Ward, 2003)

When a clear structure linking criteria exists, it is worth exploiting. When it does not, more complex approaches may be required, and this complexity requires great care, detailed analysis of objectives, including their decomposition in a structure directly related to project activities or design components, may be useful in some cases. A support could be offered for example by QFD and other techniques for functional analysis which can help for the clear understanding of the role of players and activities.

4.4.2 Identification tools and technique: literature review

A number of interesting techniques and tools supporting the identification of the issues exists in literature. Experts in their own domain have intuitive methods of recognizing a situation of risk. As such, the identification tools presented in this section are more general in nature and need a collaborative approach so that all aspects of the project are examined for risk situations. Checklist approaches, as well influence diagrams, cause-effects diagrams, event or fault trees, can be very effective in focusing the attention of managers but strongly caution against over-reliance on checklists and similar approaches to drive the identification of sources and responses. What follows is a review of potential techniques provided by Ahmed et al. (2007).

Checklists
Checklists are a very simple method of risk identification where pre-determined crucial points are examined for symptoms of potential risk situation (Webb, 1994; Duncan, 1996; Kumamoto and Henley, 1996; Cross, 2001). These are easy to use and usually evolve over time through contributions from various functional experts and collective experiences (Chapman and Ward, 1997; Ward, 1999).
There is no doubt that the checklist approach is a convenient and relatively simple way of focusing attention on project risk management and drive the next steps of risk assessment. However, it has a number of potentially serious shortcomings, as Chapman and Ward highlight:

1. important interdependencies are not readily highlighted, so that they must be considered later in the process;
2. a list, particularly a long one, provides limited guidance
3. sources not on the list are likely to be ignored;
4. the list of sources may be more appropriate for some projects than others;
5. individual sources may be described in insufficient detail

Influence diagrams
An influence diagram is a graphical representation of the structure of the decision context such as decisions, uncertain events, consequences and their interrelationships are graphically enumerated (Clemen, 1996; Clemen and Reilly, 2001). Owing to the visual display, cause-and-effects of risk situations are described and can be used for identifying risk situations before they eventuate.

Cause-and-effect diagrams
A cause-and-effect diagram or a fish bone diagram is a graphical representation of root causes of quality problems, where major causes of the ultimate problem are grouped and broken down into detailed sources (Russell and Taylor, 2000). Though, cause-and-effect diagrams are easy to use, they do not provide a foundation for further analysis such as relative importance of individual causes of a problem. Hence, cause-and-effect diagrams are used for deterministic problems in a very specific domain.

Failure mode and effect analysis
Failure mode and effect analysis (FMEA) provides a structure for determining causes, effects and relationships in a technical system. FMEA is used to determine failures and malfunctions through exploration of failure modes, consequences of a system component failure so that solutions for rectifying these problems can be visualized (Risk Management Standard AS/NZS 4360, 1999; Kumamoto and Henley, 1996; Cross, 2001).

Hazard and operability study
Hazard and operability study (HAZOP) is an extension of FMEA where check words are applied to process parameters in order to identify safety and operational problems (Cross, 2001; Lawley, 1974; Roach and Lees, 1981; Kletz, 1985). Check words create other perspectives to the overall process and focus attention on unforeseen areas in the process. In risk management for projects, HAZOP can be applied by considering project parameters such as strategy, budget and schedule to identify risk situations.

Fault trees
Fault tree analysis is a visual technique for breaking down failure in the system into source events (Kumamoto and Henley, 1996; Cross, 2001; Kletz, 1985; Dhillon, 1982; Birolini, 1993). Fault trees use event and gate symbols to structure cause and effect relationships of a failure. It is a simple technique and helps in reflecting on logical sequences that lead to failure. In project risk analysis, this technique is complicated by the large number of events and gates; however, it could be used in a smaller domain to analyze a particular failure.

Event tree
Event tree analysis is a graphical representation of potential consequences aris-

ing from a failure where possible consequences are generated and broken down from an initial event (Kumamoto and Henley, 1996; Cross, 2001). In project risk analysis its application is similar to fault tree analysis and works only on small zone of influence of potentially damaging consequence arising from a risk event.

4.4.3 Identifying risk factors in ERP projects

Our purpose in this part of the work is to provide mangers with guidelines for the risk identification phase; in particular a list of risk factors was identified in order to drive the identification process during the assessment of the project.
The identified factors are an useful guide for a more complete identification process which should be developed ad hoc for each ERP project. The output has to be considered as an input to the next indispensable steps of risk analysis and evaluation (in the quantification phases) in the general RMP.

The construction of checklists can be managed both top-down (form macro project risk classes to single risk factors) and bottom-up (from the effects on the project to the related causes, i.e. risk factors). The first approach can be assisted by guidelines which categorize risks in different project dimensions, such as project life cycle (plan and timetable), project players (both internal and external parties), project objectives and motives, resources, changes in processes and organization structure, which can stimulate and drive managers during the process.
The second approach instead, needs to start from an overall definition of what project success means in complex projects like the ERP introduction.

We mixed both the approaches. First of all, a number of key articles discussing and analyzing the ERP implementation process were collected and analyzed. The different approaches taken in the literature were compared from a risk management point of view to highlight the key risk factors and their impact on project success. Literature was further classified in order to address and analyze each risk factor and its relevance during the stages of the ERP project life cycle. Details about the literature review approach can be found in Chapter 3. The current state of the art in the ERP field is discussed (Aloini et al., 2007) presenting an extended literature review responding to the need of risk identification and focusing on the classification and the taxonomy of the principal risk factors and effects.

Then, effects were identified and risk factors analyzed starting from the Lyytinen and Hirschheim's (1987) classification of project failures, literature evidences and semi-structured interviews to practitioners, so that an overall framework, enumerating risk factors, effects and macro effects, was drawn.

Within this purpose, the first aim was to understand what project success or failure meant in this kind of project. In fact they depend on the definition of "success" (Wallace, 2004). Before investigating about the risk causes and effects, we have to define "success" for complex IT projects with a great organizational impact on the companies, referring in particular to ERP systems. The success rate in this kind of processes is relatively rare; a possible reason may be the different perception of the meaning of "success" in the mind of the people who evaluate the project performances (Agarwal and Rathod, 2006).
Lyytinen and Hirschheim (1987) organized IT project success classes differentiating between the need of matching specific planned objectives, meeting users expectations, achieving project budget and scheduled goals and obtaining users consensus. The project management literature overcome links project success criteria to general cost, time and quality of the product (Atkinson, 1999; Wit, 1988; Deane and Clark, 1997). Wateridge (1998) in a survey on the success of Information system/ Information technology projects, affirmed that players associate the project success to meeting their requirements; so according to the "users" the most important objective is their "happiness", while the project managers focus on budget and time scheduling. Linberg (1999) observed that the success for completed project is linked to the quality of the product while in case of a cancelled project, the success derives from its organizational learning. Agarwal and Rathod (2006) identify two different perspectives of success criteria: Internal perspective, linked to time, cost and scope that underline the utility of project monitoring and control processes and external perspective focused on customer satisfaction and quality of system. Procaccino and Verner (2006) contrast with the traditional definition of project success from the organizational perspective, whereby a project should deliver agreed upon functionality on time and within budget (Baccarini, 1999; Boehm, 1981; Jarrar et al., 2000; Jones, 1995). They find a general consensus among the project managers that success means to deliver a system that meets customer/user's requirements at works as intended through quality and personal achievement of people involved.

Adopting the Lyytinen and Hirschheim's (1987) definition of "failure" and "success" of IT projects, which suggested a first classification of IT failure, we identified 10 main classes of risk effect on a ERP introduction project. Macro classes from Lyytinen and Hirschheim (1987), are:

(a) *Process failure*, when an IT project is not completed within time and budget.

(b) *Expectation failure*, where IT systems do not match the user expectations.

(c) *Interaction failure*, when user attitudes towards IT are negative.

(d) *Correspondence failure*, where there is not a match between IT systems and the specific planned objectives.

This classification leads to suggest 10 risk effects and 19 risk factors usually happening in ERP projects, as shown in Figure 4.7.

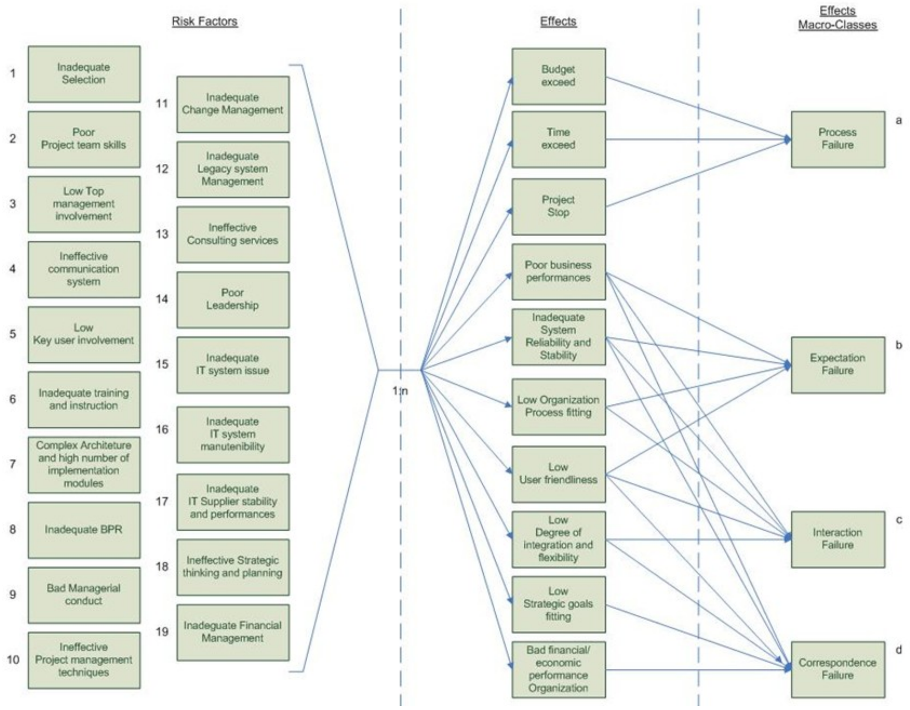


Figure 4.7: Risk factors, effects and effects macro-classes, Source: (Aloini et al., 2007)

4.4.4 Risk effects

As for the effects, the 10 classes mainly concern: budged exceed, time exceed, project stop, poor business performances, inadequate system reliability and stability, low organizational process fitting, low user friendliness, low degree of integration and flexibility, low strategic goals fitting and bad financial/economic performances. A brief description is provided as follows.

E1. Budget exceed

A successful ERP implementation is often related to the respect of planned budget because of the importance given by top management to the economic parameters. However, the allocated budget for the implementation projects often significantly exceeds the estimated amounts. A Standish Groupfound research found that over 90% of ERP implementations exceed their budget (Martin, 1998). ERP installations can exceed 40% or more of their budgets when checks on costs are lacking (HsiuJu and Chwen, 2004).
The reason of many overcame budgets is the underestimation of some important aspects like BPR process, change management and communication; another reason is the poor skills of the top management about these type of projects.

E2. Time exceed

The implementation of the ERP systems can take from six months to several years. In some cases, the implementation time is extended indefinitely. This fact has negative consequences for both the companies and the morale of their employees (Tchokogué et Al. 2005).
Wrong estimations increase the implementation cost because of an increase in the resources. Mistakes are made because of wrong expectations due to a lack of knowledge about the site environment and the own project issue (Tanaashi Group, 2008). Compensation and incentives to successfully implement the system on time (Wee, 2000) should be given to the project team.

E3. Project stop

A project stop occurs when a complete termination of all the aspects of the project takes place. This event rarely happens. Indeed, a CEO who decides on an ERP implementation is deciding to devote huge resources to the project. Once the initial decision has been made and the initial resources are allocated, there is not easy retreat. Many companies both over-spent their budget and exceeded their time allocation, but once committed they felt impelled to continue (Parr and Shanks, 2000).

E4. Poor business performance

ERP systems are complex and expensive, and the decision to install an ERP system needs a choice of mechanisms for determining, once implemented, whether it is successful or not. Although it may be more desirable to measure the system success in terms of monetary costs and benefits, such measures are not often possible because of the difficulty of isolating the effect of the information system from the high number of environmental variables that may influence the organizational performance (DeLone and McLean, 1992).
The potential benefits of an ERP system include productivity and quality improvement in key areas, such as product reliability, customer service, and knowledge management. As a result, ERP systems are expected to enhance the market value and the firm's performance through efficiency and effectiveness gains

(Hunton et Al., 2003).
An example can be the inventory reduction, headcount savings, and reduced lead times through on-time delivery (Summer, M., 2000).

E5. Inadequate system reliability and stability
System reliability is the consistency and dependency of the output information provided by the ERP system. The data outputs must be coherent and complete (Wu and Wang, 2007).
Modifying the software to fit business processes decreases the system stability; therefore many system errors could occur (Buonanno et Al., 2004). To resolve these problems many actions of emergency maintenance must be done during the system life cycle. Another issue is the use of the system modules: often one or more implemented modules are not completely used in all own functions. This is due to a lack of system knowledge and to a wrong choice of implemented modules. A further consequence of this lack is the use of two modules for the same business function.

E6. Low organization process fitting
Enterprise systems are designed to fit the needs of different organization, so they are built to support generic business processes that may differ quite substantially from the way any particular organization does business. A wrong system customization leads to lack in fitting organization requirements. This lack is evinced by a misalignment between the firm's own procedures and the ones requested by the system (Muscatello, 2003).
Furthermore, the ERP procedures could require human resources with new needed skills (Wu et Al., 2008).

E7. Low user friendliness
Many projects managers consider the implementation successful if the new system meets the customer/user's requirements at work (resulting in improved quality and personal achievement). (Aloini et Al., 2007).
Five main aspects determine whether a system is user friendliness (Shneiderman, 1980):

- *Learnability.* Learnability of a method will be a strong determinant of take-up and use in practice (Blandford et Al., 2008). Learnability is determinant for end-user satisfaction with ERP systems, leading to a successful system use (Calisir, 2004);

- *Efficiency.* Efficiency indicates how fast experienced users can accomplish certain tasks once they have learned the design. The system should be efficient to use, therefore a high level of productivity is obtainable (Zuehlke and Thiels, 2008);

- *Memorability.* It is a measure of how quickly and accurately users can remember how to use a software they have already utilized before. To have a friendly system user, it would have a design that enables users to quickly recall what they have learned and easily make the procedures the next time without having to learn everything all over again. Memorability and learnability are closely linked (Nielsen, 1996);

- *Errors.* Fewer errors indicate that it is difficult for users to cause error, and that even if errors occur, they are easily recovered. It is crucial to minimize errors in a system. Confusing utilities and wrong data entry should be revaluated making it difficult for users to make a mistake, and if an error does occur, the site design should allow the users to recover the error without assistance, as much as possible (Ahmed, 2008);

- *Satisfaction.* From the end user perspective, a successful system may be the one that improves the user job performance, without inflicting undue annoyance (Chien and Tsaur, 2007).

E8. Low degree of integration and flexibility
As an effect of ERP implementation, a low degree of integration and flexibility is often detectable. The ERP integration affects both old IT system and external software (such as Supply Chain Management software, Business Intelligence software, partner's software and other). (Themistocleous et Al., 2001).
Enterprise systems have many embedded business practices, the details of which may vary from vendor to vendor. Organizations must then accept the inflexibility of these imposed business practices (Ngai et Al., 2008), but the evolving business needs of the organization requires an ongoing maintenance of the ERP system so that it is very important that the system allows easy upgrades (Nah and Lau, 2001).

E9. Low strategic goals fitting
The project goals, when they are finally achieved, make up part of the overall effects of the project. Thus, they can be treated as project effects which are intended to be achieved. Hence, the project goals can be divided according to the same rules as the project effects. The broad range of project effects can be divided into "hard returns" which contain tangible benefits from ERP implementation and into the group of intangible benefits.
Major strategic benefits such as improved response to customer demands, improved and streamlined internal and external communication, and improved customer supplier relationships should be factored into the expected benefits (Muscatello and Parente, 2008).
Other organizational benefits are related to the system enabling business learning and staff empowerment (Velcu, 2007). Selecting the wrong software may

mean a commitment to architecture and applications that do not fit the organization's strategic goals. (Somer and Nelson, 2001).

E10. Bad financial/economic performance organization
Concerning economic/financial performance, Hayes et al. (2001) indicate that participants in the market capitals believe that the adoption of an ERP must enhance the future performance of firms; however the range of potential returns remains unknown (Berchet and Habchi, 2005).
The financial benefits come from reduced costs, increased revenues and improved market value (Chand, 2005). Economic benefits come from inventory reduction, revenue increase, and cost reduction. The economic performances, that can be measured, illustrate a concrete profit to be gained from system implementation expressed by adequate indicators (Soja, 2008). Many firms could not often make quantitative assessments of the ERP systems impact on their firms financial performance. One reason is that there are other structural changes occurring at the same time with the system implementation, making it difficult to evaluate the direct contribution of the ERP system to financial performance. However, indirect financial impacts either at the cost or income level are expected (Velcu, 2007).

4.4.5 ERP Risk Factors

As for the risk factors, in Figure 4.8 a list of potential elements is reported according to the revealed interest in literature. An accurate description of each risk factor and related operational indicator is then provided.

R1. Inadequate selection.
Implementation of an incorrect project could cause the failure or weaken it sufficiently to affect the company's performance (Hicks and Stecke, 1995; Wilson et Al., 1994). The better the ERP selection process is, the greater the chance of success is (Travis, 1999).
The potential to err in a major system selection and implementation is high, while the likelihood of an error-free selection and implementation is less likely. The goal, therefore, is to minimize decision and application risk by applying a structured method to select both the vendor and the system integrator (Travis, 1999). Several methods have been proposed for selecting a suitable ERP project (Chen and Gorla, 1998; Teltumbde, 2000; Santhanam and Kyparisis, 1995). Ptak (2000) proposed a scoring method, Teltumbde (2000) suggested 10 criteria and the use of the ATP method. Santhanam and Kyparisis (1995) used a nonlinear programming model to consider interdependencies of criteria in the IS selection process. Lee and Kim (2001) combined the analytic network process and a 0-1 goal-programming model, other models have used fuzzy multiple-

ID	Risk factor	Frequency
R1	Inadequate selection of the ERP package	✓✓✓
R2	Poor project team skills	✓✓
R3	Low commitment of top management	✓✓
R4	Ineffective communication system	✓✓
R5	Low involvement of the key users	✓✓
R6	Inadequate training	✓✓
R7	Complex ERP system architecture	✓
R8	Inadequate Business Process Reengineering	✓✓
R9	Bad managerial conduction	✓✓
R10	Ineffective project management techniques	✓✓
R11	Inadequate change management	✓✓
R12	Inadequate legacy system management	✓
R13	Ineffective consulting services	✓
R14	Poor leadership	✓
R15	Inadequate performance of the IT system	✓✓
R16	Inadequate IT system maintainability	✓
R17	Inadequate stability and performances of the ERP vendor	✓
R18	Ineffective strategic thinking and planning	✓✓✓
R19	Inadequate financial management	✓

Note: The frequency rate is related to the scientific literature.

Figure 4.8: Risk factors, effects and effects macro-classes, Source: (Aloini et al., 2007)

criteria decision making (Wei and Wang, 2004).
What is important for all these methods is to create a proper team, formed of experts, which establishes selection and evaluation criteria prior to contacting any vendor or looking at ERP solutions. This is critical for the determination of the right fit (Verville et al., 2005).

R2. Poor Project team skills
It is necessary to form a skill-balanced project team having both internal and external experts, managerial competencies, deep knowledge of the processes, and IT skills. This project team business and technological competence will contribute to the ERP implementation success or failure (Mendel, 1999; Trepper, 1999). The skills and knowledge of the project team are important in providing expertise in areas where the team members lack of knowledge (Barki et Al., 1993; Clemons, 1998). As a project team usually disbands after installation, its role is significant in the earlier stages and less important in the post installation phase. Some relevant elements are: key player involvement, true skills and competencies mix, ability in completing the assigned work, motivation, quality of ERP professional, past accomplishments, reputation and flexibility.
Companies should apply a structured process to detect whether the project team requires training and should undertake proper actions to fill the knowledge gap. Finally, tasks and objectives of the project must be clearly defined and fully comprehended by the team members (Somers and Nelson, 2001).

R3. Low Top Management Involvement
Participation, direct top management support and commitment, are expected to influence the success of ERP adoption. Sustained management support is essential throughout the project (Esteves et Al., 2002; Nah et Al., 2001). Microsoft experience underlines the importance of top management involvement in planning and implementing ERP system (Deloitte, 2000).

The commitment of top management is predictive of the ERP implementation project success, especially early in its life (Somers and Nelson, 2001). Therefore the top management should frequently interact with the project team and use proper communication methods to exchange vital information.
The roles of top management in IT implementations include developing an understating of the capabilities and limitations of the ERP, establishing reasonable goals for the system, exhibiting strong commitment to the successful introduction of ERP, and communicating the corporate IT strategy to all employees (Somers and Nelson, 2001).
Research on project failures shows that project cancellations occur when senior management delegates progress monitoring and decisions at critical junctures of the project to technical experts (Somers and Nelson, 2001). For this reason, it is vital to understand which are the top management responsibilities for the project: these may vary from a continuous control over each phase to a complete

delegate to the project team.
Lastly, the success of technological innovations has often been linked to the presence of a champion performing the crucial functions of change management leadership, facilitation and marketing the project to the users. Project champions should own the role of change champion for the life of the project and understand the technology as well as the business and organizational context. By appointing an executive individual level with extensive knowledge of the organization operational processes, senior management can monitor the ERP system implementation, because the champion has direct responsibility and held accountable for the project outcome (Somers and Nelson, 2001). It is then important to investigate if the company adopts such a champion, which function he belongs to and which responsibilities he has for the project.

R4. Ineffective Communication System
Communication is the oil that keeps everything working properly, since it provides an appropriate link and success to data for all the actors (Schwalbe, 2000). It is essential not only within the project team, but also between the team and the rest of the organization, and with the client (Somers and Nelson, 2001). For this reason, it is critical to investigate which are the subjects among which communication takes place. These subjects can be different throughout the project life cycle. It is therefore useful to contextualize them in each phase of the implementation process.
Other key aspects to investigate are the means used to communicate (mail, reports, conferences) and the type of the information exchanged, which can vary from mere project data to information to promote the project utility.

R5. Low key users involvement
Key users participation is very important, since the very beginning of the project, as Somers and Nelson show in their study (2004). User involvement is important in meeting expectations. Key users should be convinced of the system utility; moreover they must be confident and expert so that they can aid future users in training sessions. User commitment and a project champion are useful in the early stages of the project and during the implementation phase.
Key users participation and key users buy-in can be strongly related. If key users participate, they gain a better understating of the issues and technologies, and then they can make up their mind and feel part of the acquisition process and, in return, if they see the ERP as important for the organization, their participation can increase (Verville et al., 2005). It is therefore vital to determine in which phase of the project life cycle key users will be involved.
It is also important to know which competences they have and if they are active players in the knowledge diffusion process, which can be both formal and informal; moreover they must be confident and expert so that they can aid future users in training sessions.

R6. Inadequate training and instruction

The role of training to facilitate software implementation is well documented (Nelson and Cheney, 1987; Santhanam and Sein, 1994). Frequently the lack of user training and the failure understanding of how enterprise applications change business processes is posited as responsible for many ERP implementation problems (Crowley, 1999; Wilder and Davis, 1998).

Given the complexity of ERP systems, training is essential through the acceptance stages. It takes on a moderately important role during the latter stages, when training on a continuous basis is required to meet the changing needs of business and enhance employee skills (Somers and Nelson, 2004).

It is important that a proper analysis of the training needs is run, in order to identify any gap between the skills the process or the business needs and those key users have. This analysis involves gathering information to identify the areas where employees could improve their performance. Surveys, company meetings or inspections can be used to obtain this information. An analysis of training needs can also help to clarify the objectives of the training. A key aspect to consider is that people learn in different ways. Matching the proper training method to the employees' learning preferences can help in speeding up their learning and reduce the training costs. Different types of training rely on different learning methods, which can vary from e-learning courses to evening classes. Computer-based training via Intranets has been found to facilitate ERP implementations (Mahapatra and Lai, 1998).

Evaluation of the effectiveness of training is then a crucial step: not only it builds a culture of continuous professional development but it also gives the opportunity to decide whether the training has been a success and whether more advanced, further training is needed. If this evaluating process is not run, there's a high risk that key users feel the training as useless or a mere formality and they can loose the proper motivation.

It is lastly important to gather information about the extent of the resources dedicated to the training process, both from the cost and the time point of view. In fact it is frequent to find examples in literature of failing ERP implementation due to a lack of invested resources to instruct the key users. In some cases training costs are not budgeted and there are issues related to the findings. In other cases, because of other processes being late, the planned training time is not respected and it is reduced. The consequences of these problems can bring the employees to think that the training process is not considered important by the top management. Therefore the process itself looses credibility (Zhe et al., 2005).

R7. Complex architecture

While successful ERP implementation is often determined by business and organization changes, architecture choices deserve thorough consideration, since the system procurement phase. Architectural considerations are important during the initiation and adoption phases to obviate the need of additional soft-

ware (such as data warehousing); if not adequately planned, personalization and adaptation of tools may cause troubles (Markus et Al., 2000; Spangenberg, 1999).
One of the first aspects to investigate is the technical size and the organizational complexity of the ERP project. Specifically, the project size is measured in terms of the number of modules and submodules that are implemented, while complexity can be defined as the organizational scope of the project in terms of users involved and overall company size. Findings from studies conducted on ERP projects indicate that implementation effort not only grows with the number of modules and submodules that are selected for implementation, but also that ERP systems require increasing resource to be invested in larger companies and for higher number of users involved. This fact shows that both the technical size and the organizational complexity of projects are relevant drivers of implementation efforts (Francalanci, 2001).
Another key architectural consideration revolves around centralization or decentralization. When choosing one of the two solutions, few points should be taken into consideration: connectivity, scalability, availability, reliability, performance, manageability, flexibility and coherence. For centralized architecture, manageability and coherence are the greatest advantages. On the other hand, decentralized architecture offers highly scalable, available and reliable solutions. It is also important to evaluate the compatibility of existing tools within the enterprise with the ERP system and the necessity of integration with other software (i.e. SCM, CRM) (Somers and Nelson, 2001).
Lastly, the customization extent is an aspect to accurately investigate. Numerous studies of the critical success factors for ERP implementation success, in fact, conclude that a preferable way to implement ERP software is without software modification. However for reasons of misalignment and strategic alignment, customizations of enterprise systems are often necessary. These software modifications and customizations are needed for the ERP system to meet the needs of the organization. As customizations are built as part of a development effort, many times during an implementation time frame customizations may have minor bugs that the vendor supplied ERP software would not have. These bugs can cause delays in development. Based on this it can be concluded that in general less customization means shorter implementation times. Moreover, customization of an ERP has maintenance and upgrade impacts: each time a change is required to the system, the effect of the change on the customization has to be assessed by the organization and software vendors do not usually support customization in future versions of the software. The added complexity required by customization of ERP systems, then, reduces the system agility and flexibility (Davis, 2005).

R8. Inadequate Business Process Reengineering
Packaged software is often incompatible with the organization needs and business processes (Lucas et Al., 1988). The consequence is a software modification,

which is expensive and heavily costs in maintenance, or a restructuring of the organization business processes to fit the software (Hammer, 1999; Hammer and Champy, 1993). According to IBM, (Method Blue), a deep analysis of process business value and performances is necessary to prioritize activities to be supported by ERP (IBM, 2000).
To neglect business processes redesign is a risk in ERP project, ERP implementation and BPR activities.
An in depth BPR study, which analyses the business values and the performance of the processes, has to be done before starting the ERP implementation project (Somers and Nelson, 2001). Business Process Reengineering in fact brings out deficiencies of the existing system and attempts to maximize productivity through restructuring and reorganizing processes as well as human resources, divisions and departments in the organization. It allows prioritizing the areas to work on. It is therefore important to investigate if the company runs this preventive analysis.
Business Process Reengineering plays a particularly decisive role in the early stages of the implementation, from initiation through adaptation; it is moderately important in the acceptance stage, and tends to be less important once the technology becomes routine and infused (Somers and Nelson, 2004). Based on this, estimating when this process began in the ERP project life cycle, seems to be extremely relevant.
The extent of the dedicated resources and the roles involved in the process are also of vital importance to examine. Sufficient resources, both from the point of view of money and persons invested, are crucial: resource requirements need to be determined early in the project to avoid dooming project effects (Somers and Nelson, 2004). Moreover, members belonging to a wide number of different functions should form the BPR team, in order to assess a cross-company participation.
Lastly, an important activity in ERP projects is the modelling of current and future business processes. These models facilitate the exchange of information between the project members and they are the means for documenting and analyzing the structures and the processes of the organization (Gulla and Brasethvik, 2002). Different business models are proposed in literature. What seems significant is to determine whether the company uses any of them to support the BPR.

R9. Bad managerial conduct
Users respond to ERP implementation based on the managerial conduct of the project. In the same way, an effective project implementation requires a well articulated business vision that establishes the goals and the business model behind the project (Ginzberg, 1981).
Good management also improves user expectations (Hoffer, 1999) and helps in planning the training of people in the use of the finished system (Holland and Light, 1999).

A literature review indicates three areas where a consistent relationship with success or failure has been demonstrated: management support of the project development; users and team members involvement in the development efforts; conduct of the implementation process itself (Ginzberg, 1981). It is therefore important to investigate at which extent these elements were granted in the project development.
Another aspect, which is likely to be important in determining a user's respond to the ERP implementation, is the clearness of the reasons for developing the system. Effective project implementation requires a well articulated business vision that establishes the goals and the business model behind the project (Hoffer et Al., 1999). Clear goals and objectives (Ang et Al., 1995) should indicate the general directions of the project (Cleland and King, 1983) and remain clear through all its stages.
Lastly, the management must be committed: managers have to be willing to spend significant amount of time overseeing the implementation service.

R10. Ineffective Project Management Techniques
The use of inadequate project management techniques significantly affects ERP project success. Project management activities span the first four stages of the ERP life cycle from initiating the project to its closing (Somers and Nelson, 2003).
Project planning and control are a function of the project characteristics, including its size, experience with the technology, and the stability and experience of the IT development group (Applegate et Al., 1999). Risk management in particular is a vital procedure of advanced (goal-directed) project management (Anderson et Al., 1995; Cleland and Ireland, 2000). Some ERP vendors, such as SAP and Baan, provide methodologies and applications to help in conducting a successful risk management. These tools can be used to drive a change management (SAP White paper, 2003); the system calculates the risks and provides mitigation strategies for the project manager. But SAP and Baan, along with other ERP vendors, designed these applications for their own systems. Other more generic methodologies were deployed by Zafiropoulos et al. (2005).
Risk in projects can be defined as the chance of an event occurring that is likely to have a negative impact on project objectives. Managing risks in IT projects is a process of understanding and responding to factors that may lead to a failure in the confidentiality, integrity or availability of an information system (Chapman and Ward, 2003).
The treatment of risk involves the determination of the most appropriate strategies for dealing with the risk occurrence. In literature numerous examples of failed projects due to a lack of attention to the project risk can be found. For this reason it is important to determine whether the company runs a risk analysis, using any of the available tools (company tools, vendor's, consultants', etc). It is then important to investigate whether the traditional tasks of project management are accomplished, as the formal plan of the project phases (from both

time and cost points of view) and of the project budget.
Lastly, it seems vital to determine whether real time controls of the project are ensured: the monitoring and evaluation of performance is in fact, as literature review shows, a critical factor for the success of ERP systems. Implementation progress must be regularly measured for a more efficient and effective control. Through monitoring and feedbacking from users, the performance of the ERP system can be reviewed and evaluated to see whether it is achieving business goals and objectives (Ngai et al., 2008). It is important that not only they are run throughout the entire project, but also during the transitory and the post go-live phases.

R11. Change Management
An ERP system is not simple and its implementation is not purely technological. It modifies the way that the organization operates. Underestimating the efforts involved in change management, especially in the early stages of the project (Cooke and Peterson, 1998; Stoddard and Jarvenpaa, 1995), may result in project failure (Appleton, 1997; Stebel, 1992).
The first step to effectively manage the change introduced by the ERP is to early identify and evaluate the attitudes of individual users and influential groups (Aladwani, 2001). On the basis of this, it is relevant to determine whether a structured process of analysis of the users attitudes is run. This process can, in fact, offer a good starting point in comprehending the sources of employees' resistance to the ERP system.
A major strategy to implement for change management is first of all to affect the cognitive component of users attitudes: this goal can be achieved using proper communication means. An effective communication tactic is, for example, to inform potential users of the benefits of ERP. Knowledge about what a system can deliver to the organization and its worker can build anticipation for the system. Another communication tactic is to give a general description of how the implemented ERP system will work: users are reluctant to welcome the new system if they do not know how it works (Aladwani, 2001). The second part in the change management strategy is to get the endorsement and support of well-known individuals and opinion leaders. Involving group leaders in the effective participation to the implementation process, in fact, ensures their valuable commitment. Because of their commitment, leaders of the group can then convince their colleagues that ERP system is for their benefit (Aladwani, 2001).
It is then important to monitor and evaluate the change management process. It is imperative that top management makes sure employees' resistance to ERP is under control. Based on the status evaluation phase outcome, top management can take appropriate actions (Aladwani, 2001).
Finally, it is vital to properly manage users expectations. Successfully managing user expectations has been found to be related to a successful system implementation (Somers and Nelson, 2001). The expectations provided must be absolutely realistic: if users hold unrealistic expectations about the project

and if these expectations are not met, then users turn out to be ultimately dissatisfied. Based on various case studies, it has been found that users who hold unrealistic expectations about a system prior to its implementation will be less satisfied by the system than will users whose expectations are realistic (Ginzberg, 1981). Management of expectations is therefore an important factor, which has a deep impact through all stages of the implementation life (Somers and Nelson, 2001).

R12. Inadequate Legacy system

ERP systems require people to work within the system and not around it (Umble et Al., 2003); therefore, old information systems should be removed. The transition phase is a critical period. Holland and Light stressed the need of a carefully managed view of legacy systems. Adequate treatment strategies ("migration" or "wrapping") have to be considered depending on specific process and technological business needs.

To cope with the legacy system, and to be facilitated in making decisions, a company should first of all explore the purpose and the objectives of the new system that has to be implemented. Then, as a second step, a technical solution has to be determined, according to these purposes and objectives and based on the analysis of the characteristic of the legacy system and of the processes (Bennett et Al., 1999).

Another important aspect to investigate is how the company copes with the legacy system. In literature three different categories of solutions are proposed: re-development, wrapping and migration. Each of them has its own advantages and disadvantages that can impact on the ERP implementation project (Bisbal et Al., 1999).

Moreover, when a legacy system migration project is faced, it's vital to deeply comprehend what the old system used to do. Various researches show that understanding the documentation and the logic of the programs occupies about 50% of the maintenance programmers time. In many cases, even the original developers find it hard to understand their own code after a period of time. As a consequence, migration tasks tend to be expensive, complex and error prone. It is therefore significant to determine whether the legacy system is deeply comprehended, the legacy system documentation is still available and the legacy system experts are still among the company employees when the ERP implementation project starts (Wu et Al., 2005).

The last issue to consider is how the transition from the old to the new system is managed. It is critical to analyse whether the transitory period has been gradual, whether there has been a period during which the new and the old system co-lived and whether has been necessary to use the old system after the go-live, for application meant to be implemented by the ERP.

R13. Consulting service

The use of outside consultants is common for ERP projects (Dolmetsch et Al.,

1998). Their experience, specific knowledge of the modules, technical and organizational acumen and attitude with similar software applications (Piturro, 1999) and in managing the implementation (Thong et Al., 1994) plays a major role in diminishing risks.
One aspect to investigate is the phase of the project life cycle in which the consultants are involved. Consultants in fact may be drawn in various stages of the implementation: performing requirements analysis, recommending a suitable solution, and managing the implementation. Consultants play an essential role that diminishes just during the latter stages of the implementation when the system is operational (Somers and Nelson, 2004).
A consultant may have considerable experience in specific industries or in comprehensive knowledge about certain modules or both. Accordingly, an industry expert may be better to determine which suite will best work for a given company, while an expert in a particular module may know more about how to get that software up and running. Many are more familiar with one vendor's products than with others'. When choosing a consultant is then necessary to check if the consultant is well versed in the ERP appropriate to the business (Piturro, 1999).
Consultants can then have different responsibilities over the project: they can assume different roles in the project and their performance can be evaluated in various way (goals achievement, time deadline respect, budget respect etc). Nevertheless the company should keep control and accept full responsibility for all the phases of the project (Cooke and Peterson, 1998).
Lastly it is vital to comprehend the level of integration between consultants and employees: numerous examples of failing ERP system implementation projects can be found in literature, due to not profitable collaborations. In some cases, for example, employees felt it was not appropriate to criticize the project, as the consultants tended to minimize problems (Scott and Vessey, 2002).

R14. Poor Leadership

Sarker and Lee (2000) examined the role of key social enablers for successful ERP adoption: strong and committed leadership, open and honest communication, and a balanced and empowered implementation team. They found that all the three enablers may contribute to ERP success but only the first could be considered necessary. If project managers and steering committee do not commit to solve problems and provide direction to the project team, the risk of failure becomes greater.
The project manager must have sufficient strength and authority over all the stakeholders in the process, so that he or she can solve political problems among stakeholders that lead to unproductive delays. He must therefore choose a proper leadership style (Sarker and Lee, 2000).
Moreover the project manager must be credible: more than just possessing technical knowledge of the software being implemented, the PM must have good business knowledge so that he can cope with any needs and requirements (Sarker

and Lee, 2000).

R15. IT system issue

It is important to investigate whether the company adopts a structured process to define the business objectives and specific functional requirements of the system (Wayne, 2007). Related to this, it is very important to identify the function to which the employees involved in the selection belong to: it is in fact significant to determine the extent of their IT knowledge.

Technical software capabilities must be studied before implementation matters and their impact on business processes must be assessed; these kinds of questions are pivotal for ERP success. The essential technical aspects are: all necessary functionality, user friendliness, portability, scalability, modularity, versioning management, simple upgradeability, flexibility, security, presence of a complete guide, a manual procedure to help users, and data accuracy. Because of the integrated nature of ERP software, if some of these elements are absent or ineffective there can be a negative effects throughout the enterprise.

Another aspect to analyse is whether the company runs periodical reviews of the software performance, to check if it is aligned with the planned objectives.

Lastly, the ERP system should be scalable: the adopted solution in fact should grow with the company.

R16. IT system maintainability

ERP maintenance and upgrade activities are receiving much attention in ERP-using organizations. Annual maintenance costs approximate 25% of initial ERP implementation costs (Glass and Vessey, 1999) and upgrade costs as much as 25-33% of the initial ERP implementation (Carlino et Al., 2000). Therefore ERP maintenance and upgrade activities are receiving much attention in ERP-using organizations. An effective planning for maintenance activities is needed. Part of these activities would concern to systematic and consistent recording of the user-enhancements and system modification details (Carney et Al., 2000). This activity may seem excessive and a distraction in short-term but can help to contain upgrade costs and to identify the pattern of ongoing maintenance costs in the long run.

Management, control and execution of ERP maintenance and upgrade are not purely internal issues nor they are entirely driven by internal users and internal IT-staff. The ERP software vendor has significant influence on ERP-client maintenance and upgrade activities. The vendor plays an important role in maintenance support, and thus maintenance management and upgrade decisions and processes have become more complex as a result. Therefore for managing this risk factor, the firm have to determine the vendor maintenance support including: fixing the contractual issue with the vendor; and identifying the types of maintenance support provided by the vendor, and how and where to get them. The objectives have to contain total maintenance costs and establish long-term business partner relationships with the software vendor (Gable et Al., 2000).

R17. IT supplier stability
ERP systems require continuous investments in new modules and upgrades to add functionality, achieve a better fit between business and system etc. Vendors' support is therefore an important risk factor (AMR research, 2002; Kendall and Kendall, 1999).
Vendor/customer partnerships are vitally important to successful ERP projects. Research has shown that a better fit between the software vendor and the user organization is positively associated with packaged software implementation success and organizations should attempt to maximize their compatibility with their vendors. The relationship between the software buyers and the vendors should be strategic in nature with the ERP provider enhancing an organization competitiveness and efficiency (Somers and Nelson, 2001). Numerous case studies identified supplier partnering as an enabling critical factor necessary for ERP success. Based on this, it seems significant to investigate the relationship between the company and the vendor.
Another important aspect to consider is that an ERP system is a way of life and may be a lifelong commitment for companies. There will always be new modules and versions to install and better fits to be achieved between business and systems. Consequently, vendor support represents an important factor with any packaged software, including extended technical assistance, emergency maintenance, updates, and special user training (Somers and Nelson, 2001).

R18. Strategic thinking and planning
Organization must decide why an ERP system should be implemented and what critical business goals the system will address (Umble and Umble, 2002). Hence, identifying business goals, determining the strategic business issues and strategic requirement identification are essential elements of the ERP planning process.
Alignment of IT strategy with the organization's business strategy must be enabled by senior executive support. If an organization tries to install a system without establishing a clear vision, every effort can turn into a disaster (Davenport, 1998).
Moreover, considering an ERP far-reaching strategic and organizational implications, a company shouldn't make decisions about a system based on only technical criteria.
Davenport in his paper "putting the enterprise in the enterprise system" (Davenport, 1998) states that, having studied more than 50 businesses with ERP, it seems clear that the companies deriving the greatest benefits from their systems are those that, from the beginning, viewed them primarily in strategic and organizational terms. These companies didn't label the ERP project simply as a technology initiative. Instead, they viewed it as an opportunity to take a look at the company's strategy and organization. Therefore, it seems important to comprehend whether the company considered all the opportunities the ERP project could offer.
A possible danger in the ERP implementation is that a company could adopt

processes that are indistinguishable from those of its competitors. An ERP system in fact, by its very nature, imposes its own logic on a company's strategy, organization, and culture. It pushes a company toward full integration even when a certain degree of business unit segregation may be in its best interests. And it pushes a company toward generic processes even when customized processes may be a source of competitive advantage. If a company rushes to install an ERP without first having a clear understanding of the business implication, the integration itself can cause great problems (Davenport, 1998).
Lastly, it seems relevant to investigate whether the company set outcome objectives for the ERP implementation and which kind of objectives (financial, productivity, reliability).

R19. Financial management
Although ERP system suppliers have increased their focus on SMEs, current systems are still expensive. Chen (2001) stated that economic and financial strategic justifications for an ERP project prior to installation were also necessary, because a wrong global costs analysis might impact the ERP adoption and the failure of system implementation projects could cause bankruptcy (Markus and Tanis, 2000).
It is also important not only to understand the factors influencing success, but also to have an approach for measuring and tracking an ERP project success. ERP implementation projects are very different from most other types of projects. The key difference is that there are no precise industry standards, legislated codes or published performance benchmarks against which success can be quantitatively measured. This lack of benchmarks and measurement techniques has created an environment in which ERP project declare a success or a failure based on arbitrary criteria, individual perception or subjective factors. It is therefore important to analyse which investment evaluation techniques the company uses.
It's then vital for a company to clearly determine the tangible and intangible benefits linked to the ERP implementation, as well the direct and indirect costs. Many companies, in fact, proceed without sufficient analysis of costs and benefits. This is because, if costs are generally quantifiable, major strategic benefits, which are all extremely critical for the survival and growth of many firms, cannot be readily converted to cash value (Chen, 2001). Measurement should entail considerations on the business transformation an ERP allows. In fact, only the change in business models, the changes to a process-focused business organization, and the changes in relationships and processes with customers and suppliers have proven to provide a significant business value. Economic justification for an ERP project prior to installation are necessary not only because of the enormous investment and risk involved but also because the justification process helps in identifying all the potential benefits that can be accrued with the ERP implementation, which after become yardstick for the performance evaluation (Chen, 2001).

The top ten risk factors, as researched in scientific literature are shown in the following figure (Figure 4.9).

Risk ID	Risk factor	Total number of recurrences	Frequency Rate	Manifestation Life cycle phase
R1	Inadequate ERP selection	36	✓✓✓	Concept/Selection
R18	Ineffective strategic thinking and planning Strategic	31	✓✓✓	Concept/Strategic Planning
R10	Ineffective project management techniques	27	✓✓	Implementation/Deployment
R9	Bad managerial conduction	24	✓✓	Concept/Strategic Planning
R11	Inadequate change management	24	✓✓	Implementation/Integration
R6	Inadequate training and instruction	24	✓✓	Implementation/Integration
R2	Poor project team skills	23	✓✓	Concept/Selection
R8	Inadequate BPR	22	✓✓	Concept/Strategic Planning
R3	Low top management involvement	20	✓✓	Concept/Strategic Planning
R5	Low key user involvement	19	✓✓	Concept/Selection

Figure 4.9: Top ten risk factors

4.5 Risk Quantification

Risk Quantification aims to evaluate the risk level of the identified factors to synthesize a ranking which could drive and prioritize the selection of the treatment strategies. It involves the evaluating risk and the risk interaction (PMI book, 2000) to assess the range of possible project outcomes. In this approach, the definition of risk quantification entails two essential components: uncertainty (i.e the probability of occurrence of a risk factor, U - both the unconditioned and conditioned probability, the second one is due to a risk factor interaction) and exposure (i.e the impact or effect of the occurrence of a risk factor on the project, E).

$$R_i \approx U_i * E_i \tag{4.1}$$

Risk assessment can be complicated by a number of factors, including the following issues:

- Opportunities and threats can interact
- A single risk factor can cause multiple effects
- Opportunities for one stakeholder can be threats to another
- The mathematical techniques used can create false impression of precision and reliability

As it is made clear from the above analysis, the specification of the risk level is neither simple nor unique. Impact and likelihood may be expressed or combined differently, according to the type of risk and the scope and objective of the Risk Management process. Moreover the quantification methods can considerably differ.
The Australian Standard distinguishes the approach to risk quantification in: qualitative, semi-quantitative and quantitative. We introduced comments about the different approaches in chapter 2; now, we discuss them referring to the IS context.

(a) *Qualitative* which uses words to describe the magnitude of potential consequences and the likelihood those consequences will occur. Qualitative risk assess assumes that there is already a high degree of uncertainty in the likelihood and impact values so it defines them, and thus risk, in somewhat subjective or qualitative terms. As the issues in the quantitative risk assessment, the great difficulty is to define the likelihood and the impact values. Moreover, these values need to be defined so that the same scales can be consistently used across multiple risk assessments. The results of qualitative risk assessments are inherently more difficult to be concisely communicated to management. Qualitative risk assessments typically give risk results of "High", "Moderate" and "Low". However, by providing the impact and likelihood definition tables and the description of the impact, it is possible to adequately communicate the assessment to the organization management. Qualitative analysis may be used:
   - as initial assessment in order to identify risks which will be the subject for further detailed analysis;
   - where non-tangible aspects of risk are to be considered (e.g. reputation, culture, image etc.)
   - where there is a lack of adequate information and numerical data or resources necessary for a statistically acceptable approach.

(b) *Semi-quantitative*, where the qualitative scales are set with given values. The aim is to produce a more expanded ranking scale than is usually achieved in qualitative analysis, but not to suggest realistic values for risk such as in quantitative analysis. It is an attempt to overcome the subjectivity of qualitative approach, when quantitative data are not completely available. Therefore, as the value allocated to each scale is not an accurate representation of the actual magnitude of impact or likelihood, the numbers used must be only combined using a formula that recognizes the limitations or assumptions made in the description of the used scales. It should be also mentioned that the use of semi-quantitative analysis may lead to various inconsistencies due to the fact that the chosen numbers may not properly reflect the analogies between risks, particularly when either consequences or likelihood are extreme.

(c) *Quantitative* which uses numerical values (rather than the descriptive scales used in qualitative and semi-quantitative analysis) for both consequences and likelihood using data from a variety of sources. Mathematically, it gets complicated very fast, involving statistical techniques that are beyond the scope of this discussion. While utilizing quantitative risk assessment seems straightforward and logical, there are issues with using this approach with information systems. While the cost of a system may be easy to define, the indirect costs, such as the value of information, lost production activity and the cost to recover are imperfectly known at best. Moreover likelihood, that is the other major element of risk, is often even less perfectly known. Therefore, a large margin of error is typically inherent in quantitative risk assessments for information systems. This might not always be the case in the future. As the body of statistical evidence becomes available, trends can be extrapolated from the past experience. Insurance companies and financial institutions make excellent use of such statistics to ensure their quantitative risk assessments are meaningful, repeatable and consistent. Typically, to perform a quantitative risk assessment for an IT system is not cost-effective, due to the relative difficulty of obtaining accurate and complete information. However, if information is deemed reliable, a qualitative risk assessment is an extremely powerful tool to communicate risk to all levels of management. Two of the reasons claimed for this are 1) the difficulties in identifying and assigning a value to assets, and 2) the lack of statistical information that would make it possible to determine the frequency.

As mentioned before, the risk assessment process consists of two sub-phases: Risk Analysis and Evaluation. We explain them in the next two paragraphs.

4.6 Risk Analysis

The function of risk analysis is to investigate on the risk factors in order to provide a deeper understanding of the risk features which enables a more reliable estimation of the probability of occurrence, interrelationships and impact in order to determine the influence of risk factors on the system as a whole. Risk factors, in fact, form a cumulative effect on one or more aspects of the project and it is easier to mitigate risk events if they can be bunched in groups and preferably dealt at a higher level in the long run than focusing on one particular risk event, in which case the project is likely to be micro-managed.

Risk analysis may vary in detail according to the risk, the purpose of the analysis, and the required protection level of the relevant information, data and resources. Some theories include in risk analysis also the estimation of the occurrence probabilities of the risk factors, the entity of effects that we, instead, include in risk evaluation phase. Anyway, as stated above, the type of performed analysis should be consistent with the criteria developed as part of the definition of the Risk Management context.

4.6.1 Tools and techniques: literature review

In literature, several techniques currently applied for project analysis can also be applied for risk analysis in order to comprehend relationships and dependence among the risk factors/effects. Here we report some details from the Ahmed et al. review (2007) and Chapman and Ward (2003).

Estimation of system reliability
System reliability estimation is the technique of determining the probability that an item will perform a required function under stated conditions for a stated period of time (Dhillon, 1982; Birolini, 1993; Henley and Kumumoto, 1991). The elements of the system are integrated together having either a serial or a parallel relationship, and traditional reliability calculations are then used to determine the overall reliability of the system. Hence, cumulative effects on the critical components of the project are determined as system reliability.

Other two common approaches used in a system failure analysis context approach are the event tree analysis and the fault tree analysis.

Event tree analysis
The event tree analysis involves identifying a sequence of events that could follow from the occurrence of particular source-response configurations and then representing the possible scenarios in a tree diagram where each branch represents an alternative possibility. It determines how likely a particular event represented on an event tree is likely to happen from an initial event (Cross, 2001; Stewart and Melchers, 1997). The probability of occurrence of a particular outcome is determined as the product of all probabilities of occurrence in the associated branch. As the all possible failures for each outcome are pointed out, the event tree analysis leads to a comprehensive mitigation plan.

Fault tree analysis

In the fault tree analysis the process is reversed, working backward from a particular event known as the top event, in attempt to identify all the possible sequences of events giving rise to the top event.
The fault tree analysis determines the chance or a failure event occurring in the project structure represented in a fault tree (Cross, 2001; Dhillon, 1982; Stewart and Melchers, 1997). Further, the top-level chance of a failure is determined from events in lower levels passing through logical gates. This analysis provides an overview of risk in the overall project through top-level analysis or specific components of the project through analysis at lower levels.

Ishikawa or fishbone diagrams adopts a similar approach that graphically illustrates the hierarchical relationship between the causes and a given problem or outcome.

Influence diagrams
In event tree and fault tree analysis the problem of ensuring completeness in the set of the possible failure modes included still remains. A better representation of causes and effects can be achieved with influence diagrams, as used in systems dynamics (Forrester, 1958, 1961; Richardson and Pugh, 1981; Senge, 1990) and cognitive mapping (Eden, 1988). One advantage of influence diagrams over tree diagrams is that much more complex interactions can be shown, including feedback and feedforward loop effects.
Although they can provide a starting point for quantitative, systems dynamics models (Rodrigues and Williams, 1998; Eden et al., 2000; Howick, 2003) influence diagrams are essentially a qualitative tool. They do not indicate the magnitudes or the timing of influence relationships that would be quantified in systems dynamics model simulations. Thus a link between two factors X and Y does not indicate the strength of the link: whether it is continuous or not, or whether the impact on the influenced factors is immediate or delayed. Nevertheless, an influence diagram can be a useful aid to understand a complex situation, particularly if effectively interpreted. It also assists in identifying potentially important links, such as the nature of source-response chains associated with vicious circles, or particular sources that influence many other sources either directly or indirectly. Increased understanding of cause-effect relationships can also prompt the formulation of additional responses.

Sensitivity analysis and simulation
Sensitivity analysis is a what-if type of analysis to reflect on responses by the system as project conditions change (Clemen, 1996; Clemen and Reilly, 2001; Perry, 1986). A baseline for the project metrics is generated as a precursor to a what-if analysis and then project conditions are manipulated to determine their effect on the project metrics.
This leads to an understanding of the system response to changing project situations. Simulation is used as an extension to the sensitivity analysis (Berny

and Townsend, 1993). In simulation, a system model is constructed to reflect actual processes with project parameters and constraints. Then, the values for the risk parameters and constrains are randomly selected in a predefined range (Ahmed et al., 2003a, b).
A collation of the effects are tabulated and statistically analysed to provide an insight into the system behaviour under various conditions (Duncan, 1996). Simulation is a flexible technique for risk analysis, but requires large simulation runs to provide sufficient data for statistical analysis.

Analytic Network Process
The Analytic Network Process (ANP) is the most comprehensive framework which allows one to include all the factors and criteria, tangible and intangible that have bearing on making a best decision. The Analytic Network Process allows both interaction and feedback within clusters of elements (inner dependence) and between clusters (outer dependence). Such feedback best captures the complex effects of interplay in human society, especially when risk and uncertainty are involved.
The ANP, developed by Saaty, provides a way to input judgments and measurements to derive ratio scale priorities for the distribution of influence among the factors and groups of factors in the decision. Since the process is based on deriving ratio scale measurements, it can be used to allocate resources according to their ratio-scale priorities. The well-known decision theory, the Analytic Hierarchy Process (AHP) is a special case of the ANP. In ANP and AHP the ratio scale priorities for elements and clusters of elements is derived by making paired comparisons of elements on a common property or criterion.

Interpretive Structural Modeling
Interpretive Structural Modeling (ISM) developed by War?eld (1974), is a computer assisted modeling process which used to assist groups in studying and analyzing complex problems and helping transform unclear, poorly articulated mental models of systems into visible, well-de?ned models useful for many purposes. In ISM, all the elements are compared in order to construct a structural graph and illustrate those risk interrelationships. An Analytical Hierarchy Process (AHP) can then be used to quantify relationships and weigh the significance of different risks.

4.6.2 Risk Analysis in ERP projects

The thesis proposal for the Risk Analysis stage is that risk factors are analyzed and classified according to the decisional attributes defined in the context analysis phase, such as control-ability, detect-ability, project life cycle, responsibility and dependence. The output is functional both to the evaluation and to the

treatment phase since it assesses a pre-analysis of risk factor profiles and enables a more accurate selection of suitable response actions.
A first classification of the risk factor, according to tree of the five attributes selected in the Context Analysis, is proposed in Figure 4.10 and 4.11. The classification could provide important information for the next evaluation and treatment stages. Dependences will be separately discussed.

ID	Risk factor	Controllability	Detect-ability	Resposibility	Life Cycle
R1	Inadequate selection of the ERP package	YES	NO	Internal	1
R2	Poor project team skills	YES	YES	Internal	1
R3	Low commitment of the top management	YES	YES	Internal	1
R4	Ineffective communication system	YES	YES	Internal	1
R5	Low involvement of the key users	YES	YES	Internal	1
R6	Inadequate training	YES	YES	Internal	2
R7	Complex ERP system architecture	Partial	Partial	Internal	2
R8	Inadequate Business Process Reengineering	YES	YES	Internal	1-2
R9	Bad managerial conduction	YES	YES	Internal	1
R10	Ineffective project management techniques	YES	YES	Internal	1
R11	Inadequate change manageme		NO	Internal	2
R12	Inadequate legacy system management	YES	YES	Internal	1-2
R13	Ineffective consulting services	YES	YES	External	1
R14	Poor leadership	YES	Partial	Internal	1
R15	Inadequate performance of the IT system	NO	YES	External	2
R16	Inadequate IT system maintainability	YES	NO	External	2
R17	Inadequate stability and performances of the ERP vendor	NO	NO	External	1
R18	Ineffective strategic thinking and planning	YES	NO	Internal	1
R19	Inadequate financial management	YES	Partial	Internal	1

1: Pre-implementation stage; 2: Implementation; 3: Post-Implementation

Figure 4.10: Analysis of the Risk factors

We then deal in particular with the analysis of interdependences among the risk factors and their causal relationship with effects.
Dependence, among the risk factors, is a critical aspect in ERP risk assessment since snowball effect can easily occur. Interpretive Structural Modelling (Sage, 1977) technique, as other Analytic Network Process (ANP) approaches, can be useful to model dependences and interconnections among risk factor and between risk factors and effects, to draw a risk event tree.

In complex systems or projects, in fact, interdependence is a widespread phenomenon for risk management decision: airlines, electric utilities, such as public health, RD and complex IT projects, among the others, are fields in which risk factors are highly interdependent. The complex structure of the system and the high number of “agents” (subject but also class of homogeneous risk factors) involved make the risk magnitude not only depending on the agent own risk management strategy but also on those of the others’.
We can interpret an ERP project as a complex networked project in which several “agents” (as class of homogeneous or correlated risk factors) have to be correctly managed for the project success. The risks of this kind of projects are typically interdependent: the potential consequence for a firm, in fact, in

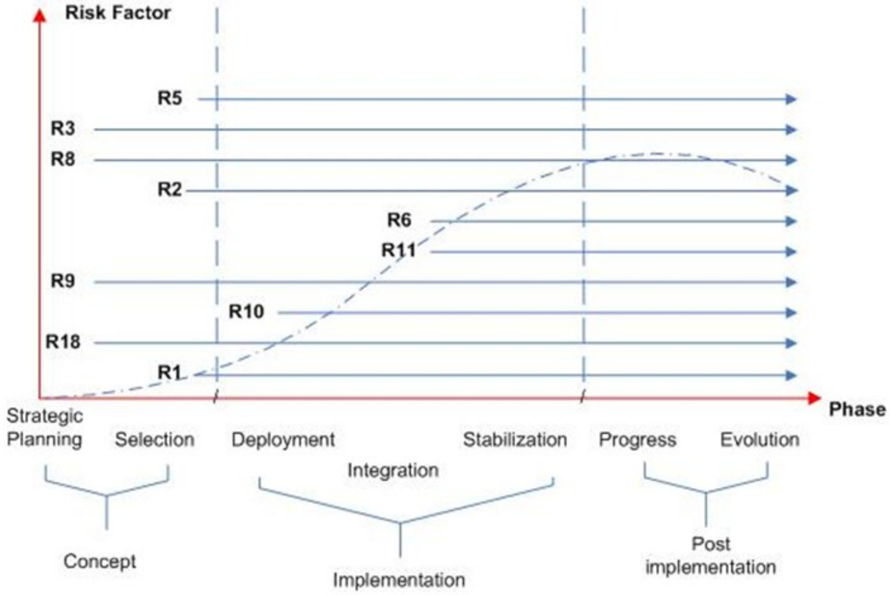


Figure 4.11: Risk factors impact during ERP life cycle

terms of failure (process, expectation, interaction and correspondence failure), not only depends on a specific agent choice but also the failure of one "agent" management reduce the effectiveness of the measures that other agents may take to improve their security. Moreover, since interdependence does not require proximity, the antecedent to failure can be quite distinct and distant from the actual disaster. So the occurrence of a specific event (first level risk factor) in the early stage of the ERP introduction life cycle could have a relevant impact on the whole project, and could be the cause of the effects that will be new risk factors for the latest stage of the project (second levels risk factors) (See for example the "inadequate selection of the ERP Software"). Furthermore an inadequate management of some risk factor in the latest stage of the project can equally have a disruptive effect on the whole project (Heal and Kunreuther, 2007).

To this end, it is firstly essential to understand risk factors inter-dependences and relationships with direct and indirect effects in order to prioritize them according to their risk level (how many factors they lead to "drive power" and from how many of them they depend on "dependence").

4.6.2.1 Dependence Analysis in ERP project: an ISM-based methodology

The purpose of this part of the thesis is to propose an effective technique for risk analysis in order to develop a better understanding of risk factors including in particular the main relationships among risk factors and between risk factors and associated effects in ERP projects.

The main expected benefits are:

- A more objective and systematic way (ISM-based) to analyze risk factors and effects inter-dependences in ERP introduction projects.
- An effective method (and criteria) for a preliminary analysis of the dependences among the risk factors and a classification helping managers in the project risk assessment, management and control (dependent factors are important for ex post control of residual risk, whereas independent factors are important for ex ante control and risk reduction).
- A graphic representation of risk factors and effects interdependences (similar to a Fault Tree) helping managers to understand causal links among the selected variables both in the assessment of a global risk index for each factor and in the selection of the opportune risk treatment strategy.

In this part of the thesis, Interpretive Structural Modeling (ISM) is used to assess risk factors and effects interdependences and build an “ERP project” fault tree, aiming to support risk analysis and assessment in ERP risk management.

In particular a theory of systems engineering (ISM) is used to built a causal tree of ERP risk factors and effects on a real project (case study) and analyze their structural relationships in order to provide the basis for risk quantification.

Given the complexity, the extension and specificity of the ERP context, the objectives and the explanatory direction of the research, a case study approach was selected in order to facilitate the problem understanding, to test ISM ability and provide a more effective knowledge extraction.

4.6.2.2 Research methodology for the dependence analysis

Interpretive Structural Modeling is a well established, computer-assisted, methodology to construct and understand the fundamental of the relationships between elements in complex systems. ISM works as an interpretive learning process and it may be used for the analysis of complex systems. Because of this, ambiguous relations among the system elements exist and it is difficult to identify the relations between them.

Next corrections to the procedures are proposed by several authors to provide a more effective and consistent analysis. Flexible interpretive structural modeling (FISM) is an extended and improved version of the interpretive structural modeling developed by J.N. Warfield (1974). Ohuchi and Kaji (1989) propose changes to FISM in order to allow for changes of one or more entries from zero to one; deletion of one or more elements and their connections and addition of one or more elements and their connections.

The method provides a structured approach to interpret the group judgments about whether and how items are related with the aim to extract from relationships an overall structure between items and to draw them in a digraph model for their interpretation (Sage, 1977). In particular the main advantages are related to:

- A standard and intuitive procedure for collecting and analyzing judgment of experts about the dependencies between the selected variables;
- A first classification of the variables according to the "dependence" and the "driving power" criteria;
- An assisted graphic hierarchical representation of variables;
- Potential modification to the initial matrix configuration (only with FISM) in order to test alternative models.

ISM is used to assess risk factors and effects interdependence and build an "ERP project" fault tree in order to support risk analysis and assessment in ERP risk management. The calculation of ISM contains the following steps (Mandal and Deshmukh, 1993):

1. *Organize an ISM implementation group* - at the beginning, a group of people with relevant knowledge, skills, and backgrounds is assembled. This group should consist of experts from different areas throughout the firm; this wide-ranging skill-set is critical, as ERM should ideally be embedded into the company's operations throughout the firm.
2. *Elements (Risk factors/effects) Identification* - Elements identification is a crucial step for the next phases of the analysis. Risk factors and potential risk effects for ISM application have to be identified, as much completely as possible to provide a consistent base for the next steps. We assessed this phase in the Risk Identification paragraph.

3. *Structural Self-Interaction Matrix (SSIM) definition* - The first step in analyzing the relationship between risk factors is to know which factor leads to another. So that, based on this "contextual relationship" a SSIM is developed. People will be asked to fill a simple matrix-table in order to assess how deeply a risk factor leads to another and on effects. The directed relationships among the risk factors are hypothesized. This matrix provides an initial impression of how, in what order, and through which other factors the various risk factors might ultimately be the source of a missed objective. Here, the adjective "directed" refers to the need of specifying the direction of the relationship (if any) between any two risk factors - e.g., from A to B, from B to A, in both directions between A and B, or A and B unrelated. Answers (YES if one factor leads to another and NO if it does not) will be analyzed and potential discrepancies will be resolved in an open discussion with other experts also in order to avoid potential loops (possibly via a Delphi approach involving those and/or other experts) (Directed-Acyclic-Graph DAG form should be guaranteed). A common SSIM table was finally compiled (Figure 4.12).

	Criterion									
Criterion	11	10	9	8	7	6	5	4	3	2
1	A	O	O	O	A	A	O	V	A	O
2	A	A	O	A	A	O	O	O	A	
3	O	V	O	O	O	O	O	V		
4	O	A	O	A	O	O	O			
5	O	V	V	O	O	O				
6	O	V	V	O	O					
7	V	V	V	O						
8	O	V	V							
9	O	A								
10	A									

Legend: Here for $i < j$,

A : Criterion for j leads to criterion i

V : Criterion for i leads to criterion j

X : Criterion for i leads to criterion j and criterion i leads to criterion j

O : No relationship between i and j

Figure 4.12: Structural Self-Interaction Matrix, Source: (Mandal and Deshmukh, 1994)

4. *Reachability Matrix definition* - The SSIM was converted in a binary matrix (Figure 4.13), substituting the filled values with 1 (if YES) and 0 (if

NO). Then the transitivity propriety is checked, so if the risk factor i leads to j and j leads to k, then i has to lead to k. The reachability matrix is then modified and data are processed.

$$R = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Figure 4.13: Reachability Binary matrix

5. *Elements (Risk factors/effects) classification* - Factors are classified according to their "dependence" (linked to how many factors they are influenced by) and "driver power" (linked to how many factor they influence)(Figure 4.14). This could help managers assessing the relevance of a specific risk factor, even if it has not evident and measurable effects.

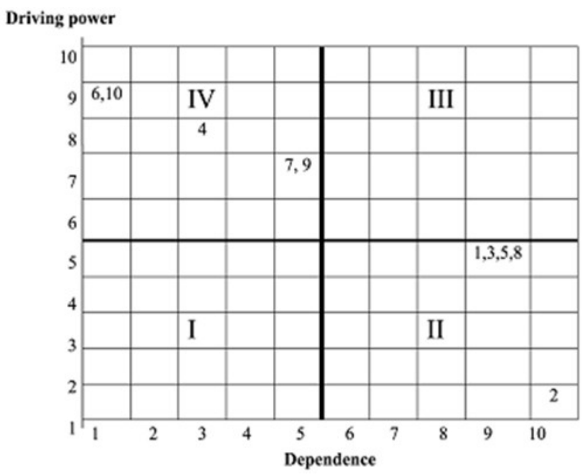


Figure 4.14: Dependence-Driving power, Source: (Mandal and Deshmukh, 1994)

6. *ISM level partition* - Each element in the matrix can reach other elements (reachability set) and can be reached by some other element (antecedent

set). The top element of the hierarchy will not reach any other element, so it is identified and separated. Then the reachability matrix is converted into the lower triangular format (Figure 4.15). This is an algorithm-based process which provides for the grouping of risks into different levels, depending upon their interrelationships. This provides a multilevel interpretive structural model in which the relationships among risks are clarified.

$$
\begin{array}{c}
 \\
R =
\end{array}
\begin{array}{c}
\begin{array}{ccccccc} R_7 & R_6 & R_5 & R_4 & R_2 & R_3 & R_1 \end{array} \\
\left[\begin{array}{c|cc|cc|cc}
\boxed{1} & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 1 & 0 & 0 & 0 & 0 \\
1 & 0 & 1 & 1 & 0 & 0 & 0 \\
1 & 0 & 1 & 0 & 1 & 0 & 0 \\
1 & 1 & 1 & 1 & 0 & 1 & 0 \\
1 & 1 & 1 & 1 & 0 & 0 & 1
\end{array}\right]
\end{array}
\begin{array}{c}
 \\ R_7 \\ R_6 \\ R_5 \\ R_4 \\ R_2 \\ R_3 \\ R_1
\end{array}
$$

Figure 4.15: Relationship structure

7. *ISM risk factors/effects model* - A directed graph of risk factors and effects interdependences is drawn (Figure 4.16). An ISM graph has no cycle or feedback, so elements risk factors/effects are put in a pure hierarchical pattern and modeled as an ERP fault tree.

4.6.2.3 Data collection

In phase 3 of ISM procedures, experts have to be involved in the SSIM definition. The investigation used an high qualified panel of academic experts and practitioners to comprehend how ERP risk factors influence each other and their direct or indirect relationship with potential effects identified drawing them in a direct graph.
We adopted a Delphi-based process in order to make the expert judgments convergent. A first pilot case study was developed in order to define a preliminary structural model. Then, experts from the academic world and from other companies were involved in the analysis. Different models were drawn, and the ISM

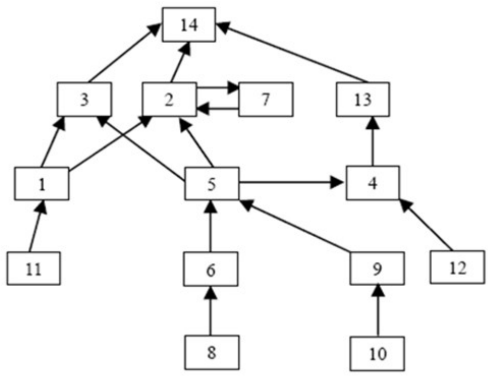


Figure 4.16: Hierarchical pattern of relationships

process was iterated till consensus was achieved and the loop and transitivity problems solved.
The pilot case study examine dependence among risk factors and effects, as identified in the identification phase, describing the experiences of a multinational company running in the Electronic Power Systems and Alternative Energy Systems Market implementing an enterprise-wide ERP (Oracle). The case study was developed using in depth structured interviews with the main project managers responsible for planning and implementing enterprise-wide/ERP systems and main key users in the implementation team within the organization.
A number of people (Figure 4.17) from the Oracle Implementation Team was selected for the interviews; a structured interview format was defined (Appendix C) and followed in each of them. Because of the ERP risk management proposal, we are interested both to the relationships among the risk factors and between risk factors and effects. So the questions we asked to the experts dealt both of these aspects. Variables were grouped in two sections according to the two main aims of the research (Interdependence among risk factors and between risk factors and risk effects) and two different matrix were developed (Figure 4.18), one in order to investigate about the first issue the other for the second one. Two main assumptions were made:

1. Risk effects are not interdependent (i.e. D is a null matrix)
2. Risk effects have no back interaction with risk factors (i.e. C is a null matrix)

In the following figures (Figure 4.19 anf 4.20) we present the two matrix that were filled in during the structured interview. The respondents were asked to

ID.	Position	Role in the ERP project team	Time with company (years)	Number of previous ERP project
1.	Senior Production Manager	Project Manager	More than 10 years	2
2.	Financial Manager	Financial Analyst	Less than 1 year	6
3.	IT Manager	Super User	Less than 1 year	6
4.	Traffic Manager	Super User	Less than 1 year	0
5.	Chief Accountant	Super User	5 years	0
6.	Sourcing Manager	Super User	5 years	
7.	Planning	Super User	6 years	0
8.	Manufacturing Engineering Manager	Super User	6 years	1
9.	Quality Manager	Super User	More than 10 years	1
10.	Production Planner	Super User	Less than 1 year	0

Figure 4.17: Interviewed subjects

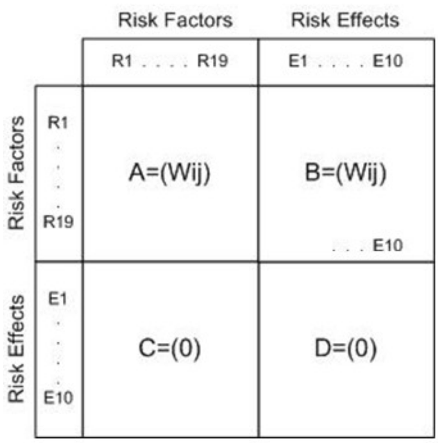


Figure 4.18: Risk factors-effects matrix

		Budged exceed	Time exceed	Project stop	Poor business performances	Inadequate system reliability and stability	Low organizational process fitting	Low user friendliness	Low degree of integration and flexibility	Low strategic goals fitting and bad financial/economic performances	Bad financial/economic performance
		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
R1	Inadequate ERP selection										
R2	Poor project team skills										
R3	Low top management involvement										
R4	Ineffective communication system										
R5	Low key user involvement										
R6	Inadequate training and instruction										
R7	Complex architecture and high number of implementation modules										
R8	Inadequate BPR										
R9	Bad managerial conduction										
R10	Ineffective project management techniques										
R11	Inadequate change management										
R12	Inadequate legacy system management										
R13	Ineffective consulting services experiences										
R14	Poor leadership										
R15	Inadequate IT system issues										
R16	Inadequate IT system maintainability										
R17	Inadequate IT Supplier stability and performances										
R18	Ineffective strategic thinking and planning Strategic										
R19	Inadequate financial management										

Figure 4.19: Risk effect matrix

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19
R1	Inadequate ERP selection	-																		
R2	Poor project team skills		-																	
R3	Low top management involvement			-																
R4	Ineffective communication system				-															
R5	Low key user involvement					-														
R6	Inadequate training and instruction						-													
R7	Complex architecture and high number of implementation modules							-												
R8	Inadequate BPR								-											
R9	Bad managerial conduction									-										
R10	Ineffective project management techniques										-									
R11	Inadequate change management											-								
R12	Inadequate legacy system management												-							
R13	Ineffective consulting services experiences													-						
R14	Poor leadership														-					
R15	Inadequate IT system issues															-				
R16	Inadequate IT system maintainability																-			
R17	Inadequate IT Supplier stability and performances																	-		
R18	Ineffective strategic thinking and planning Strategic																		-	
R19	Inadequate financial management																			-

Figure 4.20: Risk factor matrix

indicate the level of influence of each risk factor, firstly on the other risk factors and then on the risk effects, as such as perceived. Then the matrixes were compared and the conflicts solved according to a Delphi process, which involved also two academic experts. When finally a unique matrix was achieved and the problems due to the transitivity test and the loops were solved, a conclusive classification was obtained and a structural graph was drawn.

Once the ISM process was concluded and the preliminary model defined, it was used to drive the analysis phase in other 4 case studies and verify the coherence of the model. The case studies involved 4 multinational firms (in Italy) in different sectors which were recently involved in a project of ERP introduction. The sectors were divided in 2 sub-classes: Product and Service; in the first sub-class we investigated the paper and the Chemical sector, in the second one the Health Care and the Telecommunication sector. The analysis was based on in-depth interviews to the local project manager and to a key user.

4.6.3 Results and conclusions from the risk analysis

Results from the case study provide a first qualitative classification and interpretation of risk factors according to their dependence and driving power and a real proof of the usability of the tool. In the risk analysis, the information addressed by the ISM can offer managers and researchers a better knowledge of risks in ERP introduction projects and can be used as a starting point to assess the risk factors occurrence probability and the potential effects.
To sum up, main contributions from the risk analysis include the following issues:

1. A classification of risk factors according to their dependence and driving power which is useful both to understand the real nature of the factors and to enable a better assessment of the risk of a specific factor including its indirect effect on other risk factors (snowball effect). As the Figure 4.21 shows, the ISM classification suggests 4 main groups according to the respective dependence and drive power values: *Independent factors (High driving power-Low dependence); Autonomous factor (Low driving power-Low dependence); Linkage factors (High driving power-High dependence) and Dependent factors (Low driving power-High dependence).* In the case studies we assessed, the following groups are pointed out:

   In the group of the independent factors we find:
   R2-Poor project team skills
   R3-Low top management involvement
   R9-Bad managerial conduction

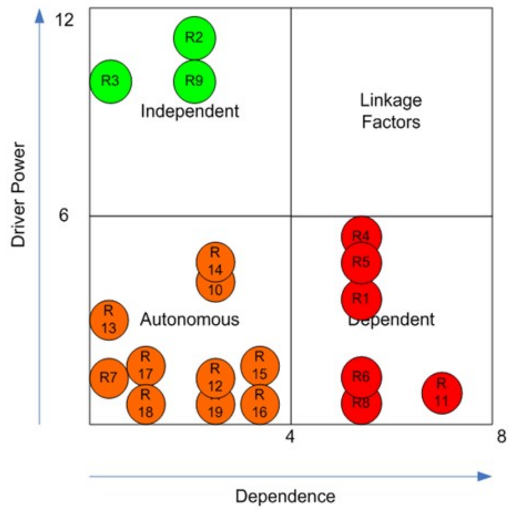


Figure 4.21: Risk factor classification

These factors are characterized by a high driving power and a low dependence. This means that the factors have a wide influence on other risk factors in the project (they lead to and enable other potential risks) and a snowball effect is likely to occur when they happen. For this reason the risk level associated with these risk factors should be higher than the other ones. Managing these risk factors should be a priority for the project managers since benefits can be given to the whole project.

Among the *autonomous factors*, there are:
R7-Complex architecture and high number of implementation modules
R10-Ineffective project management techniques
R12-Inadequate legacy system management
R13-Ineffective consulting services experiences
R14-Poor leadership
R15-Inadequate IT system issues
R16-Inadequate IT system maintenance
R17-Inadequate IT Supplier stability and performances
R18-Ineffective strategic thinking and planning Strategic
R19-Inadequate financial management

Autonomous factors are characterized both by low driving power and low dependence. These factors are more isolated than the other ones, they are weak drivers and weak dependents, and consequently relatively disconnected from the system. If we look at their profiles, we notice that the main categories they belong to are: Project Management and IT Technical

Issues. Two separate groups are identified by the Financial Management and Strategic thinking and Planning, which seems transversal dimensions to the project.

Finally, in the *Dependent factors*:
R4-Ineffective communication system
R5-Low key user involvement
R6-Inadequate training and instruction
R8-Inadequate BPR
R11-Inadequate change management

With the highest degree of dependence and the lowest driving power, factors R4, R5, R6, R8, R11 have got the top level in the model and are logically found in the cluster of dependent factors.
This indicates that the communication system, as well as the key user involvement, training and instruction activities and change management are among those critical factors which are highly dependent on how properly the project team has managed the entire project. So the risk level associated with these factors in the assessment phase should be coherent with the real dependence from other factors.

Another important group of factors is the Linkage factors, high driving power and high dependence. In the case studies we did not find any factor in this group, anyway it is equally important for factor classification. Factors of this group are key nodes of the project, they are influenced by a high number of factors and lead to several other factors, so that their accurate management is highly critic for the risk management and a very complex task at the same time.

2. A structural graph of the relationship among the risk factors
From the binary matrix it is possible to define a preliminary graph of relationships, as the Figure 4.22 shows. At the top level we find the factors with the highest driving power, as well at the down level factors with the lowest driving power and a high dependence.
Such representation of relationships is useful both during the ISM process, in order to identify loops or solve potential problems in the structure, and in order to understand the complexity of the dependencies among the factors and effects.
Starting from the relation network it is possible to map the structural graph of the risk factor relationship. In Figure 4.23 risk factors are reported from the left to the right according to a growing dependence. To make the graph clear, only the relationship between the level n and the level n+1 is drawn. This kind of representation can help in the interpretation of the graph and relationships and achieve the identification of groups of similar risk factors. In Figure 4.24, an example is reported. Risk factors are drawn according to their degree of dependence (how many factors

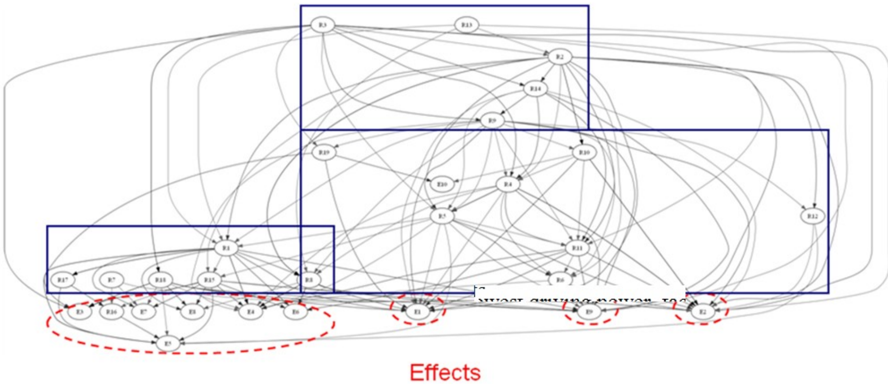


Figure 4.22: Network of the factor relationships

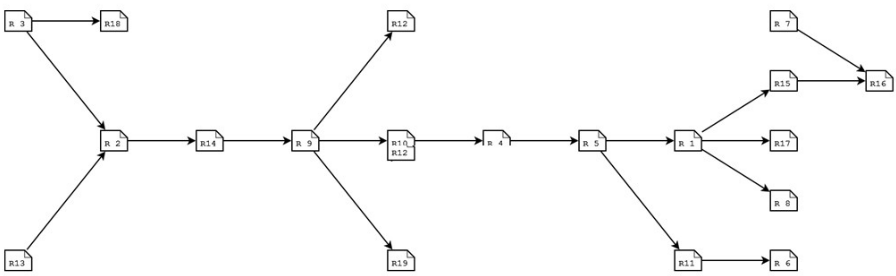


Figure 4.23: ISM structural graph

they are depending on) and driving power (how many factors they lead to); from the left to the right the dependence degree is growing. Three macro classes of factors are visible: factors linked to the project governance, factors in the project and change management group and BPR related factors. Two isolated classes are also present: Legacy System and Financial Management. The position of the factors in the model emphasizes the sig-

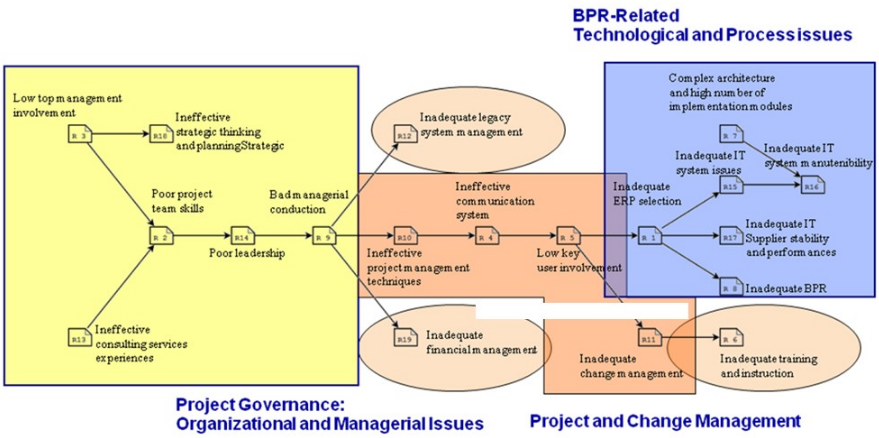


Figure 4.24: ISM structural graph

nificance of factors in the Project governance group which deeply impact on the other aspects of the project such as Project and Change Management and BPR-related and Technological Issues. An effective governance in terms of top management involvement, consulting service experiences and performance, team skills, leadership and managerial conduction not only helps in defining project objectives, achieving the project goals and avoiding project problems and conflicts but also contributes to motivate and drive an effective Project and Change Management.

The model also suggests that factors in the Project and Change Management group influence factors related to the technical and process aspects such as ERP selection, IT system issues, Supplier stability and performance, BPR, System Architecture and maintainability.

Three isolated factors are also evidenced: Legacy System Management, Financial Management and Training and Instruction.

3. A structural graph of the relationships between risk factors and effects
   The risk factor/effect matrix gives important information about how risk factors lead to risk effects. A graph of these relationships is reported below (Figure 4.25). Obviously each risk factor can lead to one or more effects, and a risk effect can be due to more risk factors. The strength of these

links is not analyzed by the ISM but the ISM analysis provide the base structure which can be used during the evaluation stage to assess the risk level of each risk factor.

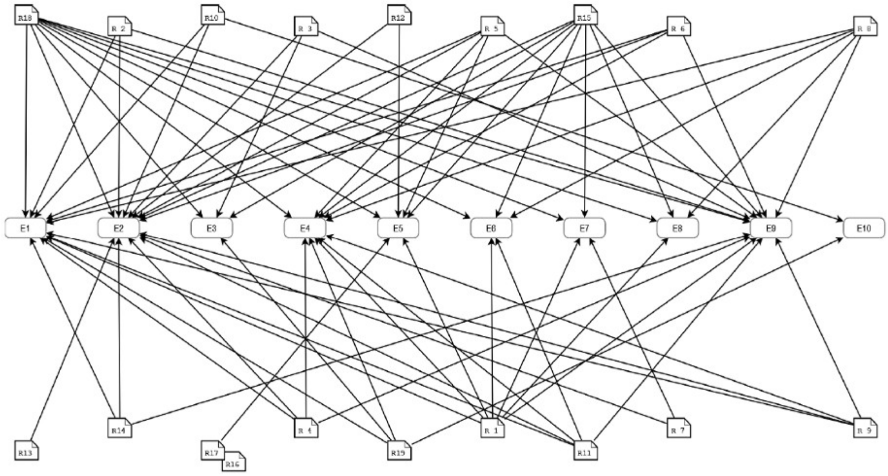


Figure 4.25: ISM structural graph

Despite the information provided is difficult to generalize since the limited number of case studies, the example shows that possibilities for using ISM technique in the risk analysis stage really exist. In the case studies the 19 risk factors and 10 risk effects identified in the risk identification stage were studied and classified in order to provide a support for the next stage of risk evaluation.

4.7 Risk Evaluation

In *Risk Evaluation* phase a ranking has to be elaborated in order to assess the priority and severity of each risk factor. Consequences, likelihoods and hence the level of risk should be estimated (this activity is sometimes assessed during the analysis phase). Finally a comparison between the levels of risk against the pre-established criteria (i.e. in the risk criteria identification stage) and a balance between potential benefits and the adverse outcomes should be done. This process enables to make decisions about the extent and nature of treatments required and about priorities. It is important to note that in some cases the risk evaluation may lead to the decision of undertaking further analysis.

4.7.1 Tools and techniques: literature review

Risk evaluation is the function of risk management where risk events need to be prioritized so that risk mitigation plans are determined or based on past experience, lessons learnt, best practices, organizational knowledge, industry benchmarks and standard practices (Ahmed et al., 2003a, b). Different aspects of the project - as for example strategies, budget or schedule - may be considered in the light of a risk event to determine risk mitigation options and incorporate the most suitable options into a mitigation plan. The criteria used by the Risk Management team have to take into account also the organization objectives, the stakeholder views and of course the scope and objective of the Risk Management process itself. The decisions made are usually based on the level of risk but may also be related to specified thresholds in terms of:

- consequences (e.g. impacts);
- likelihood of events;
- cumulative impact of a series of events that could simultaneously occur or interact.

A large number of techniques supporting the evaluation phase exists, such as statistical sums, simulations, decision trees, expert judgements, multi-criteria decision, portfolio approaches, probabilistic networks, etc. This section describes several evaluation techniques that can be applied for risk evaluation according to the reviews provided from Ahmed (2003) and Chapman and Ward (2003).

Decision tree analysis
Decision tree analysis is used to structure a decision process and evaluate the outcomes from uncertain events (Webb, 1994; Clemen, 1996; Taha, 1997; Russell and Taylor, 2000; Duncan, 1996; Clemen and Reilly, 2001; Perry and Haynes, 1985). In decision trees, decision nodes and chance nodes are represented graphically and expected monetary values (EMV) are attached to the nodes. Decision tree analysis incorporates probability of returns associated with decisions and estimation of expected returns, which could be misleading in situations that are not common. Hence decision tree analysis should be used with caution for risk analysis.

Portfolio management
Portfolio management compares multiple projects with respect to risk in investment and returns (DeMaio et al., 1994; Clarke and Varma, 1999; Dickinson et al., 2001). Projects are positioned on a matrix of risk magnitude and return, with high risk low return projects being located at a different location to low

risk and high return projects.
This enables decisions to be derived for corporate governance, based on the company strategy and the maximum portfolio value, through calculation of an utility value for a project (DeMaio et al., 1994). In project risk management, multiple risk events may be compared by placing them on a matrix of risk magnitude against a return. Mitigation options are then derived from predefined utility values. Project attributes are weighted according to project predominance of the predefined criteria.

Despite these methodologies well fit with the need of comparing different project options with the related risk, they fail in simultaneously considering risk factor interactions, so that they are not effective in project risk management where different risk factors have to be considered as a whole since a complex network of relationships exists among themselves. Since these reasons, other techniques can be also considered, as for example:

Probability and impact grids
The risk matrix (Figure 4.26), for example, is one of the most common tools used in the assessment phase. Once the likelihood and impact of a risk factor are qualitatively or quantitatively estimated, it is classified according to these values (level) in the risk matrix.
Risk events represented on a grid consisting of probability on one axis and impacts on the other are often used to define threshold regions on the grid, which represent high risk events based on past experience or organizational procedures (Risk Management Standard AS/NZS 4360, 1999; Chapman and Ward, 1997; Ward, 1999; Pyra and Trask, 2002; Stewart and Melchers, 1997; Royer, 2000). Probability and impact grids provide a simple format for showing relative importance of risk events. Figure 2 shows an example of a probability and impact grid (Royer, 2000).

Bayesian and probabilistic networks are more sophisticated approaches to the risk evaluation phase. The concept of conditional probability is useful in risk evaluation. There are countless real world examples where the probability of an event is conditional on the probability of a previous one. While the sum and product rules of probability theory can anticipate this factor of conditionality, in many cases such calculations are NP-hard.

Bayesian Networks
A Bayesian network (or a belief network) is a probabilistic graphical model that represents a set of variables and their probabilistic dependencies. Formally, Bayesian networks are directed acyclic graphs whose nodes represent variables, and whose arcs encode conditional dependencies between the variables. Nodes can represent any kind of variable, being it a measured parameter, a latent variable or a hypothesis. They are not restricted to represent random variables,

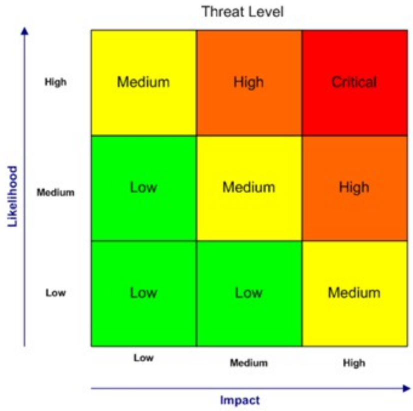


Figure 4.26: Risk matrix

which represent another "Bayesian" aspect of a Bayesian network.
The most common task we wish to solve using Bayesian networks is the probabilistic inference. For example, consider the water sprinkler network, and suppose we observe the fact that the grass is wet. There are two possible causes for this: either it is raining, or the sprinkler is on.
Efficient algorithms exist to perform inference and learning in Bayesian networks, which model sequences of variables are called dynamic Bayesian networks. Generalizations of Bayesian networks that can represent and solve decision problems under uncertainty are called influence diagrams.
Bayesian network is a carrier of the conditional independencies of a set of variables, not of their causal connections. However, causal relations can be modeled by the closely related causal Bayesian network. When BBNs describe the cause-effect relationships among variables through graphical models, child nodes are conditionally dependent upon their parents nodes basing on conditional probability theory which was developed in the late 1700s by Thomas Bayes. Using this theory, one can predict the impact of external interventions from data obtained prior to the intervention, so that Bayesian networks are often used in diagnostic direction, or "bottom up" reasoning, since they go from effects to causes (Figure 4.27); it is a common task in expert systems. Bayes nets can also be used for causal, or "top down", reasoning to investigate effects from causes.

Probabilistic Networks
Probabilistic networks differently from Bayesian network do not use the bayes rule. It is common to use frequentist methods to estimate the parameters of the CPDs, although the term "directed graphical model" is perhaps more appropriate. Probabilistic networks can be used in cause-effect direction (Figure 4.28) when the purpose is to assess a risk level of each risk factor taking simul-

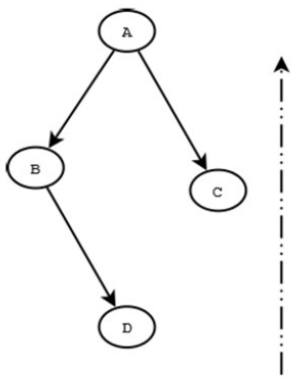


Figure 4.27: Diagnostic reasoning

taneously into account the risk factor dependences, the occurrence probability and the impact on the project effects. The estimations of the unconditioned probabilities of occurrence of each risk factor, a model of dependences among the risk factors and between risk factors and effects, and the estimations about the importance (weight) of each potential effect respect to the project success, are necessary in order to assess a global risk index for that risk factors.

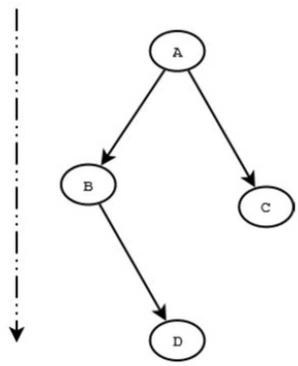


Figure 4.28: Causal reasoning

The probabilistic approaches are more complex and expensive than the risk matrix in terms of estimation of parameters, modelling of dependences and evaluation of effects. With no doubts, risk assessment may be undertaken to varying degrees of detail depending on the risk, the purpose of the analysis, and the available information, data and resources, but costs and benefits of available techniques should be carefully analyzed before a wide application to the project.

In spite of their remarkable power and potential to address inferential processes, there are some inherent limitations and liabilities to Bayesian networks. One potential problem is the possibility, especially when the probabilities are qualitatively assessed, that a user might wish to violate the distribution of probabilities upon which the system is built. A second problem is the computational difficulty of exploring a previously unknown network. This process of network discovery is an NP-hard task which might either be too costly or impossible to perform. The third problem centers on the quality and extent of the prior beliefs used in Bayesian inference processing. A Bayesian network is only as useful as the prior knowledge is reliable. Either an excessively optimistic or pessimistic expectation of the quality of these prior beliefs will distort the entire network and invalidate the results. Related to this concern is the selection of the statistical distribution induced in modelling data.

4.7.2 Risk evaluation in ERP project: a probabilistic network based methodology

The aim of this part of the thesis is to develop a probabilistic network-based methodology for the assessment of risks in ERP projects. A prototype of the software (tool) supporting and automating these activities was also designed and implemented.
As we already reported, in this phase of the risk management process a risk level has to be assessed for each risk factor. Traditional risk evaluation methods assess this value in relation to the probability of occurrence of the risk factor, its impact on the different dimensions of project success - as defined during the identification phase - and the impacts due to other potential risk factors enabled by those we are currently evaluating.

In order to achieve an effective evaluation of the risk level (ranking) of the factors, the evaluation methodology needs:

1. a computational algorithm which could keep in account of the risk factor interdependencies (risk evaluation model). Considering risk interdependencies, in particular, is a necessary and critical task for ERP project risk management; as explained before, the probabilistic networks well fit with this need, so that we decided to adopt a probabilistic network for the evaluation model; and

2. an accurate assessment of the following informational inputs (Figure 4.29):

- the estimations of the unconditioned probability of each risk factor. Each risk factor has an unconditioned probability to occur depending on the specific context of the project. We will indicate the vector of these probabilities as P(R).
- the estimations of the conditioned probabilities of each risk factor depending on other ones. A structural analysis of the relationships among the identified risk factors is necessary to draw a network of the risk factors (RR matrix) and effects (RE matrix). Probabilities or other estimators (such as frequencies) must be assessed to complete the causal structure in the model to be used for the evaluation of the risk level.
- the estimations of the impact of each risk effect (according to an own definition of project success) on the project. We will indicate the impact vector as W(E)

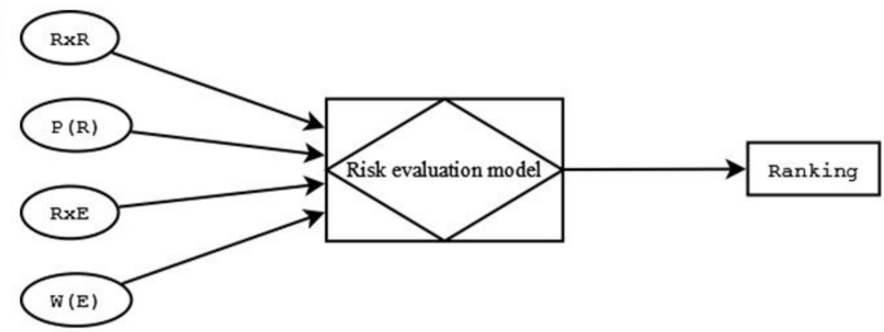


Figure 4.29: Input-Process-Output scheme of the risk evaluation

In the next two paragraphs we first introduce the evaluation (computational) algorithm approached by the use of a probabilistic network, then we deal with the input elicitation problem.

4.7.2.1 Probabilistic Risk network: specification of the computational algorithm

A probabilistic network consists of a graphical structure, representing statistical variables and the (in)dependence relations between them, and an associated numerical part, describing a joint probability distribution over the represented variables. The graphical structure of a network is an acyclic, directed graph.

Engineering a probabilistic network for an application usually has to be done with the support of domain experts and is generally considered a hard and time-consuming task. In this sense, the design of a probabilistic network involves three basic steps:

1. First, the relevant statistical variables in the domain are identified, with their possible values. Here, the variables are inherited from the risk identification phase.
2. Next, the relations between these variables are specified, resulting in the network graphical structure (Figure 4.30). Useful information about the existent relationship are provided by the ISM during the risk analysis phase, so that the RxR and RxE matrices (19x19 and 19x10 respectively) can be reduced and the elicitation process simplified.

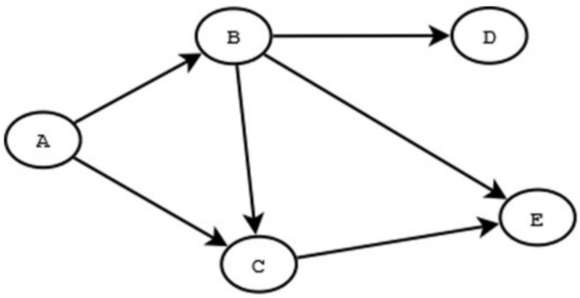


Figure 4.30: Structure of the probabilistic risk network

3. Lastly, probabilities are specified for all the variables involved. These tasks are usually performed in close cooperation with domain experts and represent the elicitation phase.

Hence the inputs we need to elicit for the model are:

- RxR - matrix which encodes the dependencies among the risk factor and their weights $RR_{ij} = P(R_j|R_i)$;
- RxE - matrix which encodes the dependencies among the risk factor and the risk effects and their weights $RE_ij = P(E_j|R_i)$;
- P(R) vector - unconditioned probabilities for each risk factor $PR_i = P(R_i)$;

- W(E) vector - entity of the impacts on the several project success dimensions $W(E_j)$.

In this purpose, we suggest a delphi-based approach aiming to fill in the RR and RE matrices the two P(R) and W(E) vectors. The scheme, which follows (Figure 4.31), aims to guide the interview with managers and key users during the elicitation process.

Figure 4.31: Risk factor/effect matrix

The computational algorithm synthesizes a risk level for each risk factor and achieves the definition of a final ranking among all the risk factors. The risk level is assessed keeping into account all the possible paths from each risk factor to all the risk effects. Each path represents a chain of events (the risk factors) and it is associated with a value representing the conjoint probability of occurrence of all the risk factors on the path. Moreover the value of each path is scaled according to the weight of the risk effect as perceived by the project team, and the values of all the paths in output from a risk factor are finally added.

So that the ranking value for each investigated risk factor is:

$$Rank[i] = \sum_{k=1}^{j} P(R_i) \cdot p(E_k|R_i) \cdot W(E_k) = P(R_i) \sum_{k=1}^{j} p(E_k|R_i) \cdot W(E_k) \quad (4.2)$$

Where $P(R_i)$ e $W(E_k)$ are the inputs and $p(E_k|R_i)$ represents the probability of occurrence of the path.

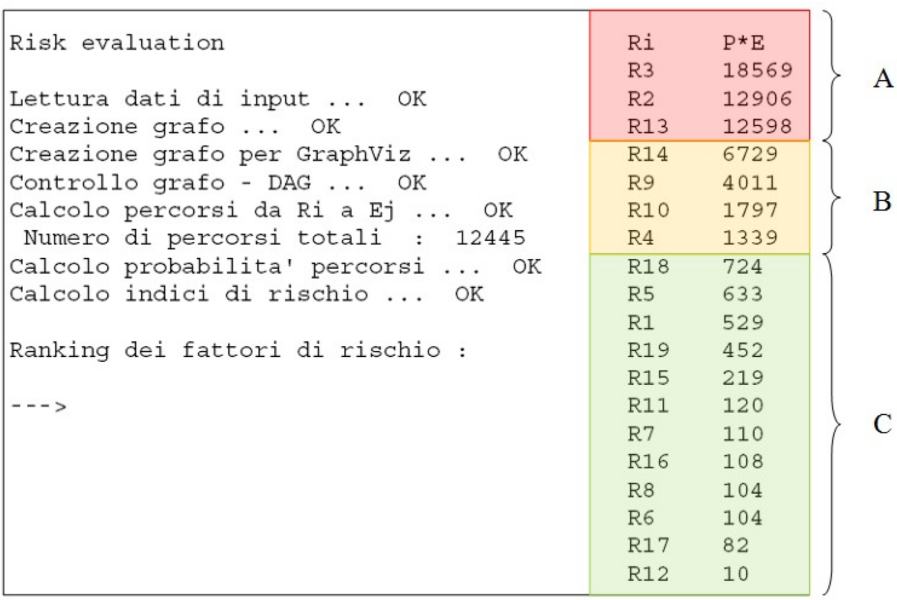
If A=x:x is a group of directed arcs from R_i ad E_k with cardinality n, $p(E_k|R_i)$

can be estimated as follows:

$$p(E_k|R_i) \approx \sum_{k=1}^{n} P(R_i \cap R_m \cap ... \cap R_p \cap E_k) = \sum_{k=1}^{n} P(R_m|R_i) \cdot ...(E_k|R_p) \quad (4.3)$$

An observation about this estimation is essential in order to explicit some limitations of the algorithm. Since the qualitative nature of the process driving the construction of the probabilistic network and the absence of a normalization procedure of probabilities associated with each arc , the definition of probability can be sometimes violated. Anyway, this is not so relevant for our proposal since the final aim of this methodology is to achieve a ranking of the identified risk factors which is coherent with their relative importance.

Once the final ranking is computed, it is possible to discriminate different classes of risk factors, as shown in Figure 4.32. A cluster analysis can be an useful tool in the purpose of identifying from 3 to 5 classes of risk factors with different treatment priority.



```
Risk evaluation

Lettura dati di input ...  OK
Creazione grafo ...  OK
Creazione grafo per GraphViz ...  OK
Controllo grafo - DAG ...  OK
Calcolo percorsi da Ri a Ej ...  OK
 Numero di percorsi totali  :  12445
Calcolo probabilita' percorsi ...  OK
Calcolo indici di rischio ...  OK

Ranking dei fattori di rischio :

--->
```

Ri	P*E	
R3	18569	A
R2	12906	A
R13	12598	A
R14	6729	B
R9	4011	B
R10	1797	B
R4	1339	B
R18	724	C
R5	633	C
R1	529	C
R19	452	C
R15	219	C
R11	120	C
R7	110	C
R16	108	C
R8	104	C
R6	104	C
R17	82	C
R12	10	C

Figure 4.32: Risk factor final ranking

4.7.2.2 Elicitation of the inputs

Probability as it is addressed here has not a scientific meaning but refers to a common sense captured in a manner that provides structure with guide decision making.
The deliverables provided by the estimation phase are numeric estimates of uncertainty associated with identified issues. Some approaches to project risk management suggest numeric probability distributions from the outset. Some others suggest a non-numeric approach, initially using likelihood and criteria ranges associated with scenario labels such as "high", "medium", and "low", commonly referred to as a "qualitative assessment", with numeric measures later, if appropriate.
As we discussed before, a wide dispute still exists in Risk Management literature between those who emphasize a formal quantitative assessment of the probable consequences caused by the recommended actions and a comparison to the probable consequences of alternatives, and people who emphasize perceived urgency (qualitative expert judgments) or severity of the situations motivating recommended interventions.
Sometimes good data are available to provide "objective" probability estimates. Often there are aspects of a project where uncertainty is very important, but appropriate data are not available. Even where past experience is relevant, the required data may not have been collected, may not exist in a sufficient quantity or detail, or may not have been accurately or consistently recorded. In such situations, quantification may have to heavily rely on subjective estimates of probability distributions.

In this case, information used to estimate the impact and the likelihood usually comes from:

- past experience or data and records (e.g. incident reporting),
- reliable practices, international standards or guidelines,
- market research and analysis,
- experiments and prototypes,
- economics, engineering or other models,
- specialist and expert advice.

Qualitative risk elicitation techniques include:

- interviews with experts in the area of interest and questionnaires,

- use of existing models and simulations.

Any process for eliciting probability assessments from individuals needs to be carefully managed if it is to be seen as effective and as reliable as circumstances permit. Spetzler and Stael von Holstein (1975) offer the following general principles to avoid later problems in the elicitation process Various protocols for elicitation of probabilities from experts have been described in literature (Morgan and Herion, 1990, chap. 7).

The most common procedure involves the following stages:

1. identification and selection of issues;
2. identification and selection of assessing experts;
3. discussion and refinement of issues;
4. assessors trained for elicitation;
5. elicitation interviews;
6. analysis, aggregation, and resolution of disagreements between assessors.

In the elicitation process, structured interviews take place between the analyst and the specialist/generalist assessors. This involves the analyst reviewing definitions of events or uncertain quantities to be elicited, discussing the specialist's approach to the issue including approaches to a decomposition into component issues, eliciting probabilities, and checking judgments for consistency.

Spetzler and Stael von Holstein (1975) distinguish three aspects of the elicitation process: conditioning, encoding, and verification.

- *Conditioning* involves trying to head biases off during the encoding process by conditioning assessors to think fundamentally about their judgments. The analyst should ask the assessor to explain the bases for any judgments and what information is being taken into account.
- *Encoding* involves the use of techniques for input encoding, starting with easy questions followed by harder judgments. Spetzler and Stael von Holstein (1975) provide some useful advices.
- The final part of the elicitation stage involves checking the consistency of the assessor's judgments and checking the assessor is comfortable with the final distribution.

To support the input elicitation stage we suggest a semi-quantitative approach mainly based on interviews to experts. In particular we designed a questionnaire for the project managers and key users of the ERP project which should be assessed using a Delphi approach in order to make the elicitation process more effective.

The questionnaire consists of three parts:

1. The evaluation of Risk factors dependencies.
2. The evaluation of Risk factors occurrence probabilities.
3. The evaluation of Risk effect relevance.

In the first part we asked to evaluate, on a scale that goes from 1 to 7, the correlation grade between the risk factors listed in the table. The question users should answer when evaluating the generic x-y combination was: “Which is the probability that if the x risk factor occurs, then the y risk factor is going to occur too?”

Following the questionnaire it was possible to fill in the RR matrix evaluating both the dependencies and the conditioned probabilities among the risk factors, as Figure 4.33 shows.

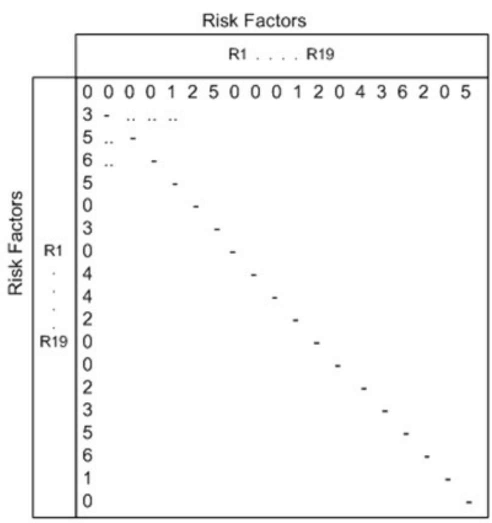


Figure 4.33: Matrix RxR

The collected value were then associated with a numeric probability according to the following scale (Figure 4.34).

1. Almost null	<0.1%
2. Very low	0.1% - 1%
3. Low	1% - 10%
4. Medium	10% - 25%
5. High	25%- 50%
6. Very high	> 50%
7. Almost certain	≈100%

Figure 4.34: Scale of probability

The same process was undertaken to analyze the risk factors/effects dependences. So the RE matrix (Figure 4.35) was finally filled in.

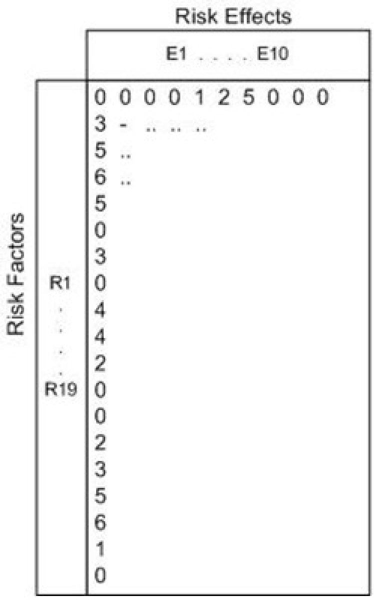


Figure 4.35: Matrix RxE

After that, the unconditioned probabilities of occurrence for each risk factor were assessed. The respondent were asked, on the base of firm culture, the working way, the organizational procedures, the used methodologies and the people involved in the project team, to associate a probability value to each risk factor according to the previous scale. The following table was filled in with this purpose (Figure 4.36).

RISK FACTOR	Probability
1. *Inadequate selection*	
2. *Poor project team skills*	
3. *Low top management involvement*	
4. *Ineffective communication system*	
5. *Low key user involvement*	
6. *Inadequate training and instruction*	
7. *Complex architecture and high number of implementation modules*	
8. *Inadequate BPR*	
9. *Bad managerial conduct*	
10. *Ineffective project management techniques*	
11. *Inadequate change management*	
12. *Inadequate legacy system management*	
13. *Ineffective consulting services*	
14. *Poor leadership*	
15. *Inadequate IT system issue*	
16. *Inadequate IT system maintainability*	
17. *Inadequate IT supplier stability and performances*	
18. *Ineffective strategic thinking and planning*	
19. *Inadequate financial management*	

Figure 4.36: Unconditioned probabilities of occurrence

Finally in the third part of the questionnaire, we asked to distribute 100 points on the risk effects, in relation to their importance (Figure 4.37). This allowed us to weight the different dimension of project success according to the priorities of the specific company.

RISK EFFECT	Score
1. *Budget exceed*	
2. *Time exceed*	
3. *Project stop*	
4. *Poor business performance*	
5. *Inadequate system reliability and stability*	
6. *Low organization process fitting*	
7. *Low user friendliness*	
8. *Low degree of integration and flexibility*	
9. *Low strategic goals fitting*	
10. *Bad financial/economic performance organization*	

Figure 4.37: Risk effect weights

4.7.2.3 The automated evaluation tool

The risk evaluation model we used for the assessment of the final risk ranking is very simple. The only critical task, from a computational point of view, was the identification of all the paths between a risk factor and the risk effects, since the number of paths increases exponentially with the number of the variables.

The software prototype we developed automates the computational algorithm (the code of the program is reported in appendix B). The algorithm was implemented in Python, an open source language which is very flexible and offers a lot of useful pre-compiled structures. NetworkX and Graphviz programs were used to build the risk network, assess the DAG test and finally draw the network diagram.

The software architecture follows the framework in Figure 4.38.

The steps implemented by the software are:

1. Acquisition of the inputs to the model as a text file;
2. Test of the inputs;
3. DAG test;
4. Building of the risk network;

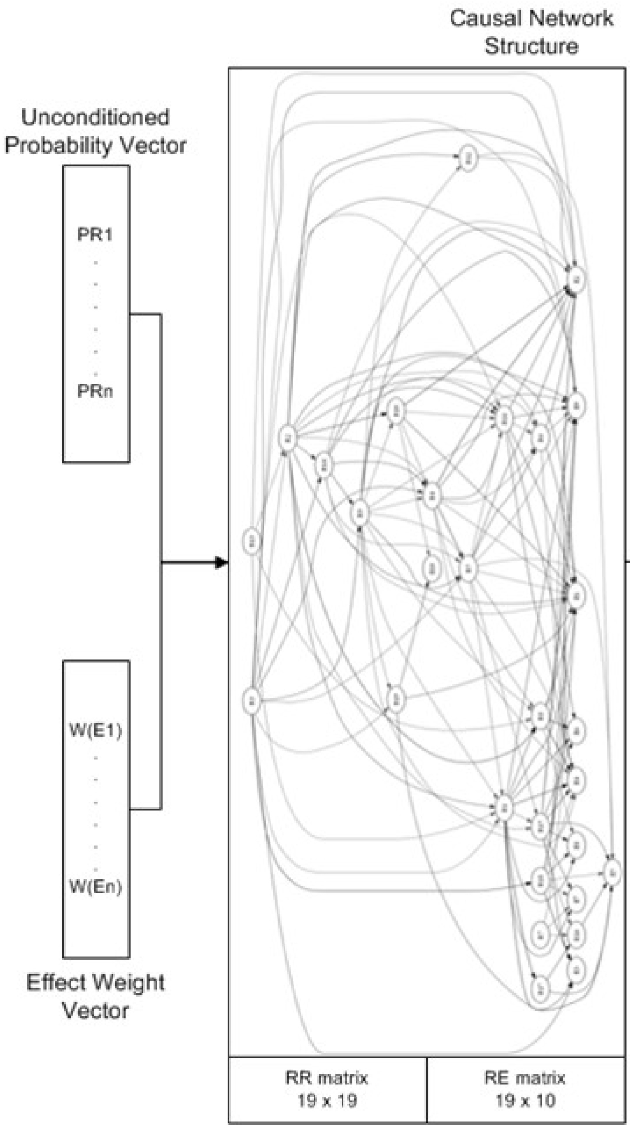


Figure 4.38: Software framework

5. Path identification;

6. Estimation of the path probabilities;

7. Definition of the risk factor score.

Once the inputs (RR and RE matrices, PR and WE vectors and the vector of the probability scale to translate experts' judgments into probabilistic values) are assessed, the software supports the risk network construction testing the inputs and achieving a DAG test. If the graph is not a DAG, the software guides the user in the network exploration in order to identify loops or incoherent graphs. When the tests are passed, the software builds the risk network and gives in output a network graph as reported in Figure 4.39.

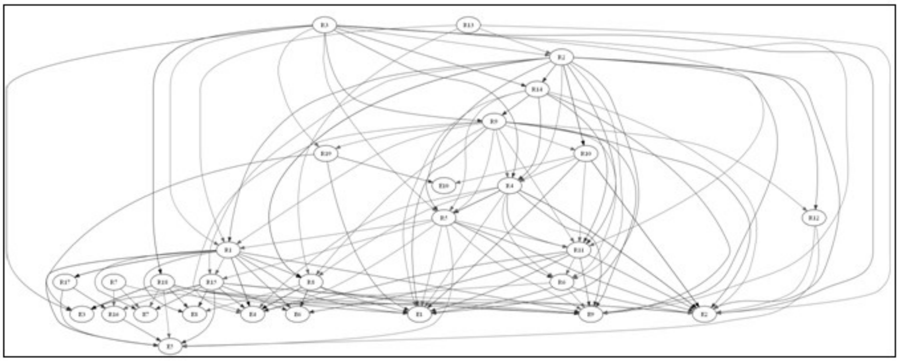


Figure 4.39: Risk factor/effect network

After that, the software computes, for each risk factor, all the paths between the risk factor and the effects. In particular, for each risk effect, the software identifies all the paths (potentially more than one) and computes a conjoint probability of the event chain keeping into account the occurrence probabilities of all the risk factors. Then these conjoint probabilities are added each other and weighted according to the estimated impact of the risk effect. The software repeats this last procedure for each effect and finally adds all the result. It finally scales the result according to the unconditioned probability of the specific risk factor we are investigating (starting node), so that a score can be associated with it.

A ranking of all the risk factors is finally given as output. See, for example, Figure 4.40.

```
Risk evaluation                                      Ri     P*E
                                                     R3     18569
Lettura dati di input ...  OK                        R2     12906
Creazione grafo ...  OK                              R13    12598
Creazione grafo per GraphViz ...  OK                 R14    6729
Controllo grafo - DAG ...  OK                        R9     4011
Calcolo percorsi da Ri a Ej ...  OK                  R10    1797
 Numero di percorsi totali  :  12445                 R4     1339
Calcolo probabilita' percorsi ...  OK                R18    724
Calcolo indici di rischio ...  OK                    R5     633
                                                     R1     529
Ranking dei fattori di rischio :                     R19    452
                                                     R15    219
--->                                                 R11    120
                                                     R7     110
                                                     R16    108
                                                     R8     104
                                                     R6     104
                                                     R17    82
                                                     R12    10
```

Figure 4.40: Software Output (Ranking)

A cluster analysis can be performed to divide the ranking into classes with a different treatment priority. This action is not supported by the software.

4.8 Conclusion

In this chapter we have presented a proposal for specific methodologies regarding the context analysis and the risk assessment phase in ERP project risk management.
After having discussed the main objectives of the context analysis and the risk assessment phase, the chapter reports the main contributions from risk management literature regarding these phases and presents a brief review of the available techniques and tools. Then the chapter provides managers with new and old techniques, adapted to the ERP case, which can be used in an innovative approach for the context analysis and risk assessment (i.e. identification, analysis and evaluation) in ERP projects.

The innovative contributions of the work are:

- the specification of the main dimensions which managers should use for a preliminary context analysis in ERP projects;

- an extended literature review aiming to the identification and classification of the main risk factors in ERP projects (risk factors were identified, homogenized and analyzed);
- the definition of the meaning of project success for such projects;
- the proposal of a panel of attributes useful for studying the identified risk factors and a ISM-based technique for the analysis of interdependencies among risk factors and between risk factors and effects in the risk analysis phase;
- a probabilistic-network based approach and a specific elicitation process to manage the risk evaluation phase;
- a software prototype automating the evaluation phase.

The main expected benefits from the use of the suggested techniques are:

- a simplification of the context analysis phase and a more complete and easy risk identification process;
- a more complete and in-depth knowledge of risk factors in ERP introduction projects;
- a clear definition of the meaning of project success for the project team and consequentially of the potential risk effects;
- a better classification of the risk factors during the risk analysis, useful to provide the necessary information to the next risk treatment phase;
- a more objective and systematic analysis of risk factors inter-dependences and their causal links to potential effects in ERP introduction projects, since it is addressed by a high qualified sample of experts;
- a classification of the risk factors according to their dependence and driver power, which can help managers in the project management (dependent factors are important for the ex post control of residual risk, whereas independent factors are important for the ex ante control and risk reduction). Furthermore we can highlight autonomous factors (low dependence and driving power) and linkage ones (high dependence and driving power);
- the definition of a direct graph of risk factors and effect interdependences (similar to Fault Tree Analysis) useful for a better understanding of the complex network of risks;
- a more effective and computerized evaluation of the risk level for the risk factors, since the software automates a lot of activities and simplifies the computation of interdependencies among risk factors and effects.

CHAPTER 5

Risk Treatment and Control

This chapter focuses on the Risk Treatment and Control phases which are the core steps of the risk management process. In particular, attention has been paid on the selection of an appropriate and timely strategy to reduce ERP project risks. After Context analysis and Risk assessment, in Risk Treatment

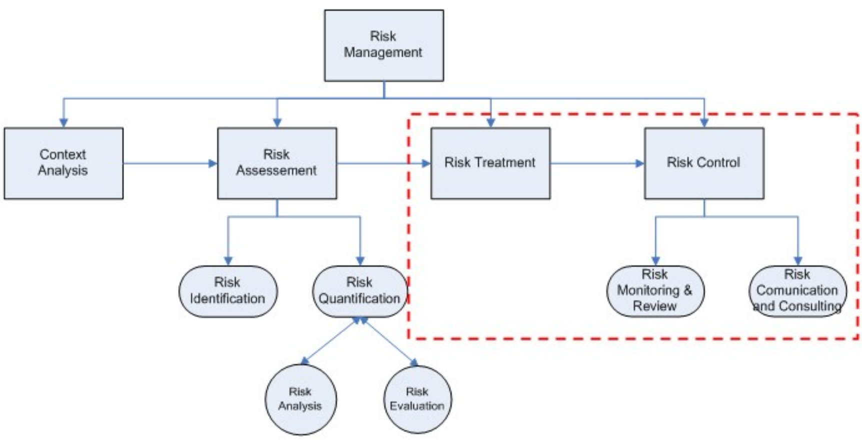


Figure 5.1: Risk Management Process

and Control phases (Figure 5.1), an effective strategy has to be adopted and implemented to manage risks.
The Risk Treatment phase includes the selection and implementation of an appropriate risk mitigation strategy, and works considering the main outcomes from the context analysis (the profiles of risk factors), risk assessment phase (the ranking of risk factors) and the ERP project life cycle.
The Risk Control phase, instead, aims to manage the project risks in order to perform a better control on the project and increase its probability of success. The main issues of Risk Control phase are: Monitoring and Review (reporting, reviewing and action taking) and Communication and Consulting (communicate hazard).

In the first part of this chapter, a brief review of the Risk Treatment and Control processes is reported from literature. The next sections deal with the peculiarities of Risk Treatment and Control in the ERP case. After that, literature evidences and semi-structured interviews to practitioners are used to draw a roadmap of the possible actions which manager can consider in order to contrast each risk factor. Finally, conclusions are reported.

The main outlines of this chapter are:

- Introduction to risk mitigation
- Risk Treatment and Control processes
- Peculiarities on the ERP case
- Roadmap of potential response actions
- Suggestions on the control phase
- Conclusions

5.1 Introduction

"If you can't afford to mitigate the risk now, be absolutely sure you can afford to resolve the problem later when it happens."

(Universal, 2002)

Risk management processes usually fail immediately after the Risk Assessment phase since nothing is definitively done (Rook, 1994). None risk management approach, in fact, is really effective if it does not lead to an appropriate support for the selection of the right strategy in Risk Treatment and Control phases.

The Risk Treatment phase closes the loop of the Risk Management process, managing the selection and implementation of risk response actions which must be included in a formal Risk Management Plan. In this context a reactive (or feed back) approach refers to risk mitigation actions started after risk events eventuate and can be seen as the initiation of contingency plans. On the other hand, a pro-active (or feed forward) approach refers to actions started basing on the chance of a risk event occurring, such as insurance (Kartam and Kartam, 2001; DeMaio et al., 1994). A combination of these two approaches is applied in risk management to avoid risk, reduce the likelihood of risk, reduce the impact of risk, transfer risk, or retain risk (Risk Management Standard AS/NZS 4360, 1999).

A major concern of formal risk management is to avoid nasty surprises that give rise to crises and require crisis management. Crisis might be defined as "a time of acute danger or difficulty" or "a major turning point". The Risk Management Plan usually contains (Chapman and Ward, 2003):

1. updated, detailed plans for all activities to be undertaken during the action horizon, with ownership of issues and responsibility for issues clearly indicated, as well as anticipated progress;
2. a short, prioritized list of issues requiring attention on the ongoing management, with changes in priority emphasized and trends assessed, and both ownerships in financial terms and managerial responsibility clearly defined.

Definitively, the Risk Management Plan is not a static document, but defines how project risk assessment and management should be implemented in the context of a particular project and should be frequently updated during the Project Life Cycle according to the realization of planned actions (reduction of risk) or when new risk factors rise up.

A new assessment should be initiated by any unplanned significant event, significant planned event, and the completion of review time cycles. Assessment may simply confirm the project can proceed as planned. However, it may indicate the need of going right back to define the project phase or the need of an intermediate loop back.

In Enterprise Resource Planning (ERP) projects, dealing with risk management is even a more ambitious task. Risk factors include technological and managerial aspects, both psychological and sociological; they are often deeply interconnected and have indirect effects on the project (Aloini et al. 2008). The selection of the most appropriate Risk Treatment strategy needs to consider not only the risky of a specific event but several other dimensions, as the project life cycle phase in which it occurs, the controllability, the delectability and the dependence (or driving power) from (to) other risk factors.

In this part of the thesis the main objective is to develop an effective risk management methodology supporting the formulation of Risk Treatment strategies and actions during ERP introduction projects in order to improve the success rate.

As for the definition of potential response actions, methodologies and techniques are not available or lack. We consider speaking about heuristics is more appropriate. A heuristic method for a solution is a useful method, often coming from practise and past experience on a specific or similar problem, which however doesn't always work and could not be easy to generalize. Heuristics are often presented as a checklist of open-ended questions, suggestions, or guidewords; the purpose is not to control the actions, but to help in considering the more possibilities and interesting aspects of the problem.

In this work, an innovative approach is presented in order to enable the selection of an appropriate and timely strategy in Risk Treatment and Control phases. Starting from literature evidences and case studies a general map of the critical variables which could drive this choice is drawn. A roadmap (guideline) is finally created and suitable strategies are explained in relation to the project life cycle, the risk factor profile and the impacts on the project.

5.2 Risk Treatment

Definitions from literature: *Risk Treatment* is the process of selection and implementation of measures to modify risk. Risk treatment measures can include avoiding, mitigating, transferring or retaining risk.

(*Definition adapted from ISO/IEC Guide 73*)

According to this definition, Risk Treatment is the process of selecting and implementing measures to modify risk. After having identified and evaluated the risks, the next step involves the identification of alternative and appropriate actions for managing these risks, the evaluation and assessment of their results or impacts and the specification and implementation of treatment plans. To accomplish this objective is necessary to:

- Identify potential actions
- Plan the actions on the Risk Management Plan

5.2.1 Identify potential actions

Identify the most appropriate actions for a specific risk factor is a hard and not codified task. As we considered before, it is usually due to heuristic behaviours which rise from practice and experience.

However, the management options towards negative-risks usually pertain to:

- avoid risk by deciding to stop, postpone, cancel or continue an activity that may be the cause of that risk;
- modify the likelihood of the risk trying to reduce or eliminate the likelihood of the negative outcomes;
- try modifying the consequences in a way that will reduce losses;
- share risk with other parties facing the same risk (insurance arrangements and organizational structures such as partnerships and joint ventures can be used to spread responsibility and liability); of course if a risk is totally or partially shared, the organization is acquiring a new risk (i.e. the organization to which the initial risk has been transferred may not effectively manage this risk);
- retain risk or its residual risks.

An organisation will apply these responses based on its risk attitude and cost/benefit results, aiming towards the "as low as possible remaining risk" and assigning to it the proper level of management.

Literature describes generic options for responding to project risks (e.g., DeMarco and Lister, 2003; Kerzner, 2003; Schwalbe, 2007). Within these high-level options, specific responses can be formulated according to the circumstances of the project, the threat, the cost of the response and the resources required. Typically, risk response strategies aim either to reduce or eliminate the likelihood of the threat occurring (that is, to reduce P); limit the impact of the risk if it is realized (reduce I); or a combination of both. These strategies are formulated and implemented in response to new risks whenever they are identified and assessed as a threat that must be controlled. Four common risk response strategies are found in literature:

The *Avoidance* strategy aims to prevent a negative effect occurring or impacting a project. This may involve, for example, a change in the project design so that the circumstance under which a particular risk event might occur cannot arise. For example, planned functionality might be "de-scoped" to remove a highly uncertain feature to a separate phase or project in which more agile development methods might be applied to determine the requirement (Boehm and Turner, 2003).

Transference strategy involves shifting the responsibility of a risk to a third part. This action does not eliminate the threat to the project; it just passes the responsibility of its management to someone else. Theoretically, it implies a principal-agent relationship wherein the agent can better manage the risk, resulting in a better overall outcome for the project. This can be a high risk strategy because the threats of the project remain, the project manager must ultimately bear with them, but the direct control is surrendered to the sub-contractor (agent). Common risk transfer strategies include insurance, contracts, warranties, and outsourcing. In most cases, a risk premium is paid to the agent to take the ownership of the risk, as penalties are sometimes included in the contracts. The agent must then develop its own response strategy for the risk.

Risk Mitigation strategy is one of the most reinforcing actions designed to reduce a threat to a project by reducing its likelihood and/or potential impact before the risk is realized. Ultimately, the aim is to manage the project in order to prevent the risk event or, if occurs, contain the impact in a low level (manage the threat to zero). For example, using independent testers and test scripts to verify and validate softwares throughout the development and integration stages of a project may reduce the likelihood of defects found in a post-delivery phase and minimize the project delays due to software quality problems.

Risk acceptance strategy can include a range of passive and active response strategies. The first is to passively accept that the risk exists and choose to do nothing with it except monitoring its status. This may be an appropriate response when the threat is low and the source of the risk is external to the project control (Schmidt et al., 2001). Alternatively, the threat may be real but there is nothing that can be done until it materializes. In this case, contingencies can be established to handle the conditions of when and if it occurs (as a planned reaction). The contingency may be in the form of provision of extra funds or other reserves, or maybe a detailed action plan (contingency plan) that can be quickly enacted when the problem arises.

Validation and maintenance of contingency plans is a critical part of this strategy to ensure that contingency plans work as expected when required. Overall, risk response strategies are effective in providing general options for consideration in formulating responses to the foreseen project threats. Each of them requires the formulation of a specific response, which should be then executed and re-assessed throughout the project as the nature of the risk unfolds or significantly changes. However, consistent with a narrow definition of risk, they provide no generic response options for unforeseen threats.

In general, the cost of managing a risk needs to be compared with the benefits obtained or expected. During this process of cost-benefit judgments, the Risk Management context established in the first process (i.e. Definition of Scope and Framework, s. section 5.2) should be taken into consideration. It is important to consider all the direct and indirect costs and benefits, whether tangible or intangible. More options can be considered and adopted either separately or jointly, for example the use of support contracts and specific risk treatments followed by appropriate insurance or other means of risk financing.

If available resources (e.g. the budget) are not sufficient for risk treatment, the Risk Management action plan should set the necessary priorities and clearly identify the order in which individual risk treatment actions should be implemented.

It is important to note that since identified risks may have a variety of impact on the organization, not all risks carry the prospect of loss or damage. Opportunities may also arise from the risk identification process, as types of risk with positive impact or outcomes may be identified, but this is out of the scope of this work.

Potential response actions can be classified not only in relation with the strategies just presented, but also in respect to the type of risk they undertake, in Figure 5.2 an example of this classification is reported.

Strategy \ Risk	Financial	Technical	Schedule
Avoidance	Action		
Mitigation			
Transference			
Acceptation			

Figure 5.2: Risk response classification

5.2.2 Plan the actions on the Risk Management Plan

Treatment plans are necessary in order to describe how the chosen options will be implemented. The treatment plans should be comprehensive and provide all the necessary information about:

- proposed actions, priorities or time plans;
- resource requirements;
- roles and responsibilities of all parties involved in the proposed actions;
- performance measures;
- reporting and monitoring requirements.

Action plans should be in line with the values and perceptions of all types of stakeholders (e.g. internal organizational units, outsourcing partners, customers etc.). Top management's support is critical throughout the entire life-cycle of the process. The better the plans are communicated to the different stakeholders, the easier it is to obtain the approval of the proposed plans and a commitment to their implementation.

5.3 Comparing costs and benefits

Selecting the most appropriate option involves balancing the costs of implementing each option against the benefits derived from it. In general, the cost of managing risks needs to be commensurate with the benefits obtained. When judgements about costs versus benefits are made, the context should be taken into account. It is important to consider all direct and indirect costs and benefits whether tangible or intangible, and measured in financial or other terms.

Decision makers should take account of carefully considering rare but severe risks that may warrant risk treatment actions that are not justifiable on strictly economic grounds. Legal and social responsibility requirements may override simple financial cost/benefit analysis.

Risk treatment options should consider the values and perceptions of stakeholders and the most appropriate ways to communicate with them. It is important to compare the full cost of not taking action against the budgetary saving.

Risk treatment may itself introduce new risks that need to be identified, assessed, treated and monitored. If there is a residual risk after treatment, a decision should be taken about whether to retain this risk or repeat the risk treatment process.

5.4 Risk Control

Risk Control phase aims to the effectiveness of the Risk Management Process in time. It consists of:

- *Risk Communication*, the process to exchange or share information about risk between the decision-makers and other stakeholders inside and outside an organization (e.g. departments and outsourcers respectively). The information can regard the existence, nature, form, probability, severity, acceptability, treatment or other aspects of risk.

  (*Definition adopted from ISO/IEC Guide 73*)

  Monitor and Review, the process for measuring the efficiency and effectiveness of the Organization's Risk Management processes, establishing an ongoing monitor and review process. This process ensures the specified management action plans remain relevant and updated. This process also implements the control activities including re-evaluation of the scope and compliance with decisions.

  (*ENISA*)

In a changing business environment, factors affecting the likelihood and consequences of a risk are also very likely to change. It is therefore necessary to regularly repeat the risk management cycle and make Risk Management become a part of the organization's culture and philosophy through a well structured communication system.

The organization must collect and document experience and knowledge through a consistent monitoring and review of events, treatment plans, results and all relevant records. This information, however, will be pertinent to information risks. Technical details concerning operational issues of the underlying technology have to be filtered out. Each stage of the Risk Management process must be appropriately recorded. Assumptions, methods, data sources, results and reasons for decisions must be included in the recorded material. Residual risk, that is the remaining risk after Risk Management options, must be identified and action plans must be evaluated. It includes all the initially unidentified risks as well as all the previously identified and evaluated risks that were not designated for treatment at that time.

It is important for the organizations management and all other decision makers to be well informed about the nature and extent of the residual risk. For this purpose, residual risks should always be documented and subjected to regular monitoring-and-reviewing procedures.

5.5 Risk treatment in ERP projects literature analysis

Potential strategies for risk treatment responding to the several risk factors which could appear during the introduction of an ERP system are difficult to find in literature.
Among all the authors we considered in our review, only two of them speak about strategies to minimize risk. The first is Sumner (2000) in his work "Risk factors in enterprise-wide/ERP projects". After having identified the main risk factors in the ERP context, he maps them in a general life cycle scheme providing potential actions responding to specific risk classes. The second author is Zafiropoulos (2005) in his work "Dynamic risk management system for the modeling, optimal adaptation and implementation of an ERP system". In the Risk Management system they suggest (See Chapter 3 for details), risk mitigation is accomplished by a specific form where strategies are suggested. So the manager has the necessary proposals for the tasks she/he needs. The form analyzes the possible risks and presents ways of dealing with each of them. So that, a mitigation strategy is proposed for each risk category and sub-category.

As pointed out in chapter 3, the Risk Treatment phase evidences a clear gap in literature. The proposed mitigating strategies are "standard", neither differentiated according to the type of risk treatment strategy (avoidance, mitigation, transference and acceptation) or phased in the project life cycle (Zafiropoulos et al., 2005). When this happens (Sumner, 2000), strategies are too general, vague and do not provide any practical or effective solution. Often they only concern with resource allocation (Yang et al., 2006) or appear as general comments to critical success factors as many we have already studied in literature. Moreover, the transversal phases as context analysis, risk monitoring and communication are scarcely supported and contributions often remand to more general risk management approaches (see Chapter 2).

Heuristics and best practises spread across all the ERP literature, have sometimes similar features to the risk treatment strategies, especially in case studies and researches in the field. However these strategies are not systematized or homogenized, resulting scarcely suitable for managers.

5.6 A roadmap for strategies selection

After Context Analysis and Risk assessment, in Risk Treatment and Control phases, an effective strategy has to be adopted and implemented to manage risks.

As introduced before, the goal of this phase is to plan a whole of consistent and feasible actions and related organizational responsibility to avoid, reduce the likelihood, reduce the impact, transfer or retain the risk. Basing on the output of the Risk assessment phase, the ERP project team has to develop plans for actions to reduce the identified risks level. The tangible output is a formal Risk Management Plan (RMP), an additional project management tool to execute a feed-forward (support to project design, actions based on the chance of a risk event) an feed-back (risk mitigation action following after risk manifestation) control. Such plan is not a static document because of the unexpected problems which can rise up, moreover the realization of planned actions and its design must overcome the trade off between the planned outcomes, the cost of their execution, constraints and available skills.

The identification of a possible response to a particular source is often a simple task and, once a source has been identified, it is frequently obvious how manager could respond. However, the most easily identified possible response may not be the most effective or the most risk efficient; other responses may be worth identifying and considering (Chapman and Ward, 2003).

Not all the strategies of risk avoidance, risk transference, risk mitigation and risk acceptance are usually suitable for all kind of risk factors; it depends both on the risk factor profile and on the costs of the actions.

In our opinion, in selecting the response strategies, a better understanding of the risk factors can be useful for the design of the RMP. The relevant attributes for factor classification are:

1. *Detect-ability*: the easy or difficult detection of the occurrence of a risk factor can significantly influence the selection of response strategies and actions. If the manifestation detection is difficult, in fact, the risk of the

factor rises and some response strategies become not-suitable.

2. *Responsibility*: the responsibility of a risk factor can be internal or external. If the responsibility of a risk factor is strictly internal, for example, risk transference strategy are scarcely suitable.

3. *Project life cycle phase*: not all the risk factors are active in each phase of the project life. Considering the phase in which a risk factor is enabled to occur is important in order to define the suitable and timely strategies. Moreover some classes of strategies are suitable only in the earlier phase of the project, as for example the risk avoidance, most of the transference actions, and so on.

4. *Controllability*: controllability of a risk factor concerns the possibility of influencing its probability of occurrence. Theoretically, controllability should be linked to responsibility, so that people which responsibility is assigned to, are those ones who can influence a factor. When this does not happen, managers can use outsourcing strategies to better manage a risk factor, but agreements and penalties should be clearly defined to avoid bad operative performances. Controllability of a risk factor also influences the suitability of strategies; if a risk factor is not controllable, risk mitigation strategies are ineffective or totally impracticable.

5. *Dependence*: as we already said, ERP projects are complex adventures, risk factors include technological and managerial aspects, both psychological and sociological; moreover they are deeply interconnected and have indirect effects on the project. The degree of dependence of a risk factor (how many factors it is depending on) and driving power (how many factors it leads to), in particular, is a critical task in risk assessment since a snowball effect can occur. This aspect should be considered not only in risk assessment for prioritization but also in the selection of the appropriate strategies since other effects can occur and new risk factors rise. Interpretive Structural Modelling technique (Sage, 1977) as other Analytic Network Process (ANP) (Saaty, 1996) approaches can be useful to model dependences and interconnections among risk factors and between risk factors and effects, to draw a risk event tree.

Furthermore, we suggest the use of a *context diagram* (Figure 5.3) such as SAFE methodology proposes (Meli, 2003), in order to add information about the risk factors profile, in terms of *control, consideration and influence*. These tools is also useful in other risk management phases, as for example to guide the brainstorming activities in risk identification etc. We allocate *factors* and *subjects*, respectively passive elements with no decision making power (events, normative, specifications,..) and entities able to decide and influence the project success (IT manager, consultants, top management, project management tools).

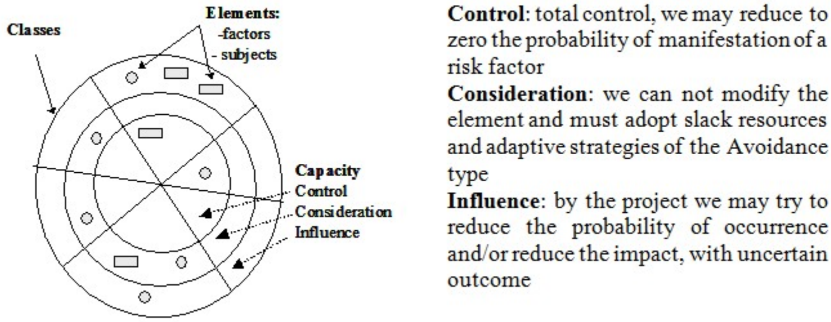


Figure 5.3: Context diagram

Factors are allocated in Classes, the cloves, such as Technology, Normative, Management, Organization, Strategy and so on. The circle crowns are related to the capacity of the project (project manager and team) to influence, consider or control, along a continuum of the elements.

The frame below, on the right side, (Figure 5.4) shows how potential actions can be planned during the different stages of the ERP project life cycle, according to the suitable risk management strategies and to the risk factors profile. This can be a good reference for the design of the Risk Management Plan. We must obviously correlate this information to the risk factor profile as we discussed above.

Life Cycle Phase	Risk Factors	Risk Factor Profile				Risk Management Strategy				
		Detect-ability	*Controll-ability*	*Responsibility*	*Dependence*	*Avoidance*	*Mitigation*		*Transference*	*Acceptance*
							Likehood	Effects		
Phase 1:n	*R1*									
	...	...	...	...	...	(action i)	(action j)	...	...	...
	R19									

Figure 5.4: Suitable Risk Management Strategies

5.6.1 Suitable response action in ERP projects

Definitely, in Enterprise Resource Planning projects, Risk Treatment involves several interrelated and context - specific aspects such as technological, managerial and organizational risk factors, the phase of the project life cycle in which they occur and have to be managed, the most appropriate strategies and specific

relative responses.
In this chapter we expect two major outcomes to be achieved:

- Variables for a better classification of the risk factors in order to guide the selection of suitable risk response actions;
- a roadmap supporting the selection of risk management strategies for each risk factor during the ERP project life cycle.

In the following figure (Figure 5.5), suitable actions for each life cycle stage are reported and classified in a specific class of strategies. Strategies in the

Life Cycle Phase	Risk Factors		Risk Management Strategy				
			Avoidance	*Mitigation*		*Transference*	*Acceptance*
				Likelihood	Effects		
Phase 1 (Project preparation)	Inadequate ERP selection	*R1*	1a	1b	1c	1d	c, f, fc, p
	Poor project team skills	*R2*	-	2b	2c	-	c, f, fc, p
	Low top management involvement	*R3*	-	3b	3c	-	c, f, fc, p
	Ineffective communication system	*R4*	-	4b	-	4d	c, f, fc, p
	Low key user involvement	*R5*	-	5b	-	-	c, f, fc, p
	Inadequate training and instruction	*R6*	6a	6b	-	6d	c, f, fc, p
	Complex architecture and high number of implementation modules	*R7*	7a	7b	7c	-	c, f, fc, p
	Inadequate BPR	*R8*	8a	8b	8c	8d	c, f, fc, p
	Bad managerial conduction	*R9*	-	9b	-	-	c, f, fc, p
	Ineffective project management techniques	*R10*	-	10b	-	10d	c, f, fc, p
	Inadequate change management	*R11*	-	11b	-	-	c, f, fc, p
	Inadequate legacy system management	*R12*	-	12b	-	12d	c, f, fc, p
	Ineffective consulting services experiences	*R13*	13a	13b	-	-	c, f, fc, p
	Poor leadership	*R14*	-	14b	-	-	c, f, fc, p
	Inadequate IT system issues	*R15*	-	15b	-	15d	c, f, fc, p
	Inadequate IT system maintainability	*R16*	-	16b	-	16d	c, f, fc, p
	Inadequate IT Supplier stability and performances	*R17*	17a	17b	17c	17d	c, f, fc, p
	Ineffective strategic thinking and planning Strategic	*R18*	-	18b	-	-	c, f, fc, p
	Inadequate financial management	*R19*	-	19b	-	-	c, f, fc, p

Figure 5.5: Suitable actions in Project preparation phase

"Avoidance" class try to re-define the problem changing the scope or the objectives. This kind of actions are suitable when the project is in the very early stages of the life cycle since objectives and boundaries are not completely defined and when specific risks present themselves as relevant and already well defined. These strategies are quite unconventional in common ERP project management practices and heuristics are difficult to identify. [Suitable in the Project Preparation phase]

Strategies in the "Mitigation" class try to reduce the probability that a risk factor occurs (Likelihood) or, if it happens, to minimize the impact on the project objectives (Effects).
This actions are suitable along all the project life but effectiveness and costs are optimized if they are planned in the early stages of the project. Usually, since project resources are limited, a prioritized list of the risk factors (risk ranking)

exists as outcome of the risk assessment phase. So that managers can compare the risk priority with the costs of a set of potential actions, perform a cost-benefit analysis and choose the most appropriate response.
These strategies are the most common in ERP project management practices and they often matched (especially in the Likelihood sub-class) with best practises or structured approaches already known or suggested in literature. We report some examples and heuristics for the "Likehood" sub class.
In the "Mitigation" class we also find the "Effects" sub-class. Strategies in this group often consist of buffers (or actions) which try to limit the impact on the project objective. These kind of actions usually admit the use of the planning for extra resources and time. Buffers should not be confused with contingencies in the acceptance class. Differently from contingencies, in fact, they do not adduct a generic extra resource allocation on the issues, but provide resources for preventive actions contrasting a risk factor (buffers have to be set in advance for an effective allocation) in order to reduce the impact. The focus is on the effects, actions try to make the effects independent from the identified causes.

Strategies in the "Trasference" class try to share or re-direct the risk to other subjects, for example by insurance or outsourcing of activities. This class of actions are suitable when the project is in the very early stages of the life cycle since they impact on project scope, objectives and responsibilities. [Suitable in the Project Preparation phase]
Definitely, these actions should be planned in advance when the project plan is still not completely defined, when some risks cannot be accepted. They are quite difficult to apply to IT projects (especially insurances) but not impracticable; in practise, actions in this class, are often reduced to externalization of activities and an accurate management of contracts and penalties.

We report below some examples of potential response actions for each identified risk factor in ERP project. Actions are numbered according to Figure 5.5.

R1 Inadequate selection of the ERP package

1.a Stating the fully adaptation of the company to the ERP business model as an explicit objective of the implementation project. Alternatively the management could choose to completely or partially develop or customize the ERP package according to the company needs.

1.b A structured process and a multiple perspective of analysis are key factors for a right ERP selection. An heterogeneous task force should be assembled or recruited in order to assess an adequate selection. Members should come from all the functions involved in the project or interested by any changes derived from it. Business, Information Technology (IT) as well specific competencies on the selection process have to be mixed. External consultants, such as consulting firms, business integrator and academic experts, carrying specific competencies on the selection and on the ERP package have to be introduced in the selection team beyond the internal staff. As for the selection process, structured approaches are well known in literature, check lists as well as complementary methodologies are available. Companies should follow these guidelines in defining selection criteria, moreover the use of demos and business cases (demonstrations) for a first key-user evaluation is highly recommended since the previous stages of selection. These kinds of actions are suitable in the early stage of the project life cycle and during the selection phase (Project preparation).

1.c A wrong selection of ERP package is difficult to verify in the early stages of the project. Once it occurs, a reiteration of the process rarely happens and, in this case, extra costs are extremely high. Planning in advance for extra time and budget to spend for customization and adaptation activities is then recommended. These are extra costs as well, so a cost/benefit analysis is essential for the evaluation of the action suitability.

1.d The responsibility of the selection is clearly internal to the project team in any ERP introduction project. However we can re-think this process planning to externalize some activities to business integrators or to a consulting firm competing for the selection; for example this could be the case of the preliminary GAP analysis which companies are usual to assess just after the ERP selection. The GAP analysis could potentially be included contractually in the selection phase, in order to be previously performed and to achieve a better selection of the ERP software, vendor and business integrator.

R2 Poor project team skills

2.b In the project team, adequate skills have to be guaranteed; this could also support a correct definition of the work group in terms of number of participants, competencies and organization. An heterogeneous team should be assembled including key people and managers from all the company functions; consultants should be selected according to their experience in the implementation of specific modules and not basing on a generic knowledge of the software package. This is essential in order to cover all the skill needs in the IT, Business and Process dimensions. Budget should be planned to buy external competencies if it is needed (Project preparation). Finally, the introduction of redundancies in terms of team member's competencies can be a possibility to keep low the probability of inadequate team skills. This is obviously an extra cost for the company, so a cost/benefit analysis should be assessed.

2.c In the project preparation extra budget and time could be planned in order to response to the needs of core skills and competencies which were not covered by profiles of people in the project team.

R3 Low commitment of the top management

3.b The top management has to be informed about its important role in motivating people during the project. Meetings with the project team should be planned as well as communication from the Top Management to the end-user during the main milestones or when problems occur. This is a critical task especially in Blue-Print and Realization phases.

3.c Mitigating the effects of a low top management commitment also means to continuously monitor the key and end-user perception about the top management presence and interest into the project. Questionnaires, as well as interviews, formal or informal meetings or other means for information exchange can be used with this purpose. In the same time, since one of the most important effects of a low top management involvement is the low participation and collaboration of key and end-user, another possible response action could be a clear system of incentives which could motivate people to complete the project in the best way.

R4 Ineffective communication system

4.b As for the internal communication among the project team, the project communication and reporting structures become critical with complex knowledge coordination requirements. The team members should participate in regularly scheduled meetings, develop regular status reports, and utilize a common repository for knowledge objects (e.g. issue resolutions, change requests, status reports, etc.). Standards for submitting information should be developed along with a formal knowledge coordination procedure (Zafiropoulus, 2005) (Project organization and planning). A structured project management approach such as an automated document management system in the company like SAP solution manager or Windows Sharepoint can be useful support tools during the realization phase. If not yet present, the technical infrastructure for project team communication and knowledge sharing need to be put in place before the project begins (Project preparation).
As for communication to end-users, it can be useful to involve the key user first, and then the end-user just in the requirement planning, process mapping phases (Business Blueprints) and detailed design (Realization). Moreover, periodic meetings should be planned between the top/middle management and the final users.

4.d The responsibility of the communication process can be outsourced to experts from consulting firms, not only as regard to the internal communication of the project but also for communications that are external to the project team. A communication plan should be contractually defined and unambiguous indicators established in order to evaluate the process performance and eventually apply contractual penalties.

R5 Low involvement of the key users

5.b Users can cause serious problems for the implementation teams by refusing to cooperate during the training and go live efforts since their fears about changes resulting from the new system. It is important to get other key users involved at various stages of the implementation (e.g. business blueprint, process mapping, realization and end-user training design). This will allow them to provide the process with inputs, while giving them the adequate time to accept any potential changes to their work structure and diffuse this acceptance to other users (Zafiropoulus, 2005). It is also important to plan for an adequate time allocation of the key users in order to achieve the necessary amount of work for the pre-established activities.

R6 Inadequate training

6.a The avoidance strategy, in this case, means to make the implementation not to be influenced by training and instruction processes. It needs the ERP system to be totally fitting with the old one, both in terms of process, functionality and presentation. This is possible in extreme cases, i.e: the old system exists and responds well to the functional and not-functional informative needs of the organization.

6.b Training should be approached as a separate project. Project management activities should be explicitly directed to this aim in order to define the involved people, identify the formative needs, understand when the courses should start, which people and which mean/form should be used. A specific budget must be planned for this process and control actions should be activated (such as final tests or simulations). Involving consultants or business integrator are quite common in training activities, as well an adequate help desk is important in the first weeks after the go-live since they are critical for users in terms of emerging problems, misunderstandings and so on (Project realization and Go-live Support). Attention should be paid to avoid compressing/cancelling the training activities during the final preparation phase, when the project is over-time or over-budget since the project scoop screep. This can hardly compromise the effectiveness of the Go-live.

6.d The training can be included in the agreement with the consulting or business integrator. In order to transfer the risk, training plans should be detailed, precise performance indicators should be established as well in order to consider the training successfully ended. Any extra-training should be programmed and executed by the consulting firm with no extra costs for the company. Penalty could be managed to avoid delay or low quality of results.

R7 Complex ERP system architecture

7.a Planning for an incremental and not simultaneous implementation plan, in order to manage the complexity of architecture or the high number of modules. This could lead to the need for holding the legacy system operative, parallel running of the systems, a transitory duplication of modules and a longer implementation time.

7.b Poorly defined project scopes can be due to a lack of focus, wasted efforts investigating areas outside the project boundaries, complex architecture and unrealistic budget. It is important to review the project scope with the users and establish procedures for changing the scope after the project begins. All the changes, even the minor ones, require additional work by the project team and therefore increases to the schedule and budget. A formal scope management procedure should be established for the project. (Project preparation)

7.c Adopting a strategy of incremental introduction which could limit the complexity in the project. Being modular in the implementation of the ERP system can impact on a more effective and efficient resource allocation and limit the project scope.

R8 Inadequate Business Process Reengineering

8.a BPR could not be a priority factor if the company business model is a best practice in the field and the ERP software is assumed to be fully adapted to the company processes.

8.b Business Process Reengineering is a critical activity for all the IT projects, especially for those which can lead to a high organizational impact. A structured approach to the process analysis can be useful both during the project preparation, implementation and post implementation phase (Scheer et al., 2002).
Structured approaches for the process mapping, for example, should be

used during the project preparation phase in order to achieve a better selection of the ERP software package, since the TO-BE situation is defined and an accurate gap analysis between the TO-BE and AS-IS status can be drawn. In project preparation phase, mapping the AS IS and TO BE configuration of a process or a functional level is essential in order to understand what the process makes and choose the right software support. Structured tools and techniques as IDEF 0 or ARIS (Architecture of Integrated Information System) toolsets can support this need defining a standard way to represent the flow of goods, services and information in the process (Kalnins et al., 1999). IDEF 3 can offer support for the dynamic mapping of the activities instead (temporized).
During the implementation stage, instead, the process mapping is used with greater detail in order to support the GAP analysis and the software parameterization, configuration or customization. Techniques such as Even-Process-Chain (EPC) which are included in the ARIS toolset, UML Usecase or Activity Diagrams can be adopted for a better representation of the process requirements and software functionalities. Other interesting tools are for example the Entity-Relationship models, UML-state, Class Diagram which can support the definition of the Database platform, nevertheless UML-collaboration and Sequence Diagrams which model the interactions between the system and the users.
Moreover, a detailed mapping process is also useful to win the user resistance to the change because it can support in showing evidence of better process performance. Finally a good mapping can be valuable after the system Go-live (Post-implementation) to support the system maintenance and evolution of its functionalities (Eriksson and Penker, 2000).

8.c Keeping the project flexible and planning for extra budget for software customization due to a wrong BPR assessment. This action also causes an over time in the development of the project but could limit the risk factor effect on the company.

8.d Despite the responsibility of a good BPR is internal, it could be possible to outsource part of the process, as for example the process mapping, to an external partner as a consulting firm. A key issue is the identification of a well structured BPR approach and exhaustive performance indicators which could allow the control of the process.

R9 Bad managerial conduction

9.b Clear and shared objectives should be planned and communicated. The identification of a project sponsor can be crucial. Once the project sponsor is identified, the project should not proceed until the appropriate authority has been identified. (Project preparation and implementation)

R10 Ineffective project management techniques

10.b A structured approach to the use of the project management techniques has to be adopted in order to continuously manage and monitor the project state in terms of time schedule, budget and objectives. These activities, as well as the risk assessment, should not be a one-time event, but they have to be iterated during the different project phases and every time an impediment occurs (changes in the project plan, problems, and so on). Risk management is an integral part of the project management and risks should be frequently monitored and controlled during the project. If the risk management procedures are not instituted, there are great chances the project will be facing negative events unprepared, with impacts on duration and costs. This can be reduced by doing frequent risk analysis, following a clear procedure. The risks with high probability as well as a high negative impact on the project must be discussed most thoroughly. As an outcome the project manager should define actions to minimize the probability that the risk comes through and/or should define a contingency plan to be able to adequately react once the risk becomes reality (Zafiropolous, 2005). The use of project/risk management tools and techniques should be planned during the project preparation, and should continue along all the project life cycle. Particular attention should be addressed to the evaluation of rapid introduction methodologies which can lead to underestimate time and the real resource need.

10.d The effectiveness of project management techniques is hard to demonstrate in order to share a specific project risk. The only thing an agreement can make is to establish which technique has to be used, for which activity, the frequency of these activities, the responsibilities, the people who should be involved, and so on. This is the case, for example, of the use of a structured risk management methodology since the early stages of the project.

R11 Inadequate change management

11.b Behavioral changes should be identified early in the project (project preparation phase). They should also be re-examined at various milestones (realization). If change is significant or the organization does not adapt well to change, a change management initiative and consultants may be required (Zafiropolous, 2005). If organizational change occurs, people have to know their new responsibilities or roles, or being able to hire the right people in time for implementation. Finally, user careers should be aligned with their attitude with the system and people should be informed on the incentives in order to avoid the unwillingness to use the new system because they are dissatisfied with the new organizational changes.

R12 Inadequate legacy system management

12.b Legacy system management, if needed, is a strategic sub-project in the ERP implementation. Structured techniques suggest to explore the purpose and the objectives of the new system first, then to determine a technical solution and finally to investigate how the company copes with the legacy system. The choice of a strategy is critical, in literature three different categories of solutions are proposed: re-development, wrapping and migration. Moreover, it's vital to deeply comprehend what the old system used to do. The last issue to consider is how the transition from the old to the new system is managed (gradual, co-lived, big bang). As a consequence, migration tasks tend to be expensive, complex and error prone, so it is essential to clearly define the scope and plan for a detailed budget.

12.d Strategies to manage the legacy system can be defined and managed contractually, as well penalties can be fixed in order to achieve the required project performance.

R13 Ineffective consulting services

13.a In specific cases, as for example when the ERP software is very new in the sector and other implementation experiences did not occur, the company could decide not to use any consulting service but to develop strategic competencies on the field or also to build strategic partnership with a software house.

13.b Consultants competencies have to be previously evaluated by managers and the steering committee during the selection of the ERP package or of the business integrators (project preparation phase). The experience on the field for the specific modules and sector should be proved.

R14 Poor leadership

14.b A proper leadership style should be chosen by managers according to the different situations. Conflict and problematic situations could be simulated in advance in order to train managers for the project.

R15 Inadequate performance of the IT system

15.b IT issues, such as technical, software and hardware capabilities, as specified in Chapter 4, must be studied before implementation matters and their impact on business processes must be assessed. The essential aspects are: availability of all the necessary functionalities, user friendliness, portability, scalability, modularity, versioning management, simple upgradeability, flexibility, security, presence of a complete guide, a procedure manual to help users, and data accuracy.
Because of the integrated nature of ERP software, if some of these elements are absent or ineffective there can be a negative effect throughout the enterprise. So formal test, control and periodical reviews of the software performances on this variables should be planned and carried out to check if it is aligned with the planned objectives.

15.d System functionalities, requirements and performance should be clearly defined at the beginning of the project when the agreement is made. Some contractual options could be planned in order to delay decisions which could not be taken in advance or needing extra-evaluations. Penalties could be managed, as deterrent, in order to avoid or disincentive irresponsible behaviours.

R16 Inadequate IT system maintainability

16.b Maintainability of the system is important along all the system life cycle. A clear evaluation of maintenance costs should be done from the earlier stages of the project and results should be included in the selection process. Migliorative, corrective and adequative maintenance are usually included in the agreement with vendors, but estimation about costs should also include the evaluative maintenance, i.e. needs for new system functionalities.

16.d System maintenance is one of the core issues of the contractual agreement of an ERP software. MAC (Migliorative, Adeguative and Corrective) maintenances are usually included in standard contracts. The accurate management of maintenance service conditions, the definition of appropriate measure of system maintainability, as well penalties and eventually assurances are key issues in order to avoid growing maintenance costs or system stops.

R17 Inadequate stability and performances of the ERP vendor

17.a Planning for an independent and autonomous internal IT department in terms of skills, competencies, from any IT supplier (business integrator or

Vendor). The suitability of the actions is dependent from the dimension and financial profile of the company, its business model and information needs.

17.b Vendor/Business Integrator's stability and their performances are important for the effectiveness and operative efficiency of the project. Analysis on the financial stability of these companies, as well explicit performance indicators, should be involved in the structured selection process during the project preparation phase.

17.c Minimizing customization and planning to develop internal competencies and guarantee the maintenance activities on the system can be an effective way to limit the effect of Vendor/Business Integrator failure or low performance. By the way, this action is very expensive and can adduct consequences for the company at the strategic level.

17.d Performance and stability of the ERP vendor or of the Business Integrator are key issues for an accurate ERP selection. By the way, transferring this risk would mean planning for penalties to be applied when such performances are not guaranteed, as well paying for assurance on their subsistence.

R18 Ineffective strategic thinking and planning

18.b The ERP investment should be framed in a broader strategic IT plan. This is essential in order to evaluate not only the operative advantages similar projects can adduct. With this purpose, adopting structured planning approach can be useful for the top and middle management (Project preparation).

R19 Inadequate financial management

19.b An adequate financial management involves both an accurate budgeting which includes all the most important costs in terms of human resource, hardware material and software, consultants and sub-contractors and the economic evaluation of the investment. Advanced and innovative techniques for the evaluation of the investment (such as real option approach) could be used (Project preparation) in order to catch long-period benefits.

Finally, the acceptance class comprehends other important both and passive "response options". Specific actions against all the identified risk factors could be planned during all the phases of the ERP implementation life cycle. A big variety of actions and options is available so that making an exhaustive list is very difficult, and probably of low utility. We suggest some sub-classes of action which can stimulate the attention of managers. In the acceptance strategy we find: contingency plans, flexible plans, feedback control and passive risk acceptance.

- As for contingencies (c), the project manager may set aside a contingency reserve of physical resources, finance, or time in case of need. It consists of developing contingency plans in which consciously accepting uncertainty but setting aside resources to provide a reactive capability to cope with adverse impacts if they eventuate. Risk analysis may be useful to determine the appropriate level of contingency provision.
- As for flexibility (f), managers can keep options open, involving deliberate delaying decisions, limiting early commitment, or actively searching out versatile project strategies that will perform acceptably under a variety of possible future conditions.
- As for feedback control (fc), monitoring is another type of response in the acceptance group, it implies a willingness to undertake more active risk management at some point, but the criteria for active management intervention may not be clearly articulated.
- As for passive Acceptance (p), it means to passively accept with recognition of the risk exposure, but with no further action to manage or monitor associated uncertainty.

5.7 Risk Control in ERP projects

In Risk Control phase, managers are required to monitor the effectiveness of Risk Treatments (determine the expected reduction in the risk level), the costs, to report on the progress of Risk Treatments at regular intervals and to have the responsibility to iterate the process in order to identify new arising risks. Our suggestions for the Risk Control phase include structured and iterative procedure for the evaluation of the risk management effectiveness (Figure 5.6).

The effectiveness analysis theoretically requires some metrics related to a valuation of risk before the RMP implementation (unconditioned risk, we suppose the risk factors free to occur) and after the RMP actions, along the life cycle. To define such indicators, the control and the evaluation of the expected risk reduction is a complex and challenging task. Just a few contributes exist in literature and, in our advice, the technique of the Index is the most interesting,

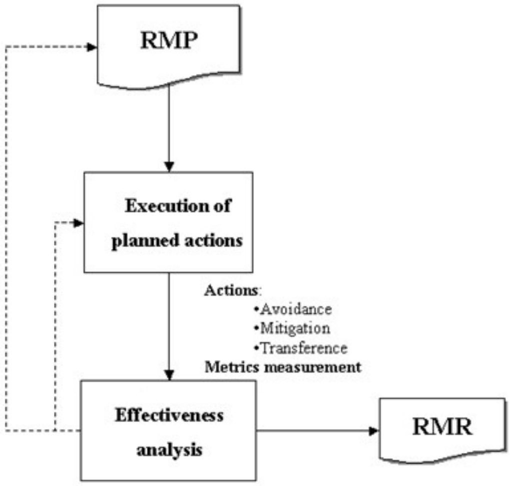


Figure 5.6: Control cycle

as reported in the SAFE methodology (Meli, 1998).
Another useful methodology to keep projects under control is the Project Top 10 risk item tracking. This technique concentrates the management attention on the high-risk, high-leverage, critical success factors rather than swamping management reviews with lots of low-priority details, saving time and getting focused where you can make the difference.
The core steps of the methodology are presented by Boehm (1991):

1. Ranking the project most significant risk items.

2. Establishing a regular schedule for higher manager reviews of the project progress.

3. Beginning each project-review meeting with a summary of progress on the top 10 risk items.

4. Focusing the project-review meeting on dealing with any problems in resolving the risk items.

An example of reporting is presented in the Figure 5.7. In our context, we may state that an indirect evaluation, based on a set of balanced success metrics (technical, financial, organizational) at different time points is more useful (Markus and Tanis, 2000):

Risk	Risk Aversion Options	Risk Monitoring
1. Changes of requirements from previous semester.	Option 1: Propose a solution for the system (describing the requirements in details) to the users and having them committed to the requirements. Option 2: Adopt an incremental approach to the development by building a prototype first.	Option 1: Once committed, the requirements must be closely monitored. Changes to requirements must be thoroughly assessed and if excessive, should be defer till later. Option 2: This has an impact on the schedule and hence close monitoring on progress and effort are required.
2. Tight Schedule	Study carefully the requirements so as not to over commit. Descope good-to-have features if possible. Concentrate on core capabilities.	Close monitoring of all activities is necessary to ensure schedule is met.
3. Size of project	If requirements are too excessive, descope good-to-have features and capabilities out of the project. Identify the core capabilities to be built.	
4. Finding a search engine	Conduct a software evaluation of search engine. Have team members actively source for free search engines and evaluate them. Determine the best for the project.	Have team members submit evaluation report and conduct demos so that an informed decision can be made.
5. Required technical expertise lacking	Identify the critical and most difficult technical areas of the project and have team members look into them as soon as possible.	Monitor the progress of these critical problems closely. If need be, seek external help.

Figure 5.7: Top10 risk monitoring

- Project metrics. Typical performance measures of project management related to planned schedule, budget and functional scope, typically Earned Value Analysis - based.
- Early Operational metrics. Metrics related to the Go Live Support phase. Although this is a transitional phase, the period from Go Live until the normal operation is critical: organization can lose sales, need additional investments and exceedingly poor performance can lead to pressures to uninstall the system. Typical metrics (for a manufacturing firm) include short - term changes in labour costs, time to fill an order, inventory levels, reliability of due date based on the ERP "Available To Promise" ability, order shipped with errors, but also system down time and response time, employee job quality/stress, and so on. In this phase such metrics support in monitoring the system to quickly point out and solve problems.
- Long - term Business results. Some typical relevant metrics (other will be context - specific, goals and objectives - related) include business process performance, end user skills, ease of migration/upgrading, IT specialists competence, cost savings and competence availability in IT investments subsequent to ERP (as in a data warehouse - Business Intelligence solution, which takes advantage from the ERP database, data clean up, and so on).

According to Markus and Tanis (2000), disastrous Project Implementation and Go Live Support metrics are sometimes coupled with high levels of subsequent business benefits from ERP. Conversely, sometimes projects with acceptable Implementation and Go Live Support metrics have no business benefits from installing the system in the long term.

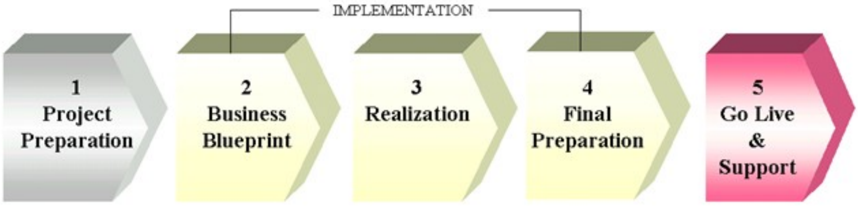
Obviously, Risk Communication is a necessary condition to enact the RMP, while Monitor and Review encompasses the typical feed -back control depicted in figure xx. The outcome of the effectiveness analysis can be formalized in a Risk Management Report (RMR) containing information about the occurred events, the executed strategies and actions and their success. The feedback can lead to changes in the RMP end even to redefine the risk factors. Risk treatment itself sometimes introduces new risks that need to be identified, assessed, treated and monitored; risk response actions, in fact, can cause the rise of new risk factors or increase the probability of occurrence of the existent ones. This should be carefully considered in the risk control phase and iteration of the risk assessment process should be activated if necessary.
If a residual risk still remains after treatment, a decision should be taken whether to retain this risk or repeat the risk treatment process.

5.8 Conclusion

Information addressed in this chapter provide managers and researchers with a better knowledge about the potential strategies dealing with risks in ERP introduction projects and can be used as a roadmap to define suitable preventive or mitigating actions. After a general overview of risk treatment and control phases, this chapter provides readers with advices and suggestions for the selection of suitable risk response strategies and control procedures. A number of key variables was proposed for a right classification of the risk factor profile which can be useful to drive the strategy selection; moreover a list of heuristics and potential mitigating actions was provided referring to the ERP projects.

A variety of suitable actions is available for each identified risk factor. Reporting an exhaustive roadmap is clearly a difficult task, especially if it has to be drawn on the experience of managers and users, and methodological guide does not exist. It is evident that a lot of mitigating actions potentially exist, but they are often difficult to identify and to implement since they require re-thinking the way in which the company operates. Most of the actions are available, more effective and cheaper in the earlier phase of the project life cycle (Figure 5.8), so that an effective and timely assessment of risks during the project preparation is highly desirable.

In the following tables (FIgure 5.9 and 5.10), available actions are reported according to the different stages of a project life cycle.
In the next part of the thesis the focus moves on the overall validation of the proposed Risk Management methodology by a number of case studies.



Avoid	-	-
Trasference	-	-
Mitigation	Mitigation	Mitigation (few)
Acceptance	Acceptance	Acceptance

Figure 5.8: Mitigating actions during the ERP project life cycle

Life Cycle Phase	Risk Factors		Risk Management Strategy				
			Avoidance	*Mitigation*		*Transference*	*Acceptance*
				Likelihood	Effects		
Phase 1 (Project Implementation)	Inadequate ERP selection	*R1*	-	-	-	-	c, f, fc, p
	Poor project team skills	*R2*	-	-	-	-	c, f, fc, p
	Low top management involvement	*R3*	-	3b	-	-	c, f, fc, p
	Ineffective communication system	*R4*	-	4b	-	-	c, f, fc, p
	Low key user involvement	*R5*	-	5b	-	-	c, f, fc, p
	Inadequate training and instruction	*R6*	-	6b	-	-	c, f, fc, p
	Complex architecture and high number of implementation modules	*R7*	-	7b	-	-	c, f, fc, p
	Inadequate BPR	*R8*	-	8b	-	-	c, f, fc, p
	Bad managerial conduction	*R9*	-	9b	-	-	c, f, fc, p
	Ineffective project management techniques	*R10*	-	10b	-	-	c, f, fc, p
	Inadequate change management	*R11*	-	11b	-	-	c, f, fc, p
	Inadequate legacy system management	*R12*	-	12b	-	-	c, f, fc, p
	Ineffective consulting services experiences	*R13*	-	13b	-	-	c, f, fc, p
	Poor leadership	*R14*	-	-	-	-	c, f, fc, p
	Inadequate IT system issues	*R15*	-	15b	-	-	c, f, fc, p
	Inadequate IT system maintainability	*R16*	-	16b	-	-	c, f, fc, p
	Inadequate IT Supplier stability and performances	*R17*	-	17b	-	-	c, f, fc, p
	Ineffective strategic thinking and planning Strategic	*R18*	-	-	-	-	c, f, fc, p
	Inadequate financial management	*R19*	-	-	-	-	c, f, fc, p

Figure 5.9: Suitable actions in Project implementation phase

Life Cycle Phase	Risk Factors		Risk Management Strategy				
			Avoidance	*Mitigation*		*Transference*	*Acceptance*
				Likelihood	Effects		
Phase 1 (Project Go-live and support)	Inadequate ERP selection	*R1*	-	-	-	-	c, f, fc, p
	Poor project team skills	*R2*	-	-	-	-	c, f, fc, p
	Low top management involvement	*R3*	-	-	-	-	c, f, fc, p
	Ineffective communication system	*R4*	-	-	-	-	c, f, fc, p
	Low key user involvement	*R5*	-	-	-	-	c, f, fc, p
	Inadequate training and instruction	*R6*	-	6b	-	-	c, f, fc, p
	Complex architecture and high number of implementation modules	*R7*	-	-	-	-	c, f, fc, p
	Inadequate BPR	*R8*	-	-	-	-	c, f, fc, p
	Bad managerial conduction	*R9*	-	-	-	-	c, f, fc, p
	Ineffective project management techniques	*R10*	-	-	-	-	c, f, fc, p
	Inadequate change management	*R11*	-	11b	-	-	c, f, fc, p
	Inadequate legacy system management	*R12*	-	-	-	-	c, f, fc, p
	Ineffective consulting services experiences	*R13*	-	-	-	-	c, f, fc, p
	Poor leadership	*R14*	-	-	-	-	c, f, fc, p
	Inadequate IT system issues	*R15*	-	-	-	-	c, f, fc, p
	Inadequate IT system maintainability	*R16*	-	-	-	-	c, f, fc, p
	Inadequate IT Supplier stability and performances	*R17*	-	-	-	-	c, f, fc, p
	Ineffective strategic thinking and planning Strategic	*R18*	-	-	-	-	c, f, fc, p
	Inadequate financial management	*R19*	-	-	-	-	c, f, fc, p

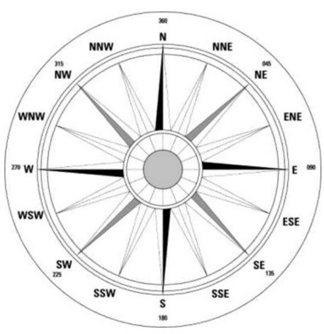
Figure 5.10: Suitable actions in Go-live and support phase

Section 3

A voyage through the open-sea needs some check-points confirming the right direction.

In this sense, this section symbolizes the stars which a sailor would use to have a first confirmation of the course he is following. As the stars allow a first orienteering to the sailor, giving him confidence and awareness about the right direction. In the same way, this section would give readers evidences about the real applicability and utility of the proposed methodology, opening the way to potential refinements.

Chapter 6 and 7 present these evidences using a number of case studies in firms, from different sectors, recently involved in ERP introduction projects. Moreover, they report some considerations about the introduction of the methodology in firms and the potential improvements to this research.



Chapter 6

Case Studies

This chapter proposes a preliminary verification of the proposed risk management methodology in order to assess the applicability, utility and usability of the suggested solutions and to achieve potential refinements.
The empirical verification, in particular, intends to investigate the proposed model by retrospective case studies in five multi-national companies from different sectors. A case study research framework was created and applied. Companies with similar profiles were surveyed and differences in the implementation projects were detected. Inferences about the adopted risk management approaches and risk treatment techniques were finally made.

In this part of the thesis, first an introduction about the case study methodological approach is formulated and a general framework planning the main steps of the work is described. After that, according to the presented framework, semi-structured interviews were conducted. In this aim, a questionnaire and a risk assessment simulation were specifically designed. Then, for each case, a group of people from the implementation project team was identified and involved in the analysis. The ERP implementation projects, run by the different companies, and the simulations were finally elaborated and main findings reported.

The main outlines from this chapter are:

- The case study methodology

- The methodological framework
- The questionnaire design
- Case study discussion
  - Procter and Gamble (Chemical)
  - SCA (Paper)
  - PowerOne (Energy-Electronic)
  - Ferrara Hospital (Healthcare)
  - Telecommunication Company (Telecommunication)
- Conclusions

6.1 Case Study methodology

6.1.1 Introduction

Looking up *case study* in the *Scientific Dictionary* the following full citation is available:

Case Study. The detailed examination of a single example of a class of phenomena. A case study cannot provide reliable information about the broader class, but it may be useful in the preliminary stages of an investigation since it provides hypotheses, which may be tested systematically with a larger number of cases.

(Abercrombie, Hill, & Turner, 1984, p. 34)

This description is indicative of the conventional wisdom of case-study research, which if not directly wrong, is so oversimplified as to be grossly misleading. Traditionally, when little is known about a phenomenon, current perspectives seem inadequate because they have little empirical substantiation or they conflict with each other or common sense. In these situations, theory building from case study research is particularly appropriate because it does not rely on previous literature or prior empirical evidence.

Even if this view is broadly accepted, some authors are partially discordant with it.

A big deal of definitions of case study researches can be found in literature and a great number of them are biased by the specific context the author investigates about. Case studies are a research approach, a systematic and organized way to produce information about a topic, as well as the product of this approach (for example a paper). Various term can be used for this approach, including *field studies, interpretive studies, qualitative research, small sample studies, action research, and constructive research.*

Yin (2002) defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used

Eisenhardt states that a case study is a "research strategy which focuses on understanding the dynamics present within single setting" (Eisenhardt, 1999).

In every case, the Case study methodology can help researchers respond to the research challenges and contribute to relevant knowledge.

6.1.2 The Case Study Approach

Case study research excels at bringing us to an understanding of a complex issue or object and emphasize detailed contextual analysis of a limited number of events or conditions and their relationship. This approach does not prescribe what theories should inform the study or which methods should be used for gathering and analyzing data. Case studies focus on bounded and particular organizations, events, or phenomena, and scrutinize the activities and experiences of those involved, as well as the context in which these activities and experiences occurs.

As Cooper and Morgan states (Cooper and Morgan, 2008) this type of approach is useful when the researcher is investigating:

- Complex and dynamic phenomena where many variables (including variable that are not quantifiable) are involved;
- Actual practices, including the details of significant activities that may be ordinary, unusual, or infrequent (e.g. changes in accounting regulation);
- Phenomena in which the context is crucial because the context affects the phenomena being studied (and where the phenomena may also interact with and influence the context).

S. Ronchi (1999) in his paper suggests a possible taxonomy of the case study approach. He detects the main aspects that characterize a case study:

The approach - A case study can be run to accomplish three mainly different aims: *exploring, describing or explaining.* It was believed in the past that case studies could only accomplish exploring aims: they were thought as analysis that had to create hypothesis and identify some phenomena that could be then deeply studied with other methodologies. Yet we can find in literature some case studies whose aim is to describe a phenomenon in a fully detailed way, in order to completely understand it. We can also find various case studies whose aim is to explain some phenomena and to detect the cause-effects links between them.
Stake (1995) included three others: *Intrinsic* - when the researcher has an interest in the case; *Instrumental* - when the case is used to understand more than what is obvious to the observer; *Collective* - when a group of cases is studied.

Time plan - A case study can be retrospective or longitudinal. A retrospective study is a sort of "picture" of the current situation, seen as the result of a series of past events; the main problems related these kind of studies are the availability and reliability of the data the analysis is based on (mainly archives and interviews). A longitudinal study is an analysis in which the researcher observes in real time all the phenomena; this type of study is certainly more accurate and reliable but, on the other hand, the costs related are higher and they proportionally increase the greater the number of the results requested is and the longer it takes to achieve them.

Number - A case study can be single or multiple. A single case study is mainly run for exploring and describing aims as it allows to deeply analyzing of the problem. On the other hand the generalizability of its results is limited. A multiple case study it's clearly more expensive and it takes longer to be run, but it allows to explaining in a more rigorous way the analyzed phenomenon. It is important to underline that investigate multiple cases is not related to the statistic principle of sampling. When using multiple cases, each case is treated as a single case. Each case's conclusion can then be used as information contributing to the whole stuffy, but each case remains a single case (Soy, 1997)

Other important aspects are:

The level of analysis - A case study can involve different levels of analysis: the target of the study can be a set of different companies operating in the same market, a set of different markets (each of them represented by a company) or a set of different projects. Finally, case studies can employ embedded design, that is multiple levels of analysis within a single study (Yin, 2002)

The data collection method - Based on the problem and research questions being addressed, a variety of methods may be used, including analysis of archival materials, observation, interviews, and quantitative techniques. The evidence may be qualitative (e.g. words), quantitative (e.g. numbers), or both. A study can rely exclusively on qualitative data, can supplement them by frequency counts or compare quantitative data from questionnaire with qualitative evidence from interviews and observations (Eisenhardt, 1999). Finally, case studies can be used to test or generate a theory. What appears to be particularly interesting is this last aim, theory generation from case study evidence.

6.1.3 Justification of the case study methodology for verification proposal

Case study research is a complex methodology which often is reputed inadequate for research testing and verification. This is due to various aspects.

Flyvbjerg (2004) points out that there is a sort of conventional wisdom about case study researches, according to which a case study cannot provide reliable information about a broader class of problems and it is a methodology to be used only in preparing the real study's larger surveys.

He summarizes the problems with this conventional wisdom about case study researches in five misunderstandings:

1. First of all, it is believed that general, theoretical knowledge is more valuable than concrete and practical knowledge.
2. Secondly, it is believed that one cannot generalize on the basis of an individual case; therefore, the case study cannot contribute to scientific development.
3. The third misunderstanding is about the fact that the case study is believed to be most useful in the first stages of a total research process.
4. Then it is believed that the case study contains a bias: it tends to confirm researcher's preconceived notions.
5. Lastly it is believed that it is difficult to summarize and develop general propositions and theories on the basis of specific case studies.

These common misunderstandings are investigated and confuted by Flyvbjerg (2001, 2004). 1.

1. The case study produces the type of context dependent knowledge that research on learning shows to be necessary to allow people to develop from rule-based beginners to virtuoso experts and in the study of human affairs appears to exist only context dependent knowledge (Flyvbjerg, 2001). He states:
   "*Predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals*".

2. Eckstein showed that the case study could be used to test predictive theories just as well as other methods. The case study is ideal for generalizing using the type of test that Karl Popper (1959) called "falsification". Flyvbjerg (2004) states:
   "*One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas the force of example is underestimated*".

3. Eckstein (1975), contravening the conventional wisdom in this area, asserted, "Case studies are valuable at all stages of the theory-building process and goes so far as to argue that case studies are better for testing hypotheses than for producing them". Flyvbjerg (2004) states:
   "*The case study is useful for both generating and testing of hypotheses but is not limited to these research activities alone*".

4. Campbell (1975) and other authors (Ragin, 1992; Flyvbjerg, 1998, 2001), have shown that the critique is fallacious, because the case study has its own rigor, different to be sure, but no less strict than the rigor of quantitative methods. The advantage of the case study is that it can "close in" on real-life situations and test views directly in relation to phenomena as they unfold in practice. They states:
   "*The case study contains no greater bias toward verification of the researcher's preconceived notions than other methods of inquiry. On the contrary, experience indicates that the case study contains a greater bias toward falsification of preconceived notions than toward verification*".

5. Despite the difficulty or undesirability in summarizing case studies, the case-study method in general can certainly contribute to the cumulative development of knowledge. Flyvbjerg (2004) states:
   "*It is correct that summarizing case studies is often difficult, especially as concerns case process. It is less correct as regards case outcomes. The problems in summarizing case studies, however, are due more often to the properties of the reality studied than to the case study as a research method. Often it is not desirable to summarize and generalize case studies. Good studies should be read as narratives in their entirety*".

These characteristics of case studies can lead both to weaknesses and strengthens of the methodology itself.

For example Eisenhardt (1999) states that the intensive use of empirical evidence can yield theory that is overly complex, also (Ronchi, 1999) states that there is a sort of will of explaining all the various aspects of a problem. The result can be a theory that is very rich in details but lacks in simplicity. Since quantitative methods such as regression analysis cannot be used, researchers might not be able to assess which are the most important relationships and which are simply idiosyncratic to a particular case. Another risk is that this theory describes a very idiosyncratic phenomenon or that the theorist is unable to raise the level of generality of the theory.

Authors agree defining three main strengths of this technique:

1. The likelihood of generating novel theory.
2. The emergent theory is likely to testable and falsifiable.
3. The theory is likely to empirically valid.

Weaknesses usually mentioned are:

1. The theory may be overly complex from the tendency to try to capture all the data.
2. The resulting theory may be narrow and idiosyncratic and therefore not generalizable

6.2 Testing the applicability of the ERP risk management methodology

The main aim of this part of the work is to verify the applicability, utility and usability of the developed risk management methodology in a real ERP project context. With this purpose a case study approach was adopted.
It is essential to clarify that the case studies we assessed do not aim to test the effectiveness of the risk management methodology as concerning the improvement of the success rate in the ERP introduction projects. Since the limited time and resource, in fact, a similar test would have not been possible.
To achieve this last objective, it would be necessary to apply the methodology

(following all the presented phase) and the supporting techniques along all the project life cycle. It would be desirable planning for an action research on a real ERP implementation project in which managers and researchers could work together in order to apply and test the methodology, collecting day by day, step by step, feedbacks, user perceptions and results. But a similar research is out of the scope of this thesis, since it will normally take two or more years.

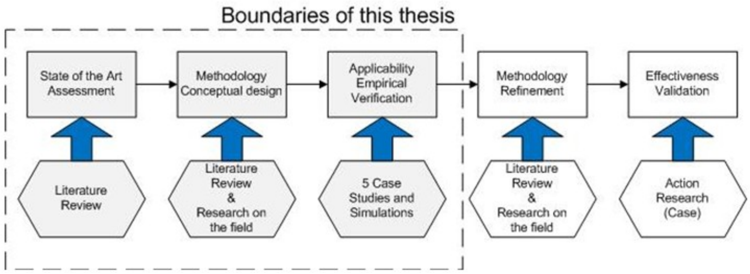


Figure 6.1: Accomplished steps of the research

As the figure 6.1 shows, instead, what we are here proposing is a preliminary empirical verification of the model applicability in a real ERP context.

We developed a specific case study framework driving this part of the research which aim to analyze real case study of ERP implementation, to identify emerging risk factor and potential effect on the project success, to perform a risk assessment simulation with project managers and key users of the project, and finally to compare results with what really happened during the implementation; obviously also collecting user and managers feedback on the proposed methodology.

Outputs from the verification process can lead to corrections and refinements of the methodology and represent a preliminary step to the next validation process.

According to this framework we carried on 5 case studies, from different companies operating in very different sectors. If we want to adopt the Ronchi's classification, our case studies are:

- *Explaining and instrumental case studies* since they aim to describe and explain the Erp implementation process according to a risk management view, showing the potential links between the use of a risk management approach and the project performance. They also try to understand opportunities for the methodology application.
- *Retrospective case studies* since they reports a picture of the past. The

ERP implementation has finished, here the project outcomes are represented as the results of past taken actions and events. They look back to the project in order to proof the applicability methodology

- *Multiple case studies* since we investigated 5 different companies form different sectors (Chemicals, paper, energy, healthcare, telecommunication) distinguishing between manufacturing and service companies. The characteristic of the production process and the process peculiarities of sectors, can in fact lead to different needs and system complexity. The company culture moreover can cause a different predisposition to the adoption of a project risk management view.

- *Multiple data collection* method were used. Data were mainly qualitative and collected from different sources in order to catch different perspective an point of views on the project.

6.3 The Case study framework

Case study research is a methodology that is undoubtedly difficult to use: it is complex, it can take a long time to be implemented and the risk of achieving not interesting results is high. For these reasons, a well-done planning of the research steps is necessary. A plan creates a rational link between the objectives of the research, its realization and its data analysis; the researcher can obtain good results only if the research plan is accurate and reliable (Ronchi, 1999)

A complete planning of the case study research first of all implies a definition of a theoretical framework, which supports the entire study and can lead to a greater generalization of the achieved results. A framework for case study research is provided by Eisenhardt (1999), which synthesized previous work on qualitative methods, design of case study research and grounded theory building.

We agree and adopt the Eisenhardt's framework to explain the main steps of this the case study research aiming to the verification of the model applicability.

The framework is summarized in the following Figure 6.2.

6.3.1 Getting Started

An initial definition of the research question, at least in broad terms, is important. The rationale for defining the research question is the same as it is

Step	Activity	Reason
Getting Started	Definition of research question	Focuses efforts
	Possibly a priori constructs	Provides better grounding of construct measures
	Neither theory nor hypotheses	Retains theoretical flexibility
Selecting Cases	Specified population	Constrains extraneous variation and sharpens external validity
	Theoretical, not random, sampling	Focuses efforts on theoretically useful cases—i.e., those that replicate or extend theory by filling conceptual categories
Crafting Instruments and Protocols	Multiple data collection methods	Strengthens grounding of theory by triangulation of evidence
	Qualitative and quantitative data combined	Synergistic view of evidence
	Multiple investigators	Fosters divergent perspectives and strengthens grounding
Entering the Field	Overlap data collection and analysis, including field notes	Speeds analyses and reveals helpful adjustments to data collection
	Flexible and opportunistic data collection methods	Allows investigators to take advantage of emergent themes and unique case features
Analyzing Data	Within-case analysis	Gains familiarity with data and preliminary theory generation
	Cross-case pattern search using divergent techniques	Forces investigators to look beyond initial impressions and see evidence thru multiple lenses
Shaping Hypotheses	Iterative tabulation of evidence for each construct	Sharpens construct definition, validity, and measurability
	Replication, not sampling, logic across cases	Confirms, extends, and sharpens theory
	Search evidence for "why" behind relationships	Builds internal validity
Enfolding Literature	Comparison with conflicting literature	Builds internal validity, raises theoretical level, and sharpens construct definitions
	Comparison with similar literature	Sharpens generalizability, improves construct definition, and raises theoretical level
Reaching Closure	Theoretical saturation when possible	Ends process when marginal improvement becomes small

Figure 6.2: Case study planning, Source:(Eisenhardt, 1999)

in hypothesis-testing research. Without a research focus, it is easy to become overwhelmed by the volume of data. Such definition of research questions within a broad topic permits the investigators to specify the kind of organization to be approached, and, once there, the kind of data to be gathered.
A priori specification of the investigated constructs can also help to shape the initial design of theory-building research. This type of specification appears to be valuable because it permits researchers to measure constructs more accurately. Potentially important constructs might be found in literature and then explicitly measured, for examples in the interview protocols or in the questionnaires. If these constructs do emerges as related to the subject investigated, there are strong measures on which grounding the emerging theory.

The general purpose of this research was to develop an effective risk management methodology in order to create a project management tool which could be used as a support to the activities planning processes the project control. The proposal of the case studies, here, is to provide evidence of the applicability, utility and usability of the risk management methodology in different context where ERP implementation occurred. However, from the analysis of the case studies some interesting considerations about the model application can be also derived.
With this aim an extended literature analysis was performed, so that we could define in advance the constructs (risk factors and effects) we aimed to investigate on and ground them in the extant literature as well.

6.3.2 Selecting Cases

Selection of cases is an important aspect of building theory from case studies. As in hypothesis-testing research, the concept of a population is crucial, because the population defines the set of entities from which the research sample is to be drawn. Also, selection of an appropriate population controls extraneous variation and helps to define the limits for generalizing the findings.
As the number of cases which can usually be studied is limited, it is important to define whether to analyze cases which are unique in some way, or cases which are considered typical. Pettigrew (Pettigrew, 1973) suggests choosing cases which are extreme situation.
As we just stated, our idea was to explore different markets in order to gather a broader view on ERP implementation projects and collect different experiences in terms of success dimension addressed during the project. Therefore, we selected a limited number of firms with comparable profiles, operating both in the manufacturing and services fields. They were multinational companies from the chemical, energy, paper, healthcare and telecommunication sector competing in the Italian market. In the analysis we compared the several project in order

to understand if some similarities were detectable and to clarify the relation between the adopted implementation methodology and the manager perception about the applicability of the RM model.

6.3.3 Crafting instruments and Protocols

Case study research typically combines multiple data collection methods. While interviews, observations and archival sources are particularly common, inductive researches are not confined to these choices. Some investigators employ only some of these data collection methods, or they may add others. Of special note is the combination of qualitative with quantitative evidence. This type of combination can be highly synergetic. Quantitative evidence can indicate relationships that may not be salient to the researcher. The qualitative data are useful for understanding the rationale or the theory underlying the relationships revealed in the quantitative data or may suggest directly theory which can then be strengthened by quantitative support.
Also, of special note is the use of multiple investigators. Team members often have complementary insights, which add to the richness of the data, and their different perspective increase the likelihood of capitalizing on any novel insight that may be in the data. Moreover, convergence of observations from multiple investigators enhances confidence in the findings. One strategy for employing multiple investigators is to make the visit to the case study site in teams.
Soy (1997) states that exemplary case studies prepare good training programs for investigators, establish clear protocols and procedures in advance and conduct pilot study before moving into the field. Advance preparation assists also in handling large amounts of data in a documented and systematic fashion.

In this research we decided to design a questionnaire, composed by both open and close questions. The questionnaire was divided in three parts: the first one was meant to gather data about both the interviewed person (such as his role in the project, his role in the company etc) and of the company (sizes, decisional processes, productive models etc); the second one consisted on a series of questions on risk factors and risk effects, whose aim was to collect all the useful information to clearly comprehend how the project was run; the third one was created to test the applicability and the usability of the software we developed.
In particular, to elaborate the questions for the second part of the survey, a structured method was applied, in order to be sure that all the aspects meant to be investigated were reflected in a specific question. For each risk factor we reviewed existing literature and determined measures and indicators, which could facilitate to evaluate if and how the analyzed risk factor had occurred in the ERP implementation process. Based on the found indicators, questions

were then derived.See Appendix A to examine the questionnaire.

Moreover, in the data collection phase, multiple subjects were involved (usually two or three person from the selected company were interviewed) and different data source (face to face interview, project documentation etc.) were used in order to collect the different perspectives. Finally, the interviews were always assessed in team and the moderators were adequately formed on the questionnaire's issues and proposal.

6.3.4 Entering the Field

The researcher must collect and store multiple sources of evidence, comprehensively and systematically, in formats that can be referenced and sorted, so that convergence lines of inquiry and patterns can be uncovered (Soy, 1997).

A striking feature of research to build theory from case studies is the frequent overlap of data analysis with data collection. That allows researchers to exploit the advantage of a flexible collection and to make adjustments during data collection process. Field notes are an important means to accomplish this overlap. They record feeling and intuitive hunches, pose questions, and document, testimonies, stories and illustrations, which can be used in later reports. They assist in determining whether or not the inquiry needs to be reformulated or redefined, based on what is being observed.

In our case, a semi-structured interview approach was adopted to address the research questions. While interviewing the managers, we wrote down all the information we were collecting and also asked for official project documentation. This approach was viewed as the most appropriate way to obtain the in-depth views and experiences of knowledgeable individuals who are intricately involved in the evaluation and testing of ERP systems. Audio taped interviews were conducted by one of the researchers and then later transcribed to ensure accuracy and completeness in capturing responses.

6.3.5 Analyzing data

Data analysis is the heart of the case studies research, but is both the most difficult and the least codified part of the process. The researcher examines raw data using many interpretations in order to find linkages between research object and the outcomes, with reference to the original research questions (Soy, 1997).

A first key step is *within-case analysis.* This analysis typically involves detailed case study write-ups for each site, which are often simply pure descriptions, but they are central to the generation of insight because they help researchers to cope early in the analysis process with the often enormous volume of data. There is no standard format for such analysis; the overall idea is to become intimately familiar with each case as a standalone entity. The unique patterns of each case can emerge and the cross case comparison can be accelerated.

Coupled with within-case analysis is in fact the *cross-case search* for patterns. The overall idea behind this searching tactic is to force investigators to go beyond the initial impressions. Cross- case analysis divides the data by type across all cases investigated; the researcher then examines the data of that type thoroughly. This can lead to strengthened findings or conflicts that have to be deeply analyzed (Soy, 1997). Cross case research tactics enhance the probability that the investigator will capture the novel findings that may exist in the data.

In research we applied the both cited steps. First of all we carefully analyzed all the data gathered during the interview, describing the findings for each section of the questionnaire (Chapter 6). This helped us to intimately comprehend the company, how the project had been run and all the problems which had arisen. At the end of this within-case analyses, we reached a deep knowledge of each case. Therefore, we were able to carry out a cross case analysis: we compared the cases of the companies, examining the results we had found for each indicator (Chapter 7). Starting from the risk effects, a classification of the different project was assessed in order to identify the most successful ones. Then the potential causes of these evidences, as well the main problems revealed during the project, were investigated.
A comparison table was filled in for each case study, then the data were interpreted and re-coded according an evaluation scale. Results were finally drawn in a radar diagram to achieve an easier interpretability. In this way we could easily identify similarities and differences in the different projects.

6.3.6 Shaping Hypotheses

From the analysis, concepts and even possible relationship between variables begin to emerge. The next step of this highly iterative process is to compare systematically the emergent frame with the evidence from each case, in order to assess how well or poorly it fits with case data.
The central idea is that researchers constantly compare theory and data in order to refine the definition of the constructs. A second step is verifying that the emergent relationship between constructs fit with the evidence in each case.
At this point the qualitative data are particularly useful for understanding why

or why not a relationships hold. When a relationship is supported for example, the qualitative data often provide a good understanding of the dynamics underlying the relationship, answering the “why” questions.
The peculiarity of case studies is that researchers cannot apply statistical tests: they must judge the strength and consistency of a relationship within and across cases.

In our research, after a in-depth analysis of each case study, we applied a structured framework driving the comparison among the case studies in order to catch and draw relevant conclusions. After the description of each case, as first step, we created a table in which, for each risk factor and risk effect, we summarized the main differences between the issues and actions undertaken by the two companies (Chapter 7). Then, according to the indicators we defined for the several constructs, we classified the cases on the basis of an overall evaluation of the project success (risk effects) and the way which risk factors were managed. Then we focused on the most important risk factors from the ranking, identified by the software, comparing them with actions really planned by the managers during the project in order to identify potential causes of a good or bad performance. Finally, we analyzed the preventive and corrective measures assessed by the companies and compared these actions with those ones potentially suggested by the proposed methodology.
Moreover, a feedback on the model utility and usability was also collected from the interviewees.

6.3.7 Enfolding Literature

An essential feature of theory building is comparison of the emergent concepts, theory or hypothesis with the extant literature. Above all it appears important to examining literature that conflicts with the emergent theory. In fact, the conflicting literature represents an opportunity. The juxtaposition of conflicting results forces researchers into a more framebreaking thinking mode and leads them to look for the reason of the conflict. Literature discussing similar findings is also important because it ties together underlying similarities in those phenomena that are normally not associated with each other. The result is often a theory with a stronger internal validity, a wider generalizability, and a higher conceptual level.

Researches in this field are not so numerous. However, for our proposal, we continued to examine the extant literature first of all to define the indicators for the risk factors evaluation. Secondly, we analyzed a great deal of case studies based on ERP projects assessed in other companies in order to compare findings and results.

6.3.8 Reaching Closure

Two are the main issues in reaching closure: when to stop adding cases and when to stop iteration between data and theory.
About the first problem, the researchers should stop adding cases when the theoretical saturation is reached: when incremental learning is minimal because the researchers are observing phenomena seen before. In practice the point at which stop adding cases is very often determined by pragmatic considerations such as time and money. In fact it is common for researchers to plan the number of cases in advanced. There is no ideal number of cases. Eisenhardt (1999) suggests a to investigate from 4 to 10 cases, while Yin (2002) indicates to examine from 3 to 6 different situations. What is important is to underline is that small number of different case studies might not provide enough data to generate theory and the empirical grounding of the results is likely to be unconvincing. For budget and time reasons we limited our analysis to 5 case studies.

About the second closure issue, stopping iteration when saturation is reached is again a key idea. That is when the incremental improvement to theory is minimal. Soy (1997) points out the necessity of presenting the results in well-organized reports, which transforms a complex issue into one that can be easily understood. Researchers have to pay particular attention to displaying sufficient evidence to gain the reader's confidence that all possibilities have been explored. In this issue the present work can be considered still in progress, since many opportunities for the data analysis are still available.

6.4 The Questionnaire

One of the planned steps is to craft instrument and protocols to gather the useful data. The instrument we chose to utilize in our semi-structured interview approach is a questionnaire, which combines both qualitative and quantitative data. As we have already pointed out, quantitative evidence can indicate relationships that may not be salient to the researcher; qualitative data are useful for understanding the rationale or the theory underlying the relationships revealed in the quantitative data or may suggest directly theory which can be strengthened by quantitative support. The questionnaire we designed is well founded in literature and it is divided in three parts:

- *Part One*: the aim is to gather data about both the interviewed person (such as his role in the project, his role in the company etc) and of the company (sizes, decisional processes, productive models etc); It mainly consists on closed-type questions, which can allow to easily contextualise the case study and compare it to the others we examined.

- *Part Two*: which consists of a series of questions on risk factors and risk effects, whose aim was to collect all the useful information to clearly comprehend how the project was run according to our risk management framework. To elaborate the questions for this part, a structured method was applied, in order to be completely certain that all the aspects meant to be investigated were reflected in a specific question. For each risk factor we reviewed existing literature and determined measures and indicators, which could facilitate in evaluating if and how the analysed risk factor had occurred in the ERP implementation process. Based on the found indicators, questions were then derived.

- *Part Three*: it was created to test the applicability and the usability of the software we developed. We asked the managers to fill a matrix, evaluating for each risk factor the strength of its link with the other risk factors and effects (cellars i-j of the RR and RE matrix indicates the likelihood that if risk factor i occurs, then factor or the effect j occurs too). Managers were also asked to indicate their perception about the unconditioned probability of occurrence of each risk factor and to distribute 100 points among the risk effects on the basis of the importance they assigned them for the project success.

Based on these data, the software calculated a ranking that was then shown to the managers, in order to verify if, in their opinion, it was correct. On the basis of the scores obtained, we clusterized the risk factors in four classes. This allowed to indentify the most influencing and important risk factors, which we will call in this work "Band A risk factors", on which we then focused to examine the preventive actions the companies undertook to treat them.

6.4.1 Focus on the second part of the questionnaire

As we have already said, the questions in the second part of the questionnaire were derived from the indicators defined for each risk factor and effect. It is important to stress that these indicators were defined on the basis of an extended literature review, in order it was grounded with extant literature. In the following tables the questionnaire items, literature references and their relative indicators are reported for each risk factor and effect (Figures 6.3 - 6.11).

Risk Factor Indicator	*Literature*	*Item in the questionnaire*
SELECTION		
Structured process of vendor and system integrator selection	Travis, 1999	2, 3
Involved roles	Verville, Bernadas and Halingten, 2005	4
PROJECT TEAM SKILLS		
Team mix	Somers and Nelson, 2001	5, 7
Training necessity	Clemons, 1998	8, 9, 10
Clear and shared job assignment modality	Somers and Nelson, 2001	6
TOP MANAGEMENT INVOLVEMENT		
Type and frequency of the interaction	Somers and Nelson, 2001	12, 13
IT overall strategy communication	Somers and Nelson, 2001	11
Commitment exhibition	Deloitte Consulting, 2000	11
Responsibility of the top management	Somers and Nelson, 2001	11
Use of Project Champion	Bancroft, Seip and Sprengel, 1998	14

Figure 6.3: Questionnarie items: part 1

Risk Factor Indicator	*Literature*	*Item in the questionnaire*
COMMUNICATION		
Used means	Al-Mashari and Zaire, 2000	15
Involved subjects	Somers and Nelson, 2001	16
Type of information exchanged	Rainer, Snyder and Carr, 1991 Keil and Montealegre, 2000	17
KEY USERS INVOLVEMENT		
Phase in which key users are involved	Somers and Nelson, 2004 Verville, Bernadas and Halingten, 2005	18
Required competences	S. Bagchi, S. Kanungo and S. Dasgupta, 2003	19
Active role of key users in knowledge diffusion	S. Bagchi, S. Kanungo and S. Dasgupta, 2003	20
TRAINING		
Training modality	Mahapatra and Lai,1998	21
Dedicated resources	Zhe, Lee, Huang, Zhang and Huang, 2005	25, 26
Formative needs identification process		22
Evaluation of the acquired skills at the end of the training process		23, 24

Figure 6.4: Questionnarie items: part 2

Risk Factor Indicator	*Literature*	*Item in the questionnaire*
ARCHITECTURE		
Number of modules/number of users/number of servers	Francalanci, 2001	27, 28, 32, 33, 34, 35, 36
One-site or multi-site structure	Umble, Haft and Umble, 2003	29
Compatibility/integration with other softwares	Somers and Nelson, 2001	31
Customization extension	Davis, 2005	30
BPR		
Preventive analysis of processes' business value and performance in order to prioritize interventions	Somers and Nelson, 2001	37
Life cycle phase in which BPR was implemented	Somers and Nelson, 2004	38
Dedicated resources	Somers and Nelson, 2004	39, 40, 41
Use of business models	Gulla and Brasethvik, 2002	43
Involved roles	Yusuf, Gunasekaran and Abthorpe, 2004	42
MANAGERIAL CONDUCT		
Objectives and goals clearness throughout the project's duration	Ginzberg, 1981	44
Top management, key users and team member involvement	Ginzberg, 1981	45, 46
Project Manager's commitment	Sarker and Lee, 2003	47

Figure 6.5: Questionnarie items: part 3

Risk Factor Indicator	*Literature*	*Item in the questionnaire*
PROJECT MANAGEMENT TECHNIQUES		
Risk Management approach implemented	Chapman and Wars, 2003	48
Formal plan of project's phases	Gupta, 2000	49, 50
Real time control over the project	Ngai, Law and Wat, 2008	51
Control over the project in post go-live phases	Yu, 2005	52
CHANGE MANAGEMENT		
Preventive evaluation of users' attitude towards the change	Aladwani, 2001	53
Explanation of the benefits and functioning modes of ERP by top management	Aladwani, 2001	54, 55
Influential groups' involvement	Aladwani, 2001	56
Monitoring of changes' progresses	Aladwani, 2001	57
Management of users' expectations	Somers and Nelson, 2001 Ginzberg, 1981	58
LEGACY SYSTEM		
Preventive analysis of the system	Bennett, Ramage and Munro, 1999	59
Treatment strategy adopted	Bisbal, Lawless, Wu and Grimson, 1999	60
Management mode of the transition from the old to the new system	Kremers and Dissel, 2000	64
Legacy system's comprehension	Wu, Saharaoui and Valtchev, 2005	61, 62, 63

Figure 6.6: Questionnarie items: part 4

Risk Factor Indicator	*Literature*	*Item in the questionnaire*
CONSULTING SERVICE		
Stage of the involvement	Somers and Nelson, 2004	65
Required competences	Piturro, 1999	66
Responsibilities of consulting	Cooke and Peterson, 1998	67, 68
Integration's extent with internal personnel	Scott and Vessey, 2002	69
LEADERSHIP		
Business and technical competence required for project managers	Sarker and Lee, 2003	72, 73
Leadership style adopted	Sarker and Lee, 2003	74
IT SYSTEM ISSUE		
Structured preventive process for new software's objectives and needs identification	Wayne, 2007	75
Role of the person who defines new software's objectives and needs	Bergstrom and Stehn, 2005	76
Review of the new system functionalities during the implementation	N. Vrcek, Z. Dobrovic and D. Kermek, 2007	77
Scalability	Olson and Zhao, 2007	78

Figure 6.7: Questionnarie items: part 5

Risk Factor Indicator	*Literature*	*Item in the questionnaire*
IT SYSTEM MAINTANABILITY		
Structured technique of documents management	Carney, Hissam and Plakosh, 2000	79
Structured process implementation for maintenance interventions	Carney, Hissam and Plakosh, 2000	80
Vendor's responsibilities	Ng, Gable and Chan, 2002	81
IT SUPPLIER STABILITY		
Partnership with vendor	Somers and Nelson, 2001	82
Vendor's support for updates and new modules	Somers and Nelson, 2001	83
STRATEGIC THINKING AND PLANNING		
Clear comprehension of ERP potentialities	Davenport, 1998	84, 85
Outcome objective definition	Davenport, 1998	86
ERP rigid processes imposition awareness	Davenport, 1998	87
FINANCIAL MANAGEMENT		
Investment evaluation technique adopted	Laterreur, 2006	88
Clear and complete identification of costs and benefits	Chen, 2001	89, 90, 91, 92, 93

Figure 6.8: Questionnarie items: part 6

Risk Effect Indicator	*Literature*	*Item in the questionnaire*
BUDGET EXCEED		
Exceed percentage	Martin, 1998 HsiuJu and Chwen, 2004	98
Most relevant cause	McCaskey and Okrent, 1999 Volwer,1999 Umble, Haft and Umble, 2003 Plaza and Rohlf, 2008	99
TIME EXCEED		
Exceed percentage	Parr and Shanks, 2000	100
Most relevant cause	Tchokogué, Bareil and Duguay, 2005 Tanaashi Group, 2008 Wee, 2000	101
PROJECT STOP		
Occurrence	Parr and Shanks, 2000	102
Motivation	Parr and Shanks, 2000	103
POOR BUSINESS PERFORMANCE		
Operative parameters' improvement	DeLone and McLean, 1992 Hunton, Lippincott and Reck 2003 Sumner, 2000	104, 105

Figure 6.9: Questionnarie items: part 7

Risk Effect Indicator	*Literature*	*Item in the questionnaire*
INADEQUATE SYSTEM RELIABILITY AND STABILITY		
Partial use of modules		106
Duplication of modules		107
Number of maintenance interventions	Buonanno, Faverio, Pigni, Ravarini, Sciuto and Tavaglini, 2004	109
Most relevant cause of maintenance interventions	Buonanno, Faverio, Pigni, Ravarini, Sciuto and Tavaglini, 2004	108
Provided information's coherence and completeness	Jen-Her and Yu-Min, 2007	110
LOW ORGANIZATION PROCESS FITTING		
Procedures misalignment	Muscatello, Small and Chen, 2007	111
Organizational misalignment	Wu, Ong and Hsu, 2008	112
LOW USER FRIENDLINESS		
Learnability	Blandford, Green, Furniss and Makri, 2008 Calisir, 2004	113.a
Efficiency	Zuehlke and Thiels, 2008	113.b
Memorability	Nielsen, 1996	113.c
Errors	Zabed, 2008	113.d
Satisfaction	Chien and Tsaur, 2007	113.e

Figure 6.10: Questionnarie items: part 8

Risk Effect Indicator	*Literature*	*Item in the questionnaire*
LOW DEGREE OF INTEGRAZION AND FLEXIBILTY		
New software easy to integrate with legacy systems	Markus and Tanis, 2000	104.a
New software easy to integrate with external softwares	Themistocleous, Irani and O'Keefe, 2001	104.b
Expandable	Nah and Lau, 2001	104.c
Easy exceptions and modifications management	Ngai, Law and Wat, 2008	104.d
LOW STRATEGIC GOAL FITTING		
Improvement of the decision-making process	Soja, 2008	115
Improvement of the information quality	Soja, 2008	115
Selling improvement	Muscatello and Parente, 2008	115
Market share improvement	Muscatello and Parente, 2008	115
Users' skills improvement	Velcu, 2007	115
Time to market reduction	Muscatello and Parente, 2008	115
Customer focus improvement	Velcu, 2007	45, 46
Quality and processes improvement	Somers and Nelson, 2001	47
FINANCIAL/ECONOMIC PERFORMANCE		
Financial/economic parameters improvement	Hayes, 2001 Berchet and Habchi, 2005 Chand, 2005 Soja, 2008 Velcu, 2007 Muscatello and Parente, 2008	116

Figure 6.11: Questionnarie items: part 9

6.5 Case Study A: Procter & Gamble Co.

6.5.1 Company Overview

Procter & Gamble is an American global corporation based in Cincinnati, Ohio, USA, that manufactures a wide range of consumer goods. The company was established in 1837 by Mr. Procter, a candle maker, and Mr. Gamble, a soap maker. P&G is credited with many business innovations including brand management, soap operas and “Connect and Develop” innovation.
The company has 76,5 Billion Dollars of sales and counts 300 different brands, among which 23 are global ones, which have more than 1 billion dollar sales each. The total number of employees is 138.000 and it has 80 head offices around the world. The number of plants is 80, while the research centres are 25. In 2005 P&G acquired Gillette, forming the largest consumer goods company in the markets. This added brand such as Gillette razors, Duracell, Braun and Orabl-N to their stable.

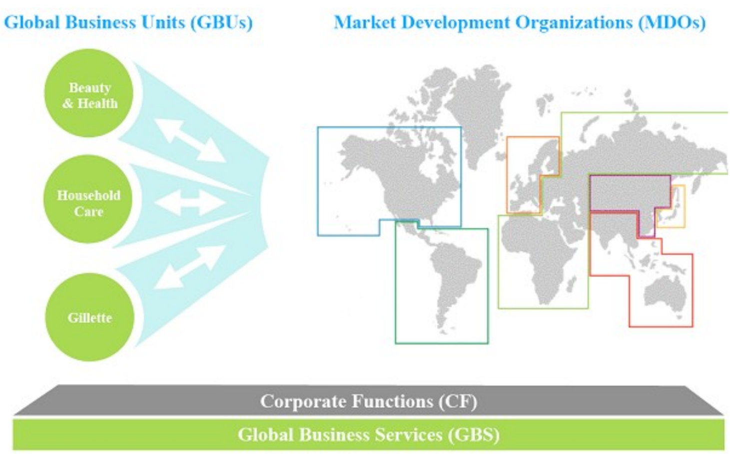


Figure 6.12: P&G’s GBUs

P&G has three Global Business Units (figure). Beauty Care GBU focuses on cosmetics, deodorants, feminine care, fragrances, hair care and skin care; Household Care GBU focuses on house hygiene, snacks, coffee and batteries; Gillette GBU includes products for children and families, oral hygiene, products for pets care, household appliances and razors. GBUs’ philosophy is to think globally and their general role is to create strong brands, firm strategies and continuous innovations, for both products and marketing.

Market Development Organizations (MDOs) act locally. They interface with the trade to ensure that the marketing plans are transformed in a success for the local consumers. Global Business Services (GBS) provide a wide range of service to all the company's functions. This include accounting, ayrolls, orders to suppliers, logistics, systems management.
Lastly, the company has nine Corporate Functions (CF) including Consumer Market Knowledge, Research and Development, Product Supply, Finance, Customer Business Development, Marketing, External Relations, Human Resources and Information and Decision Solution.
The company decisional system is called "PACE Model": for each process there is a Process owner, an Approval, some Consulted people and some Executors.
P&G's production type is PTD (produce to demand); the production system adopted is "continuous-in line" and it is characterized by high volumes and high mix

6.5.2 The ERP Implementation Project in Pomezia Plant

In 2005 Procter & Gamble developed the ERP implementation Project throughout Europe, Middle East and Africa (EMEA), in order to obtain a standardization which could allow the company to obtain great savings and enable the 2010 vision "100 Billion $ Company".
This research focuses on the project implementation in Pomezia Plant. The Plant was built in 1961 and produces washing powders. It has a 16 MM$ turnover (2007/2008), 6 making units, 10 packing lines and a 20500 pallets warehouse. The products are sold mainly in Italy, with some small percentage to other European Countries, as shown in Figure 6.13. The ERP implementation project started in September 2006 and lasted 15 months. The project life cycle is shown in Figure 6.14.

6.5.3 The Interview

The interview was carried out talking to three different people in order to ask questions to the managers who were really involved in that issue so that they could best answer to the questions. Most of the questions were answered by the West Europe Frabricare Supply Network Solutions (SNS) Leader, who has been covering this role for 2 years and a half. The manager is working for Procter & Gamble since 1998 and before the ERP implementation project, she had already had experience in IT projects. She was one of the project board member.
The Project Manager for Pomezia ERP implementation project was also interviewed, in order to gather more accurate information about the development in

Figure 6.13: Countries reached by Pomezia Plant production

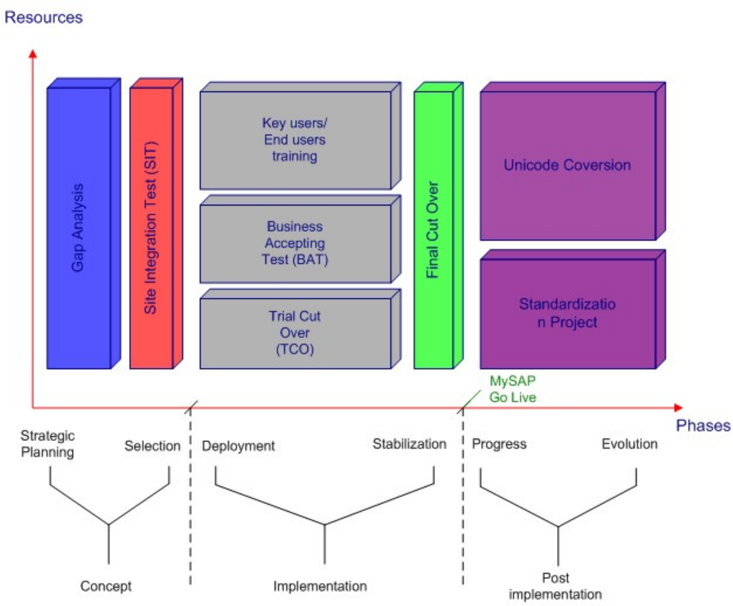


Figure 6.14: P&G Project Life Cycle

loco. Finally the EMEA ERP implementation project manager was interviewed about the strategic aspects of the project.
Project documentation such as the budgeting plan, the structure of the project team and the project plan were also consulted in order to triangularize the data sources.

This section covers each construct of the research model with summative findings.

Motivations
There are numerous motivations that brought Procter and Gamble to decide to implement an ERP system. First of all, the company had the necessity of replacing the old legacy system; then their objective was to enhance the efficiency of the transactions, increasing their speed. They also required to face a change in their needs and in their processes and to face a change in the company structure, as they acquired The Gillette Company in 2005. Moreover, a better integration and safety of the database was sought, in addition to a reduction of the number of the systems employed and of the interfaces. Their goal was, in fact, to reduce complexity and therefore to enhance system management and maintainability.
A side objective was to have better managerial tools available, in order to enhance the decision making process as well as the planning one to obtain more accurate information and to have a fast access to them.

6.5.4 Risk factors

R1 Selection
The company did not have the necessity of selecting any ERP package, vendor or system integrator, since they already had a strategic partnership with Hewlett-Packard Development Company (HP).

R2 Project team skills
The project team was structured in this way. There was a global sponsorship formed by two people, one belonging to the Information Decision Solution (IDS) function and one belonging to the Finance (FI). The board was composed by managers coming from the different regions: Europe, Middle East and Africa (EMEA), Russia and Turkey. The board also included a manager from HP, as HP was a key partner. There were then various Program Managers, according to the different modules and a Project Manager for each region. The big region EMEA was divided in two sub regions (Western Europe (WE) and Central and Eastern Europe, Middle East and Africa (CEEMEA)) and for each sub region there two internal Project Managers. In WE then, there was a further decom-

position between the customer service projects and the plants ones. For each Global Business Unit/Region, a steering team was created, which had to ensure all the resources for the training processes and the tests. The team members in the Pomezia plant project belonged to IT, Logistic, Finance, Purchasing, Production and Customer Service functions. There was also an HP representant.
To identify the training needs of the project team, a structured process was implemented. HP contributed to fill the knowledge gap, running an internal formative course, based mainly on technical teachings. The project team had competences about big IT projects management.

R3 Top Management involvement
The Top Management was involved in the review and approval phases and in the decisional activities, anytime there was an overtaking in the success criteria previously defined. He also had to ensure the necessary resources and budget to the project.
The top management interact with the project team making use of various communication means: mails, board meetings, calls, official monthly reports on the project status. This interaction had mainly a monthly frequency.
The project had a champion, who belonged to the Information and Decision System (IDS) function. He had global responsibilities, which were to ensure a good project ending, without impacts on the business.

R4 Communication system
Throughout the project life cycle the communication means used were the same as previously described: mails, board meetings, calls, reports.
During the whole project life cycle, communication took place among the project team members, the regional teams and the global teams. Each of them had its own interface, but communication involved everyone.
The planning phase was the most active from the communication point of view: teams were formed, resourced were assigned, cut over were planned and the impacts on the business were defined. In the implementation phase, the board was consulted less frequently, just when there were issues to face. In the post implementation phase communication mainly focused on promoting the project success. Success criteria were reviewed and an analysis of the main problems was run, in order to increase the knowledge and learn. It was then assured that the post cut over processes were followed for emergency issues.

R5 Key users involvement
Key users were mainly involved in the Business Assessment Testing (BAT), cut over and post cut over phases. They belonged to the Logistic, Finance, Purchasing, Production and Customer Service functions.
Key users ran a prior analysis of all the existing work processes and of their cross regions optimization: based on this, they detected the training necessities. They then carried out a "waterfall" training and performed a "daily manage-

ment system" on the other users. This task consisted in reviewing how all the operation were executed and checking how these operations were affected by the users' interfaces and by the re-engineered processes.

R6 Training

The key users were trained by the project team, who held internal courses. The formative needs had been identified by a structured process. At the end of the training an evaluation of the acquired skills was carried out. The official qualifications were given by the "SAP council". This council is organised locally, to verify the capability gained by the key users.
Further training processes were necessary only when employees changed their own assignment. The planned duration of the training process was respected. The cost of the process had been budgeted, among one of the entries of the total cost of ownership.

R7 Architecture

Five modules were implemented. The operation had two phases: in the first one, three modules were implemented contemporarily (C Basic Component, FI Financial and CO Controlling); in the second one, the last two were implemented at the same time (MM Material Management and PP Production and Planning). The ERP system adopted a multisite architecture while the assumed approach was a corporate one: everyone has to use the same package. There had not been any customization of the software, except some modifications for specific reports. The company tried to standardize and to adapt the most.
The ERP system had to be integrated with the legacy system for some area the new software did not cover. In particular, the company maintained some local systems as some excel macros which used to support some processes and that at the moment take data from the ERP system. They had to modify the extraction macros.
The ERP system had to be integrated also with the shipping systems (RFID) and the order taking ones. In Pomezia the number of users is circa 150. The plant does not have its own service; it depends on the regional ones, which are 3. The number of interfaces of the ERP system with different users is circa 50. In Pomezia the system is a client server type. Multiple databases are used.

R8 BPR

The company carried out a preventive analysis of the processes, in order to prioritize the areas on which working because of the ERP system implementation. In particular, a specific team was created for each SAP process.
The Business Process Reengineering process was performed in the development phase of the project life cycle. The process lasted 4 months (over the 15 months of the entire project's duration) and it required resources equally to 10 people full time working on it ("10 FTE").
The BPR team was formed by responsible for each process and in total counted

about 100 people. The team members belonged to logistic, finance, purchasing, production and selling functions. A representative of HP was also involved. No gap analysis tools were used.

R9 Managerial Conduct

The project manager had to clarify again the objectives throughout project implementation. This was due to the fact that people did not work full time on the project, therefore frequently switching from an assignment to another, they often had to be reminded about the general ERP implementation project objectives. Key users were generally very involved in the project, while the team members were more drawn in the BPR phase.
The team manager had full commitment on the project. She states that she used “to follow people everywhere” to check on them.

R10 Project management techniques

The risk analysis was run by the consultants (HP) and using the company’s own risk management logic. The project phases had been formally planned, both in terms of time and costs. The project was controlled very carefully (real time control) and they had planned an evaluation of the system effectiveness in the post go-live phase. The project budget was determined by the top management. It was a top down decision.

R11 Change management

The company carried out a very intensive preventive evaluation of users’ the attitudes towards the change: they ran a “satisfaction survey” which estimated users’ approval of their tasks’ change. This survey was part of the BPR process. The top management communicated the benefits of the ERP systems to the employees, which were mainly savings, but did not directly explained how the ERP system would have worked. These explanations were provided to the various subjects implementing a “waterfall” process.
The most influential group leaders of the company were fully involved in the project and the impacts of the ERP system on the employees’ careers were clearly communicated. In particular, the project management states that “nothing changed because of the new system”. Lastly, change management progresses were monitored throughout the project phases.

R12 Legacy system management

The company ran a preventive analysis of the IT system, in order to define the priorities of the tasks and determine which components to keep in the ERP system.
The legacy system functioning had not been fully comprehended in Pomezia plant, but both the documents concerning the old IT system and the expert employees were still in the company.
The treatment strategy adopted was the migration one. There was no gradual

transitory phase, as a cut over was executed to pass from the old to the new system. The two systems co-lived just in the BAT phase, in order to check the ERP system's performance in comparison to the legacy system's ones. After the go-live, the legacy system was never used to cover applications the ERP system was meant to cover

R13 Consulting service

The company made use of the consulting service HP provided, which was involved since the very beginning of the project till the very end. The competences the company required were mainly technical, and the responsibilities assigned to the consultants concerned the development, the quality, the costs and the timing of the project.

The consultants' performance evaluation was correlated to the objectives achievement and the company planned penalties, clearly included in the contract. The integration between the consultants and the employees was judged sufficient in Pomezia plant, but good considering the overall project (because of the special partnership with HP).

The means used to communicate with the team members were mails, meetings, reports conferences and also "night phone calls", as the Project Manager pointed out. Finally, the collaboration with the consultants fairly increased the internal knowledge of the company: they held the training courses and improved the project management knowledge.

R14 Leadership

The project manager had competences both in business and IT fields and had had previous experiences as team manager. The leadership style she used was coherent with the "P&G leadership style": inclusive, engaging and supportive.

R15 IT system issue

The company carried out a structured process to define the functionalities and the performances the new system had to provide. HP consultants, key users and the project manager were involved in this process.

During the project implementation, periodical reviews of the system's functionalities and performances were ran, in order to verify they were aligned to what had been planned and to the current necessities.

The ERP system is scalable: the scalability was one of the very main project objectives.

R16 IT system maintainability

The documents concerning the maintenance process were managed according to a structured technique and the company defined procedures to follow for the interventions.

The agreement on the maintenance service was part of the global support on the applications HP provides. The type of this agreement was different for the various modules. The company defined which issue HP has to correct and the resolution timings. The type of intervention planned is adaptive and corrective, not enhancing.

R17 IT supplier stability and performance
The company, as already said, had a partnership with HP. It was not possible to determine which kind of support HP provides for upgrades and releases, since these matters were defined in the contract and the interview manager did not know about it.

R18 Strategic thinking
The ERP implementation project is part of a long term IT plan, which involves the entire corporate. In particular, it has to facilitate the 2010 business vision, which is to become a "100 billion company".
As the project manager pointed out, the ERP project was not seen as a mean to drive the change through the company. It was not considered an opportunity to transform the company, the overall strategy or the vision. The ERP was intended to modify the way the company worked and to "change the landscape": to abolish locally, regionally managed tools. As another important aspect, ERP had to help managers in the decision making processes.
The outcome objectives of the project were to enable to do the business, to support the company vision, to facilitate the operations and to decrease the cost of managing the IT system. It had to integrate the platforms through the globe (which brings to a cost reduction) and to standardize (which enables the 2010 vision). The company carefully considered the fact that adopting the ERP system implicated rigid process to be bounded to.

R19 Financial management
The investment evaluation techniques adopted by the company were the value creation, the NPV and the costs/benefits analysis. Most of the benefits of the project were indirect: the company therefore evaluated them on the base of the enabling potentialities. In particular the costs/benefits analysis was made considering both direct and indirect costs and benefits, and above all taking into account the future expansion. The analysis also included considerations on intangible benefits, as the possibility of running a bigger company than what they could have done with the previous system.
The strategic option of the investment on the ERP system had been preventively considered while any consideration on the productivity loss had been made, since the project was not implemented for productivity objective. It was considered a productivity investment to run the project itself in order to carefully plan all the key users' needs, requirements and preferences to run the project, to carry on tests, to rearrange the work processes, to be sure that there were no conflict with other on-going initiatives. The company experienced problems with the cut over phase, which turned out to be longer than designed. This was the main

unplanned cost they met.

Risk Management
The company planned several preventive actions to face problems, such as over dimensioned budget, a backup budget, contractual penalties and communication plan to follow for unseen issues. The bigger matter, from the project risk management point of view, was the longer cutover for unforeseen difficulties in the platform data transfer.
The corrective action undertaken was following the "emergency plan" previously set: all the plants were provided of these plans, were alternative procedures (ad hoc renewed) were fully documented. When the issue occurred, the communication of that immediately ran through all the plants and everybody knew exactly what they had to do.
The regional project manager pointed out that, if he had to start over again the project, he would better plan the project initiation phase (assessment), since it was too slow in the beginning.

6.5.5 Risk Effects

E1 Budget exceed
The project respected the budget in Pomezia Plant

E2 Time exceed
The project was one-month late, due to the already cited longer cutover

E3 Project stop
The project was not stopped

E4 Business performance
The ERP system implementation did not bring any improvement of the operative parameters (LT, number of error-free shipping, average time of the orders' fulfillment etc).

E5 System reliability and stability
The ERP modules were partially used, as they were not used at the 100% of their capability. There was no replication of them, where for replication it's meant the situation in which two modules where used to perform the same task. No bugs occurred; therefore no maintenance interventions were necessary. The Project management could not say if the ERP system brought to an improvement of the completeness and coherence of the information, since no enhancement was planned.

E6 Organization process fitting
According to the project management's opinion, the ERP system did not bring to a misalignment between the company s own procedures and those the system imposed. Moreover, the ERP software did not create a gap between the roles which used to be previously covered in the company and the one requested by the system.

E7 User friendliness
The project management judged the system not very learnable, while evaluated the efficiency, the memorability and the users' satisfaction as high. The likelihood of committing errors was judged low, since the system gives many suggestions. The errors that can occur are due to inattention.

E8 Degree of integration and flexibility
According to the project management's opinion, the ERP system can be easily integrated with the legacy system, since it has standard interfaces. It can also be very easily integrated with external software's and it is very easily expandable. Lastly, the system can manage exceptions and procedures' modifications, but not easily.

E9 Strategic goals fitting
The ERP implementation achieved the following objectives: improvement of the information quality, enhancement of the employers' skills and improvement of the processes' quality.

E10 Financial and economical performance
As a consequence of the ERP implementation, standardization was achieved. This, combined to an easier manageability, allowed to sustaining a 100 billion dollars business and this is the economical/financial parameter improvement directly imputable to the ERP system.

6.5.6 Risk Assessment Simulation

The interviewees were involved in a risk assessment simulation using the software we presented in chapter 4. Based on the information they provided about the probabilities of occurrence of each risk factor and the impact of the effects, the software calculated a risk factor ranking. Results were then shown to them, in order to verify if, in their opinion, it was coherent with what really happened and their perception during the project implementation.
In the following table the outcoming ranking is shown (Figure 6.15).

The Risk Factor scores are clusterized according to K-Means algorithm with

RANK	ID	RISK FACTOR	SCORE	CLASS
1	*R5*	Low key users involvement	347.11	A
2	*R2*	Poor project team skills	304.61	A
3	*R8*	Inadequate BPR	75.65	B
4	*R17*	Inadequate IT supplier stability and performance	19.07	C
5	*R9*	Bad managerial conduct	15.05	C
6	*R3*	Low top management involvement	12.12	C
7	*R13*	Ineffective consulting services	9.10	C
8	*R4*	Ineffective communication system	8.71	C
9	*R18*	Inadequate training and instruction	4.71	D
10	*R14*	Ineffective strategic thinking and planning	4.00	D
11	*R1*	Poor leadership	2.21	D
12	*R19*	Inadequate selection	2.15	D
13	*R10*	Inadequate financial management	1.24	D
14	*R15*	Ineffective project management techniques	0.79	D
15	*R6*	Inadequate IT system issue	0.56	D
16	*R12*	Inadequate Legacy system management	0.24	D
17	*R16*	Inadequate IT system maintainability	0.19	D
18	*R7*	Complex architecture and high number of implementation modules	0.03	D
19	*R11*	Inadequate change management	0.02	D

Figure 6.15: P&G Risk Ranking

four clusters (A, B, C, and D). The result of this clustering is showed in Figure 6.16.

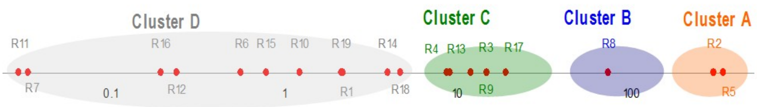


Figure 6.16: Risk factor clustering P&G

The clusters are shown with logarithmic axis.

6.5.7 Usability and Utility

The managers did not consider the software to be able to improve the project management, since the provided result did not represent something new and it was too onerous to be implemented. The software appeared easily understandable and usable but not useful for the ERP implementation project.
They however agree with the methodology's proposal and with the utility of

a similar approach during the assessment phase of the ERP implementation. Lastly, the managers pointed out that in a project what it is vital is the assessment effort the company makes about the risk factors, not a ranking of them.

6.6 Case Study B: Svenska Cellulosa Aktiebolagat (SCA) Spa

6.6.1 Company Overview

SCA is a global consumer goods and paper company. It develops, produces and sells personal care products, tissue, packaging solutions, publication papers and solidwood products in more than 90 countries.
SCA is global leader in incontinence care market and European leader in tissue market. The company operates in four business areas: Personal Care, Tissue, Packaging and Forest Product. Personal Care division offers incontinence care, baby diapers, and feminine care products including towels, pantyliners and tampons. Important consumer brands are Tena, Libero and Libresse. Tissue business units include product like toilet paper, kitchen rolls, handkerchiefs, napkins as well as related equipment to consumers and Away-From-Home tissue customers. Some of the brands are Tork, Tempo, Zewa and Edet. Packaging offers containerboard and packaging solutions like transport packaging, protective packaging, consumer and point-of-sales packaging as well as services. SCA's packaging solutions are mainly used to transport food, industrial products and consumer durables. Forest Products produces publication papers, pulp, solidwood products and timber. The percentage of the total volumes covered by each business unit is represented in Figure 6.17

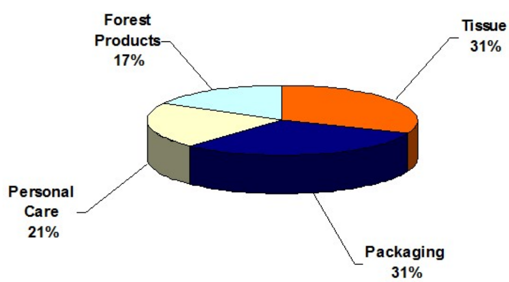


Figure 6.17: Volume percentages covered by business units

The company was founded in 1929 and is headquartered in Munich, Germany. SCA has about 50,000 employees in some 50 countries. Europe and North America are the main markets, but the Group also holds strong positions in certain segments in Latin America, Asia and Australasia.
Expansion will continue mainly in Asia, Latin America, Central and Eastern Europe. SCA's ten largest markets are (in order): UK, Germany, USA, France, Sweden, Italy, Netherlands, Spain, Denmark and Australia. Annual sales in 2007 amounted to 11.4 billion EUR. SCA produces to forecast and to customer's order (MTS and MTO).
The process flow structure is "continuous-in line" one and the manufacturing model is high volume/low mix, typical for a paper mill. The corporate has a centralized decision making process and it adopts a divisional organization structure.

6.6.2 ERP implementation project in Italy

The company acquired three important Italian competitors: Italcarta (packaging) in 1975; CartoInvest (the fourth largest tissue producer in Europe) in 2002; Busto & Tema (packaging) in 2003.
SCA sells in Italy baby diapers, feminine hygiene products and light incontinence products. The company has a 10% market share for consumer tissue and it is the third bigger player in the market. The leading brands distribute in Italy are Nuvenia, Tena, Tork, Libero and Tempo. The main Italian productive sites are located in Lucca. In Italy SCA has about 200 employees and it invoices about EUR 390 million.
The ERP implementation project examined in this case study involves the sites of Milan and Lucca. The project started on the end of April 2004, when a steering group was designed including managers belonging to the corporate. The structure of the project teams is represented in Figure 6.18.
As it is shown, there were two project managers: one for the project and one for the IT projects. A sponsor manager was nominated as a link with the top management. The project team included Italian key users assisted by the corporate managers who had both IT and business competences. No consultants were hired. The project was divided in five planned gates; every gate had a milestone where the steering group and the project managers decided whether the project could go on to the following phase. Figure 6.19 shows the project life cycle.

The phases and milestones were:
o Project pre-study: (Tollgate 1): March 2004;
o Project preparation (Tollgate 2): May 2004;
o Detailed blue print (Tollgate 3A): July 2004;

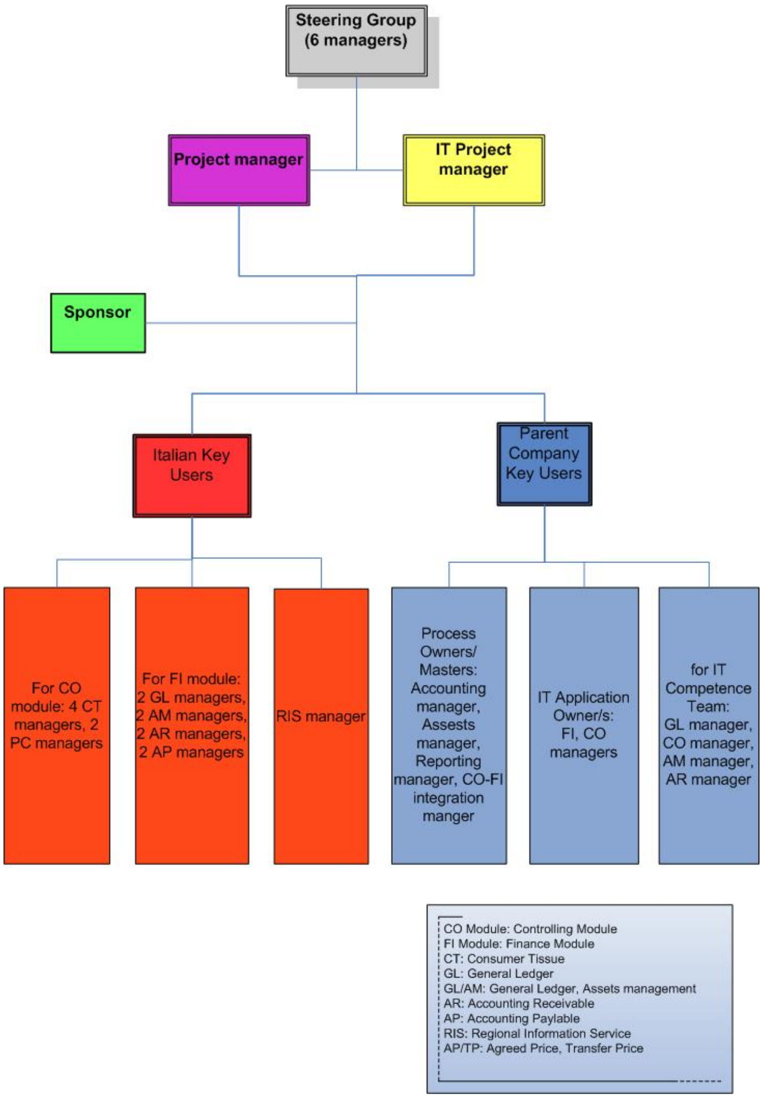


Figure 6.18: SCA Project team structure

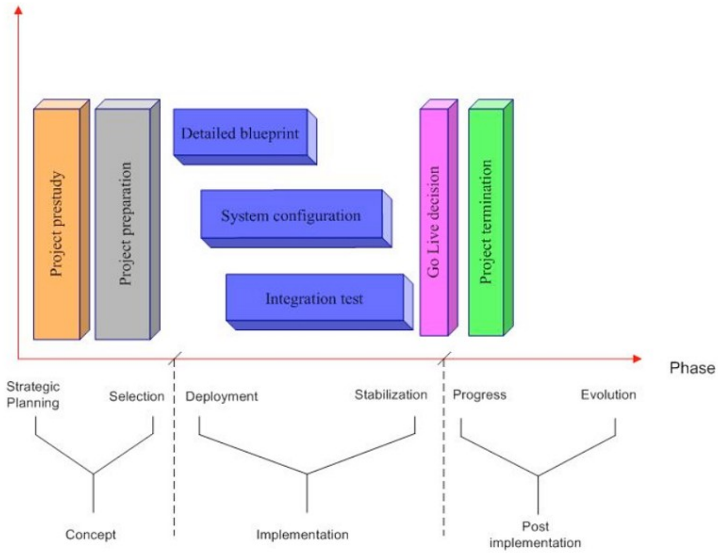


Figure 6.19: SCA Project Life Cycle

o System configuration (Tollgate 3B+C): August 2004;
o Integration test (Tollgate 3D): October 2004;
o Go Live decision (Tollgate 4): December 2004;
o Project termination (Tollgate 5): March 2005.

Project pre-study. The first phase was a preliminary study to determine whether to start the project.

Project preparation. The second phase included the project set-up. The steering group defined the details of the plan and the overall team work. The team defined the organizational changing and training needs. Meanwhile Italian key users started to use a simulation of the ERP system used in Finland.

The third phase was the execution phase that was subdivided into four parts, each one linked with feedbacks:
Detailed blueprint. The steering group came to Italy to interview the users about the process flows. The team made a blueprint which described the processes "as is" and the processes "to be".
System configuration. The steering team went back to Germany to find the essential adjustments that ERP system required to be aligned with Italian processes. Based on this analysis, IT department had to buy additional parts or develop specific solutions.
Integration test. Two type of test were run in Italy to verify the ERP sys-

tem: the "inbox test" which verified if every module of new system met the function's needs; and the "outbox test." which verified the correct interactions between each ERP's module. Based on the results of these tests, the system was modified to overcome the main problems; key users made a document to describe every possible procedure that the system had to include.
Go live decision. In this phase the steering group decided if the ERP system was ready to go live.
Project termination. This last phase represented the end of the training process and the team went back to Germany.

6.6.3 The Interview

To obtain the information about this project we mainly interviewed two managers: the IT manager and the Chief Accountant. Both the managers work in SCA since 2003, when SCA corporate acquired Lucca's site. The IT manager had experience in IT projects, while the chief accountant had not any. They were involved in the project team as key users. An Italian Top manager was also interviewed in order to investigate other strategic chooses.

This section covers each construct of the research model with summative findings.

Motivations
SCA corporate had already implemented the ERP system in the sites located in Germany, France, Spain and England: therefore the corporate had the necessity to align the Italian site.
Moreover, ERP was implemented in Italy in order to improve efficiency, costs control and to obtain compatible fiscal data. The implementation decision was completely taken by the corporate.
The project purpose was the replacement of Italian current Financial systems with a SAP R/3 Finance and Controlling (FI & CO) module: this meant a complete migration from the previous legacy system to SAP system. The go live date was set on the 1st of January 2005. The system was based on the general set-up realised by SCA. The implementation had to fulfil legal requirements of this site and to harmonize the business processes of SCA as stated by the Process Owners.

6.6.4 Risk factors

R1 Selection
The company did not have the necessity of selecting any ERP package, vendor or system integrator, since they already had a strategic partnership with SAP corporate. Moreover, SCA company had already trained IT employees on SAP system software therefore external personnel was not needed for the implementation project.

R2 Project team skills
The project team was composed by internal figures: key users representing each distinct function. Part of the key users focused on the CO module, others on the FI one. No process to detect the project team training needs was implemented: for example, some key users did not know English so there were problems in communication with the corporate personnel.
To train the key users about the system an internal formative course was run. Key users did not have any experience about these type of projects while the steering committee and the project managers were the same who implemented the ERP system in other SCA sites.

R3 Top Management involvement
The Top Management was involved in the review and approval phases. The top management interacted with the project team using mails and meetings. This interaction had mainly a monthly frequency but this increased in particular moment of the project like the beginning where the frequency was about four times a month. The project had a champion, who belonged to the corporate company. He had the responsibility about supervising the project's phases.

R4 Communication system
Throughout the project life cycle the communication means used were the same as previously described and several workshops were organized. These workshops prevented the key users to run their normal business activities. The objective of the workshops was the description of the Italian plant and the analysis of the modification request from the key users.
During the whole project life cycle, communication took place both among the project team members and the corporate personnel

R5 Key users involvement
Key users were involved in the project since the beginning but they had a passive role limited to an operational level. They belonged to the IT, Logistic, Purchasing and Production functions for the CO module, while to IT and Finance for the FI module. Key users who could speak English carried out a "waterfall" training.

R6 Training

The key users were trained through on site and off site courses held by the corporate. Workshops provided an opportunity to improve the training.

The formative needs had been identified by a structured process at the beginning of the project. At the end of the training no evaluation of the acquired skills was carried out. Further training was necessary after the system go live. The experts coming from the corporate company spent five more weeks on the site to help the employees to use the system while working.

The planned duration of the training process was respected. It was established on the basis of the previous ERP implementation projects held in the other SCA sites. The cost of the training had been budgeted, among one of the entries of the total budget.

R7 Architecture

Two modules were implemented at the first step: FI (financial) and CO (controlling) modules. Afterwards other modules were implemented, following an incremental strategy. This strategy reduces the implementation risk and it allows splitting the needed investments and efforts in more years. Implementing more modules at the same time would have had a high likelihood of collapsing the factory's business. After the first implementation (FI and CO modules) the second one concerned MM (material management), PP (product planning) and PM (plant management) modules. The implementation of SD (sales and distribution) module is currently in progress since it is the most complex one.

The ERP system adopted a multisite architecture. The approach is a corporate one: everyone has to use the same package to obtain the required integration. There had been a little customization of the software, about 5%, related to some modifications for specific operation. The company tried to adapt the most of SAP system already utilized in other sites. Few modifications were needed, especially in paper mill business where the operations were less standardized.

The ERP system had to be integrated with the EDI (electronic data interchange) software and the legacy system for some area the new software did not cover. In Italy the number of users of SAP is circa 300. Each user has a different account because each one has a different access class. The system is client server oriented and it uses a single database and several servers sited in Sweden.

R8 BPR

The company carried out a preventive analysis of the processes, in order to prioritize the areas on which working because of the ERP system implementation: the first area was the financial one. The Business Process Reengineering process was not performed. Just a blueprint was edited in the development phase of the project life cycle with the "to be" processes. The edit of this blueprint involved all key users and the steering committee and the total time spent was about 12% of the whole project time duration. But this blueprint was not used during the implementation so after go live some processes had to be changed in order to adapt them to system model. The edit cost of the blueprint phase had been budgeted; it was one of the entries of the total budget. No gap analysis tools were used.

R9 Managerial Conduct

The project manager had to clarify again the objectives throughout project implementation. This was due to the fact that people did not know the English language. The policy adopted was to complete the implementation on time so external resources were engaged to support the normal business operations. Another key feature of managerial conduct was the will to not modify the system in order to contain the implementation cost and obtain a better maintenance's management. The interviewees said that the only modifications they obtained were those due to "fiscal reason" because the steering committee did not know the Italian treasury law so that they preferred to accept the advanced requests in these cases.

All team members were generally very involved in the project dedicating 80% of own time along all project.

R10 Project management techniques

The risk analysis was run using the company's own risk management logic. The project phases had been formally planned, both in terms of time and costs. The project budget was determined by the top management on the basis of previous implementation projects in other sites. It was a top down decision. The project was controlled very carefully (real time control) and they had planned an evaluation of the system effectiveness in the post go-live phase.

R11 Change management

The company did not carry out any preventive evaluation of users' attitudes towards the change. The interviewees said: "any change management was conducted because the implementation was fully imposed". The project team in fact, imposed the implementation to Italian sites with an authoritative conduct, confining the Italian staff to a mere supporting role not assigning any type of power.

The top management communicated the benefits of the ERP systems to the employees, which were mainly an increase of their own skills due by ability to use SAP system. The employees were also indirectly informed about the impact of the implementation on their own careers The top management explained also how the ERP system would have worked. The leaders' of the most influential groups of the company were fully involved in the project.

R12 Legacy system management

The company ran a preventive analysis of the IT system, in order to define the priorities of the tasks and determine which components to keep in the ERP system. This was been done in the blueprint phase.

The legacy system functioning had been fully comprehended: even if there were not the documents concerning the old IT system, the expert employees were still in company and they had a excellent mastery of it. The treatment strategy adopted was the migration one. There was no gradual transitory phase, as a cut over was executed to pass from the old to the new system with the system's go-live.
After the go-live, the legacy system was never used to cover applications the ERP system was meant to cover but just to recover some bills because not all the data were migrated.

R13 Consulting service
The company did not make use of the external consulting service but a group of experts came from the corporate to help the Italy managing the project just at the beginning. This group had both business competences about SCA, technical competences about SAP system and competences of project management. They had the complete responsibility on the project.
Any information about how they were assessed is not available by interviewees. The integration between the group and the employees was judged poor because of language's matters. The means used to communicate with the team members were e-mails and meetings. Finally, the collaboration with the consultants very much increased the internal knowledge of the company: they held the training courses and improved the project management knowledge.

R14 Leadership
The project had two project mangers: one for IT issues, belonging to the corporate, and one for business belonging to the site. Both managers had had previous experiences as team manager. The leadership style used was to force the key users to accept the system as much possible without adjustments.

R15 IT system issue
The company carried out a structured process to define the functionalities and the performances the new system had to provide, editing the blueprint at the beginning of execution phase. The corporate team, key users and the project manager were involved in this editing.
During the project implementation, periodical reviews of the system's functionalities and performances were run, in order to verify they were aligned to what had been planned and to the current necessities. That was performed trough tests about the system's application and editing all possible business cases that system had to support.
The implemented system is rigid: every modification has to be request to the corporate trough a bureaucratic process.

R16 IT system maintainability
The documents concerning the maintenance process were managed according

to a structured technique and the company defined procedures to follow for the interventions: each request has to be sent to the help desk the corporate, which assigns a ticket number to it; if the request is accepted then it is solved as soon as possible. The agreement on the maintenance service is not known by interviewees but they know the latest version of SAP have to be set according to vendor's contract.

R17 IT supplier stability and performance
The company, as already said, had a partnership with SAP. It was not possible to determine which kind of support SAP provides for upgrades and releases, since these matters were defined in the contract and the interview manager did not know about it.

R18 Strategic thinking and planning
The ERP implementation project is part of a long term IT plan, which involves the entire corporate: this plan covers the implementation of the system in all SCA's sites to allow having a tool of govern and administration.
The ERP project was not seen as a mean to drive the change through the company. It was not considered an opportunity to transform the company, the overall strategy or the vision. The ERP was intended as a tool which enabled the sites' integration and it was the only possible solution although it would make rigid the business processes.
The outcome objectives of the project were to improve the process' automation and increase the administration's ability.

R19 Financial management
The investment evaluation techniques adopted by the company is unknown by interviewees. The strategic option of the investment on the ERP system had not been preventively considered as any assessment about the system's benefits was not been conducted: the only target was to obtain a tool of administration and a system which could be integrated with other sites.
Any other information about the investment assessment and the reasons of extra costs is not available. The company had planned a transitory period of productivity drop but indeed it did not occur.

Risk Management
The project did not have any planned preventive actions and during implementation there was no need of these because the project managers had much experience about of this type of project, acquired trough the other implementations in different SCA's sites.
The major problem detected in the implementation concerned the communication system and low key users involvement. Indeed the interviewees pointed out that, if they had to start over again the project and if they would have the opportunity to manage the project, they would give more power to the Italian

staff and they would not bounded it to a passive role, they would try to involve it in the project's decision.

6.6.5 Risk Effects

E1 Budget exceed
The interviewees did not have a complete visibility on the budget, but they consider it about 150% excess.

E2 Time exceed
The project respected the planned project time. This is due to a good expertise about this type of implementation and probably to the use of extra resources.

E3 Project stop
The project was not stopped: this possibility was not even taken into consideration; the interviewees said: "there were not possibilities to not implement the system".

E4 Business performance
The ERP system implementation did not bring any sensible improvement of the operative parameters (LT, number of error-free shipping, average time of the orders' fulfillment etc) but a better data access was provided.

E5 System reliability and stability
The ERP modules were partially used, as they were not used at the 100% of their capability: an example of this effect is the PM module. There was no replication of the modules, where for replication it's meant the situation in which two modules where used to perform the same task.
Some maintenance interventions were necessary both for new query request and continuous improvement. The main cause of the maintenance interventions was wrong system's specifications. The interviewees rather agreed that ERP system brought to an improvement of the completeness and coherence of the information.

E6 Organization process fitting
According to the interviewee's opinion, the ERP system brought to a misalignment between the company own procedures and those the system imposed. Moreover, the ERP software created a gap between the roles which used to be previously covered in the company and the one requested by the system so it was necessary to reorganize the roles in the company.

E7 User friendliness

The interviewees judged the system not very efficient, while they evaluated the learn-ability, the memor-ability and the users' satisfaction (even if there were some performances problems) as high. The likelihood of committing errors was judged low, since the system gives many suggestions.

E8 Degree of integration and flexibility
According to the interviewees' opinion, the ERP system cannot be easily integrated with the legacy system. The integration with external software's is difficult but it is very easily expandable. Lastly, the system can easily manage exceptions and procedures' modifications.

E9 Strategic goals fitting
The ERP implementation achieved the following objectives in order of amount: improvement of the information and decision quality, enhancement of the employers' skills and improvement of the processes' quality.

E10 Financial and economical performance
As a consequence of the ERP implementation, any improvement of the financial performance was detected by interviewees.

6.6.6 Risk Assessment Simulation

The interviewees were involved in a risk assessment simulation using the software we presented in chapter 4. Based on the information they provided about the probabilities of occurrence of each risk factor and the impact of the effects, the software calculated a risk factor ranking. Results were then shown to them, in order to verify if, in their opinion, it was coherent with what really happened and their perception during the project implementation.
In the following table the outcoming ranking is shown (Figure 6.20).

The Risk Factor scores are clusterized according to K-Means algorithm with four clusters (A, B, C, and D). The result of this clustering is showed in Figure 6.21.

The clusters are shown with logarithmic axis.

6.6.7 Usability and Utility

The managers did not consider the software to be able to determine the strategy and the policy to adopt for the implementation, therefore in their opinion it

RANK	ID	RISK FACTOR	SCORE	CLASS
1	R13	Ineffective consulting services	3224.13	A
2	R3	Low top management involvement	1963.22	A
3	R2	Poor project team skills	1181.58	B
4	R14	Poor leadership	858.60	B
5	R4	Ineffective communication system	676.11	B
6	R9	Bad managerial conduct	492.66	C
7	R8	Inadequate BPR	298.62	C
8	R10	Ineffective project management techniques	143.71	D
9	R5	Low key users involvement	65.367	D
10	R6	Inadequate training and instruction	16.61	D
11	R7	Complex architecture and high number of implementation modules	8.12	D
12	R11	Inadequate change management	3.37	D
13	R19	Inadequate financial management	2.7	D
14	R18	Ineffective strategic thinking and planning	2.49	D
15	R16	Inadequate IT system maintainability	1.2	D
16	R12	Inadequate IT supplier stability and performance	0.28	D
17	R17	Inadequate selection	0.09	D
18	R15	Inadequate IT system issue	0.05	D
19	R1	Inadequate Legacy system management	0	D

Figure 6.20: SCA Risk Ranking

Figure 6.21: Risk factor clusters SCA

cannot improve the project management. However they agree with the utility if a risk management methodology in the earlier phases of the project.
The software appeared easily understandable and usable. It also appeared useful for the ERP implementation project if used during the early planning phase in order to allow a better project assessment.
Lastly, the interviewees pointed out that to utilize this software a better explanation of the risk factors should be provided.

6.7 Case C: Power One Spa

6.7.1 Company Overview

Power-One is a leading designer and manufacturer of power conversion and power management products, most of which are sold into the communication infrastructures, server/storage and other high technology markets. Their products are used to convert process and manage electrical energy, both in alternating current ("AC") and direct current ("DC") form, to the highest quality levels of, reliability and precision required by communication infrastructures and other equipments. Providing hundreds of different standard products and creating custom products, Power-One has one of the most wide product lines in power conversion and power management industry. That makes Power-One be part of the few companies that can virtually power each component and system of an infrastructure network.

Their power conversion and power management products include:

- AC/DC power supplies that convert AC from a primary power source, such as a wall outlet, into a precisely controlled DC voltage. It provides a broad range of AC/DC power supplies that power a wide variety of equipment in the communications, networking, server/storage, computer, instrumentation, industrial, and electronic industries;

- DC power systems that are used by communications and Internet service providers to power and used as backup power for large communication infrastructure equipment;

- DC/DC converters that modify an existing DC voltage level to a different DC voltage level to meet the power needs of various subsystems and components within electronic equipment;

- Inverters for Renewable Energy converting solar or wind energy into useable AC/DC power; and

- Additional products including digital control products for motors and a variety of other application-specific specialty power products.

Power-One designs power conversion and power management products primarily to meet the needs of communications and server/storage infrastructure equipments; industrial applications; high-end consumer and industrial appliances, and renewable energy inverters (Figure 6.22).

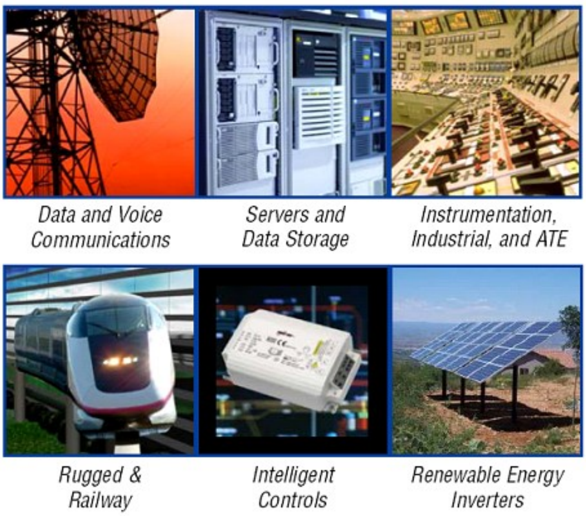


Figure 6.22: P1 Market secotrs

The company customers include many leaders of the technological-industrial field: Alcatel/Lucent, Cisco Systems, Ericsson, Huawei, Motorola, Nokia-Siemens Networks, Nortel Networks, Siemens AG, Sun Microsystems, and Teradyne. Thousands of additional customers are serviced by one of the most extensive distribution networks of the company.

Power-One was originally incorporated in 1973. The corporate has constantly aimed to become a leader in the market across several acquisitions (Figure 6.23).

Once reached the leader position for standard electronic products, the top management decided to expand towards the customize product market. For this

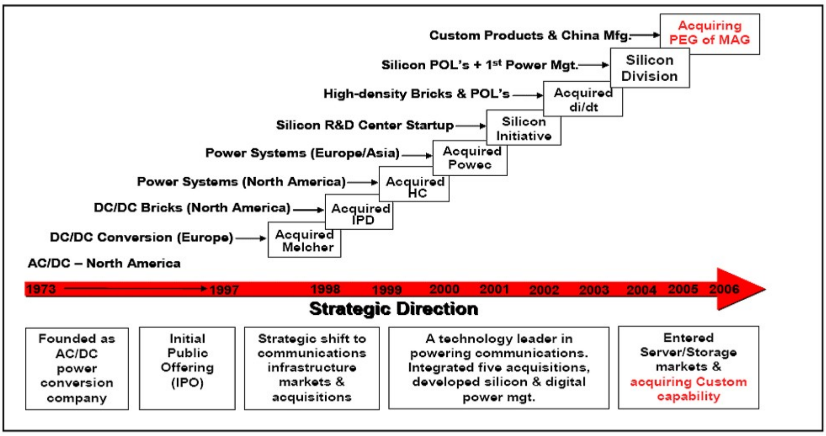


Figure 6.23: P1 History

reason, in October 2006, Power-One completed the acquisition of Power Electronics Group (PEG), and Magnetek Inc. The PEG was composed by three factories located in Valdarno (Italy), with three low-cost “feeder plants” respectively in Hungary, Chatsworth (USA) and Baoan (Shenzhen, China), counting 1,500 employees in all. Through this highly strategic acquisition, a team of experienced engineers was cast upon the employee base group, with a significant improvement of the custom AC/DC design capabilities, the expansion of the product portfolio, the broadening of the customer list and markets, and the development of a low-cost manufacturing operation in China.

Now Power-One has 15 plants in Americas, Europe and Asia with a total amount of 4,000 employees. It has about 511 million dollars revenue with a balance sheet of about 72 million dollars. The following tables illustrate the revenue growth and the percentage of the net sales in the primary markets (Figure 6.24).

The global presence, the technology leadership, and the local customer support contribute to make Power-One competitive on a world-class level. Strategically-located, the global operations facilitate the industry-leading support for global customers. Although each factory is optimized for specific products and volumes, flexible work cells allow the manufacture of additional products based on customer location, lead times, and shipping costs. This combination of strategic locations and flexible infrastructure enable world-class responsiveness. The process flow structures are batch and project flow.
The firm uses a centralized decision making with a matrix organization design. Power-One utilizes Oracle Enterprise Resource Planning (ERP) software to help in managing logistics and manufacturing operations, including the support of

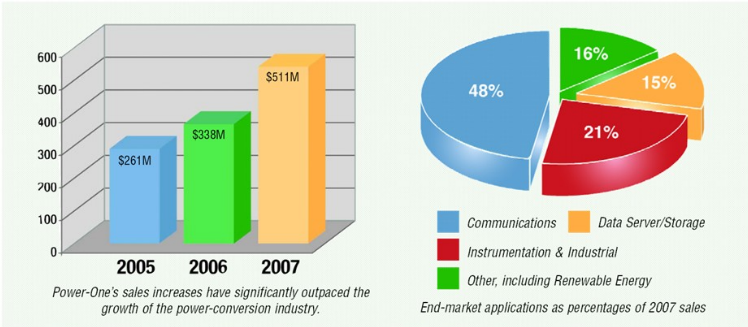


Figure 6.24: P1 Sales

Vendor Managed Inventory (VMI) and Electronic Data Interchange (EDI) programs.

6.7.2 Power-One Italy Spa

Power-One Italy Spa is sited in Valdarno with a 180 K sq. ft extended plant. It counts about 500 employees. This site is one of few including both manufacturing and R&D. Indeed, this factory has a research key role for the new renewable technologies. The corporate focuses the production of complex products on the Italian site, meanwhile on the Chinese site the production is mainly based on standard products. The Italian plant production needs a more complex organization in comparison to the other sites. One reason is the low volume/high mix manufacturing models with several different types of manufacturing products to forecast; assemble to order; engineer to order; and produce to customer order. A second reason is the several levels of the material bills (a range from 11 to 20 levels). These features are only present in the Italian site, while the Chinese plant, on the contrary, uses a high volume/low mix manufacturing model and material bills with 2/3 levels.
The Power-One inc. also considers the Italian site as a base for European market, so several efforts are made to encourage its development.

6.7.3 The ERP Implementation Project

That conversion concerns both the Italian and Chinese plants. The conversion would originally have had to start in the Baoan site first, as it was considered a "pilot" project with a less complex introduction process, but the Chinese plant had to stop the project because of others IT projects in progress. So the project started in the Italian site in March 2007 and in Baoan in June 2007 with a scheduled "go live" in November 2007 for both of them. The estimated time was based on previous eleven implementation projects (Figure 6.26).

Implementation	*Sites*
I	Camarillo, Mexico
II	Republic Dominican, Puerto Rico
III	Boston (USA)
IV	Switzerland, Slovakia, Ireland
V	Norway, Grain Britain
VI	Shenzhen, Hong Kong
VII	Sweden
VIII	di/dt
IX	Power Systems North America
X	Singapore
XI	Russia
XII	Baoan Valdarno

Figure 6.25: P1 Oracle implementation order

In our survey we analyzed the Italian conversion. The old IT system was COPICS: a legacy system that used Italian language with character interface. It was also exported and used in Baoan site. The project focused on the migration from COPICS system to Oracle system using the discovered solutions in the previous implementations, standardizing the processes with the system business model. The migrated data were only active data whereas the historical data didn't migrated to new system. The implementation consisted in several Oracle modules: Oracle Business Suite, Oracle Financials, Oracle HRMS (Human Resource Management System), Oracle Mobile Supply Chain Applications and Oracle Order Management. Only English language was used.

The project phases, showed in Figure 6.26, were:
Preparation Phase. It consisted in defining the project scope and the staff as key users and consultants. In this phase a project plan was edited and a kick-off meeting established the project start. A communication tool was also identified. It was a web site on own corporate-intranet called Share Point; each project communication and document was posted on it.

Solution Phase I. It was also called CRP0 & CRP1 Test Instance. CRP means Conference Room Pilot: key users training and a test about software solutions. Through this test the gaps between "as is" business processes and Power-One best practises embedded in the system were pointed out. In this preliminary phase the training started and CRP1 test was prepared.

CRP1, CRP2 and CRP3. The CRP1, CRP2 and CRP3 tests were conducted identifying and resolving gaps and bugs. During these tests, the legacy system data were converted and migrated on new database. When CRP3 started, end-users training also began. Prepare Rollout. In this phase all the gaps and bugs had to be resolved and verified; the user profiles were established and end-users training was completed. So the system was ready to go live.

Go Live. The implementation consisted in a cut-off of the legacy system so the transactions were stopped to preserve data integrity and data migration completed. Post Implementation. A support was provided to help users. The system performances were monitored and continuous improvements realized.

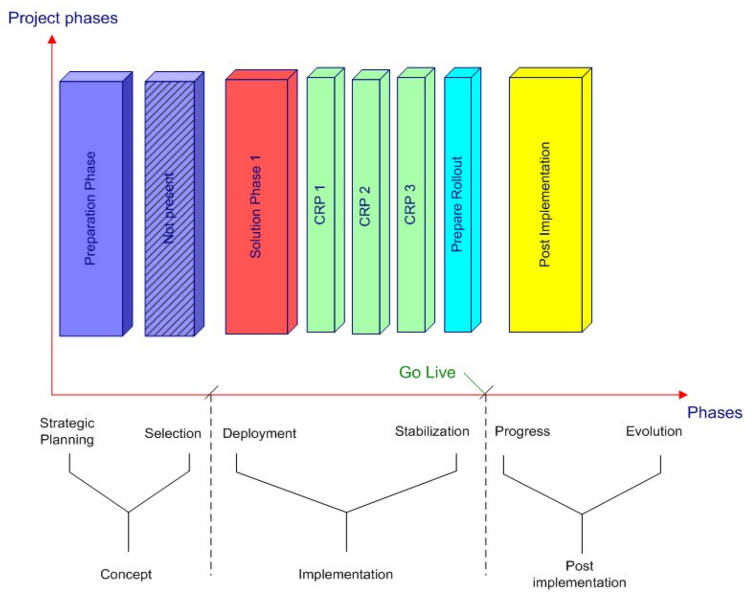


Figure 6.26: P1 project life cycle

The project team is showed in Figure 6.27.

The same procedures and methods has been followed by both the Italian and Baoan implementation. The Steering Committee had the whole responsibility of the projects and it was composed by two top managers. They had the job of super-visioning the project, approving decisions and allocating resources. The Director of Implementation had the job of defining the project scope, leading top management relationship, projecting management activities and monitoring solutions. Both the Steering Committee and the Director of Implementation

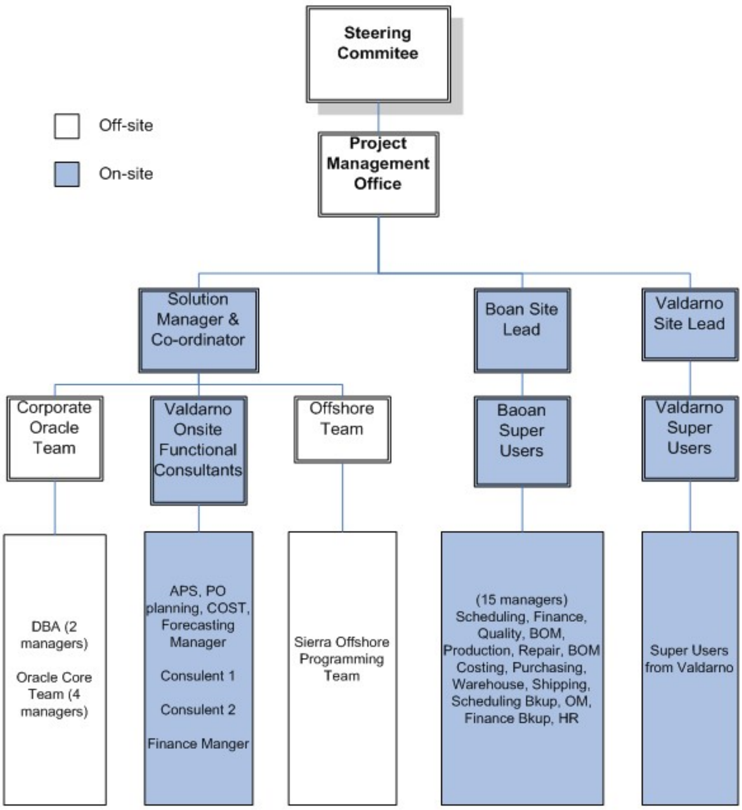


Figure 6.27: P1 Project Team

were operating from headquarters in California.
There were two project managers in loco for each factory (Baoan Site Lead and Italian Site Lead) and a Solution Manager & Co-ordinator attended in Italy. The last one was a coordinator for both projects and he had the responsibility of engaging solutions; he was an external consultant. Each site had several Super Users, or Key Users. They pinpointed the business requirements as a "as is" processes mapping; meanwhile the Super Users were learning about the new system. They tested the Oracle processes and verified migrated data. Finally they trained the end-users to the system.
Super Users spent up to 70% of their whole activity in supporting the external IT consultants during the whole project. A table shows the numbers of the Italian Super Users subdivided into their own offices (Figure 6.28).

Office	*Numbers of Super Users*
Sales – Customer Service	3
Purchasing	2
Sourcing	1
Production	5
Planning	2
Logistic	4
Quality	4
IT	1
HR	2
Finance	5
R&D	5
Total	**34**

Figure 6.28: Key users origin

The Solution Manager & Coordinator had to coordinate three different teams: Offshore Team, Corporate Oracle Team and Italian Onsite Functional Consultants.
The Offshore Team was composed by an external consultant team operating off-site (India). It had to migrate data and to resolve each request about software customization.
The Corporate Oracle Team was composed by employees with Oracle expertise. It supported the onsite team to resolve issues and gaps.
The Italian Onsite Functional Consultants were responsible for Italian implementation. Their main tasks were to learn both Italian business requisites and the yet implemented Power-One solutions, lead the Super Users during the whole project, apply the Power-One Best Practise Solutions, train the Super Users, coordinate and collaborate with the offsite consultants.

6.7.4 The Interview

To collect data on the implementation project we interviewed the IT Manager of Power-One Italy Spa. Power-One engaged him on April 2007 because this role wasn't covered before and he had expertise in Oracle system and had already implemented four ERP systems. He doesn't appear in the team project scheme because his role wasn't defined but supported the team project and was completely involved at the beginning of CRP 3.

This section covers each construct of the research model with summarized findings.

Motivations
There are numerous motivations that brought the company to decide to implement an ERP system. First of all, the company had the necessity of replacing the old legacy system; then the objective was to improve the efficiency (for Finance function) and have better management tool (for HR function) at their disposal.
Moreover the company had to reduce the number of the employed systems and of the interfaces. Lastly the ERP implementation project was a decision imposed by the holding in order to achieve a better integration with the rest of the corporate which already had implemented SAP.

6.7.5 Risk factors

R1 Selection
The company did not assess any process for the selection of the ERP package, the vendor or the system integrator, since they already had a strategic partnership with Oracle Company. All the Power One sites, in fact, had just implemented Oracle so that the selection was constrained by the needs of a better integration and a thrifty implementation. In addition, the Power One Inc. had a partnership with an Indian system integrator, which had supported the Oracle system implementation in previous projects. This constrained choose has carried on adopting part of the Oracle system business model: during the system selection neither a previous gap analysis was conducted to choose a better matching system nor the user opinions were considered.

R2 Project team skills
The project team was composed by the system integrator staff, the parent company staff and all the key users representing all the distinct company functions, so that heterogeneous skills could be mixed together. Moreover, many members

had already experienced implementation projects. The main problem among the project team was the team size: the project involved more than 500 employees and the Italian processes presented had very different business peculiarities in comparison with the other sites, so that interviewees perceived that the project team was undersized. The main reason was a limited budget: just three business analysts were engaged in the team project, two of them came from an Indian business integrator (Power One partner) but different people were alternated in this role for visa reasons. This was a problem in terms of project work continuity. Furthermore, belonging to different countries, the staff had communication problems because of the different time zones and the different languages. Nothing was done in order to evaluate the English knowledge of Italian users and to fill this gap.

R3 Top Management involvement
We have to discern the role of the corporate top management from the local management. The first one only participated to approve the drastic changes to the project budget or schedule such as the postponement of Go live. The local top management, instead, was involved in all the review and approval phases. The members interacted with the project team mainly through e-mails and weekly frequency meetings. Therefore, the involvement of the corporate top management was not so good as the local one; what the project key users perceived was their absence.
Two champions were involved from the corporate: one to coordinate the technical issues and one to coordinate the human resources for the Business issues (key users).

R4 Communication system
Throughout the project life cycle, the communication means used were e-mails, a share point web site and conference calls. E-mail represented a really good support to the direct communication since the team members were scattered around the world in high different time zones. The share point web-site was a web site collecting all the projects in order to achieve information sharing. The site was hosted on the firm's intranet so that only the project members could access it. It collected the project's methodology, operative instructions, activities plan, etc. Therefore, the milestone achievements, the updated open issues, recognized gaps and test outcomes were here communicated. The tool was mainly used by steering committee and key users (Figure 6.29).

The interviewees perceived a lack of communication which led to a lack of coordination and to inefficient efforts of the team members. They were divided by functional area competence, as well as the analysts and the key users; coordinating actions were really a difficult task. Interviewees also observed a lack of communication of the system benefits to the users.

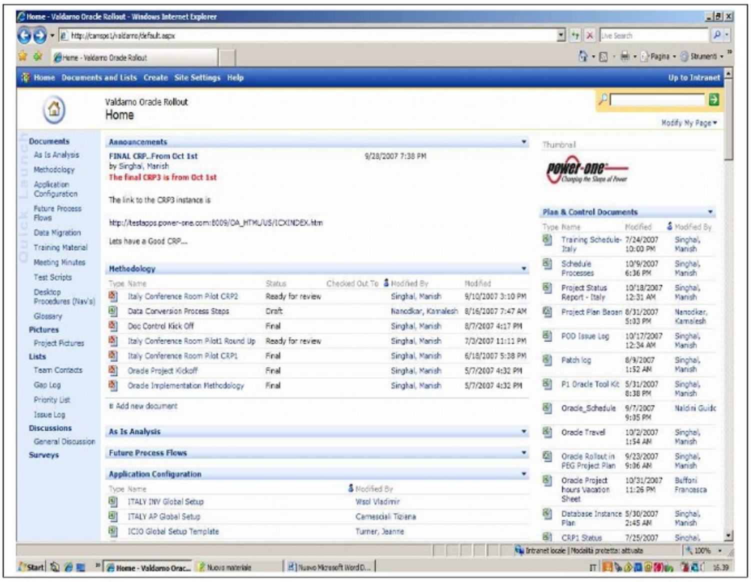


Figure 6.29: Share Point Web Site

R5 Key users involvement
Key users were not involved in the project planning but just in the operative implementation. They continued having a key role during the project and after Go Live till today, for example collecting all the user requests. Key user were selected from all the principal company functions: IT, Logistic, Purchasing, Planning, Production, Finance and R&D..They diffused the system knowledge carrying out “waterfall” training inside the plant and using both formal and informal methods.
Moreover, even if key users seemed to be low motivated and collaborative at the beginning of the project because they did not accept the inevitable changes due to the new system, they showed much commitment and responsibility in the course of time.

R6 Training
Key users were trained through on site courses held by system Integrator Company. Other courses were held by the process owners from other Power One’s sites. In addition, Navigators of other company sites were used to train people. Navigators are handbooks with operative instructions disposed by system integrators for other sites using the Oracle system. This training, however, did not fill in completely the user gaps of knowledge because it achieved only a general approach with the system without allowing Italian users in drawing their jobs in the new system. Both courses and navigators, in fact, were designed for dif-

ferent solutions of other sites, so that they were not completely suitable for the Italian implementation.
Furthermore, the formative needs were not identified by a structured process but just a survey on the knowledge of the English language was conducted in order to identify user needing of language support. At the end of the training, no evaluation of the acquired skills was carried on.
Extra assistance was necessary after the end of the regular training, so that a remote held desk was set up and user manuals were defined by the Italian users. In the more problematic cases conferences group were organized and key users from the other sites were invited.
The planned duration of the training process was not respected primarily because the key users continued to be engaged in their normal activities so sometimes they could not take part to the training. Secondly, the training costs were budgeted among one of the entries of the total budget but information about the budget misalignment are not available.

R7 Architecture

The complexity of the project was very high since the contemporary implementation of all the modules, the implementation speed and the lack of available resources.
In the Italian plant the project involved both the replacement of the Legacy system, and the implementation of quite all the Oracle modules (Manufacturing, Finance, Distribution, Human Resource, Supply Chain, Order Management, Planning, Procurement).
The system architecture adopted was multisite, due to the global organization of the company that had acquired several sites scattered in different countries. The implemented software was an Oracle ERP system which was hardly customized by Power One Business integrator, around to 70% of whole, during the various implementations in all the world. Further modifications , about 10%, regarded specifically the Italian business: Valdarno's site was the only one presenting all the different company functions while another relevant factor was the diversity of the production system which was very customized and complex (from 11 to 20 levels in the bills of materials while the other sites presented just 2-3 levels). The ERP system needed to be integrated with the Supply Chain Management system and with the legacy system for some areas that the new software did not cover such as bills and salary payments. The number of users of SAP in Italy is about 300. Overall, there were 60 different types of account. The system used a java interface, a single database and a multiserver architecture.

R8 BPR

The company carried out a preventive analysis of the processes, in order to prioritize the working areas of the ERP system implementation: the first area was the logistic one. This was performed throughout the gap analysis.
The company carried out the BPR through an inappropriate methodology and in

short time: they used a questionnaire. It was submitted by key users to analyze the site requirements. It was not enough to design how business processes were. It was necessary to use more adequate tool and to allocate more time. A mapping process tool would have allowed to show the peculiarities of the Italian site processes since the beginning, showing the GAP between the AS IS processes and TO BE ones. The IT manager set by himself a comprehensive mapping process in advanced phase (September 2007), aiming to illustrate to the top management how the processes would be affected by ERP system. All the key users were involved to edit this process map and the total time spent was about 15% of the whole project time duration. Any information about the allocated budget is available.

R9 Managerial Conduct
The managerial conduct is linked to a clear vision of business, which would give the clear objectives leading the whole project. The aim of Oracle implementation was to operate process standardization through the project, to integrate the purchased plants within the Power One Inc. The top management needed a tool allowed to manage a complex business group like Power One Inc. The main goal was to standardize by policy adopted to manage the customizations: any customization needed the approval of the Steering Committee who gave acceptation only if the customization was considered strictly necessary. This policy, that meant damaging the processes and the whole business, founds its reasons in the Valdarno site context: it was not possible to rigidly standardize such processes in the same manner of other sites. It was necessary to consider the complexity of the Italian processes to define the project's goals, the features of Valdarno site business such as custom products instead of standard products and other factors such as the Italian labour's cost.
The policy management was top-down one. The project's goals were not clear but the key users showed a good commitment, striving to achieve the system's customizations because they knew the existing system would have not fitted.
The project manager had to clarify more times the objectives of the implementation throughout the project, a repetition of concepts partly due to the employees' lack of English knowledge.
The interviewees had a full commitment in the project but just before Go Live.

R10 Project management techniques
The risk analysis was not run. The project phases had been formally planned, both in terms of time and costs. The project budget was established by the consultants, the IT office and the top management of company based on previous implementation projects in other sites. It was a top-down decision. The project's advancing was controlled through weekly meetings. It is not available if the budget was controlled with real time indicators.
Evaluation of the system effectiveness in the post Go Live phase was not planned by steering group but internally to prevent business damages, observe the "ob-

scure point system" and measure users satisfaction. This evaluation was performed through round tables, made separately on the specific areas involved, editing a list of concerning problems, published on the portal. The team allocated the priorities and milestones for each solution to these problems.
The interviewees said the project management, consultants, system integrators and the top management were not present in Valdarno. In particular, the will of top management was only to preserve the same business performances. The project manager left the Valdarno site immediately after the Go Live in February, coming back only in July. So during that period, when many income problems needed personally to be solved, the team members were forced to resolve problems by phone, with several troubles tied to the different time zone and language.
As concerning the management techniques described at the eighth point (Inadequate BPR) about AS IS Analysis, during this phase the methodology became the main aim to pursue. The purpose was to complete the analysis on time following the planned steps provided, rather than implement a new IT system to support the business management. The reason of this approach should also be attributed to consultants. They had the clear objective to complete the project on time: if the ERP system had needed interventions in post Go Live phase, it would have not been a problem for system integrator whereas it would have been a source of gain.
A greater synergy between team members, a better time planning (for instance, CRP2 and CRP3 milestones were too close to each other, so it seemed to run a single unbroken test session for a whole month) and an appropriate use of indicators of project advancing should have occurred.

R11 Change management
The company did not carry any preventive evaluation of users' attitudes towards the change. Furthermore a formal change management was not conduct by steering committee. The top management and leaders of the company groups were fully involved in the project. They communicated the benefits of the ERP system adoption to the employees during the kick-off meeting, for example explaining the Slovakian implementation case and showing how the ERP system works.
Despite this, the employees were not aware of the implementation impact on their own careers.

R12 Legacy system management
The company did not run a preventive analysis of the IT system because the steering committee did not reputed it necessary for a cut-off of IT system.
The documentation concerning the Legacy system was still present in the company but it was not very useful for the project. This maybe because the expertise was still in the company and the experts had an excellent knowledge of the system functionalities. The treatment strategy adopted was the migration one.

There was no gradual transitory phase from the old system to the new one. The legacy system continued working just only during the test phase but after the Go Live was completely dismissed.
They stated that Legacy system management did not represent a real risk factor for their project.

R13 Consulting service
The company was supported by an Indian IT consulting company that developed a partnership with Power One having participated also within the other implementation projects. It was skilled both in SAP and Oracle software suite, so that it had competencies both for IT issues and Power One business issues. The consultants were involved just at the beginning. They mapped the company processes, analyzed the system requirements and solved the open issues.
The integration between consultants and the employees was judged excellent since the large commitment of both consultants and key users. The means used to communicate with the team members were mainly phone calls, e-mails, meetings, reports and conferences.
As well, the collaboration with the consultants increased the internal knowledge of the company.
The interviewees also observed a lack in definition of the tasks and responsibilities of the team members; in addition, they noticed the need of an Italian coordinator supporting the IT manager in directing the team members.

R14 Leadership
The project had a unique project manager for both Italian (Valdarno) and Chinese (Baoan) implementation. This fact penalized the process because a stable figure in each site is strongly needed.
The Project Manager experienced ERP implementation projects since he managed the implementation in other company sites but was mainly skilled on IT issue.
The interviewees retained he did not use neither a coach style nor an authoritative style during the project: he was interested in the user requirements but "he attempted to persuade the users the system did not need to be modified". So that requests were often refused, probably for policy reasons.

R15 IT system issue
The company did not carry on a structured process to define functionalities and performances the new system had to provide: the steering committee retained enough to adopt an existing model. Such assumption was undoubtedly wrong and it probably originated many of the troubles: the Valdarno's business was highly different from the other sites and, hence, as the functionalities the system would had to provide.
During the project implementation, periodical reviews of the system functionalities and performances were run, in order to verify if it was aligned to what

planned and to the current necessities.
The implemented system can increase and decrease the functionalities according to business's needs but each modification has to be request to consultancy trough a bureaucratic process.

R16 IT system maintainability
The documents concerning the maintenance process were managed according to a structured technique. The company also defined the procedures to follow for interventions: a ticket was given for each request; all the requests came to an Italian analyst who tried to fix them; if he failed then they were sent to the system integrator; this step was subjected to the corporate approval.
The agreement on the maintenance service is not known by interviewees but the adaptive, corrective and perfective maintenance services were included. They added the Italian plant paid to Oracle a regular fee for the assistance on standard modules and on hardware databases every year.
Currently the system is successfully used and there are not particular problems as for maintenance.

R17 IT supplier stability and performance
The company did not have any partnership with the ERP software house (Oracle). However, it had a partnership with the Indian system integrator that provided the IT support to Power One. It was not possible to determine which kind of support Oracle provides for upgrades and releases: these matters were defined between Oracle and system integrator and the interviewed managers did not know anything about the agreement.

R18 Strategic thinking and planning
The IT strategy would have to be aligned with the corporate strategy to achieve the same goals. In this case, the ERP implementation project belonged to development strategy of Power One Inc. The Group has decided to acquired the PEG's division of Magnetek Inc, after which it had to reorganize the own assets to achieve the synergies and the new opportunities. The Group carried out the Oracle implementation project to integrate the new plants. This project had two main benefits: on one side it allowed each plant to exchange the same data types, and, on the other side, it standardized the procedures of each plant adopting the Power One best practices.
The ERP implementation project is framed in a long term IT plan, which involved the whole company: the plan aimed to have an integrated government and administration tool for managing all the company's sites. The ERP project was considered a mean to drive the change through the company: it was not as an opportunity to improve the Valdarno business but it belonged to a global process of reorganization of all sites.
As the previous IT system, the ERP was not considered flexible as well.
Therefore, the project did not aim to affect the Valdarno business, as the out-

come objectives of the project were to return on the same performance levels as before the implementation.

R19 Financial management

The investment evaluation techniques adopted by the company are unavailable by interviewees. The strategic option of the investment on the ERP system was not preventively considered as well.

The project had different motivations concerning the whole integration and the business remapping. That made it difficult to conduct analysis about costs/benefits of ERP system implementation during its introduction.

The implementation project of Business Intelligence tool is nowadays in progress.

The company had planned a period of temporary productivity drop during February and March; which actually occurred.

The unforeseen costs were due by Go Live delay and, hence, by wrong evaluation of time project. Indeed, a project delay entailed a further load of consultant fees and a postponement in returning to regular business performances.

Risk Management

The project did not have any planned preventive action. The interviewees said the main problems occurred were the team size and allocated resource. The team size was too limited for such implementation project for two different sites; both in terms of human resource ("such as the number of consultants dedicated to Valdarno implementation") and time resource ("the planned phases was not well spread") the allocated resources were not enough so "it was inevitable the Go Live postponement". Consultants visa was another problem occurred: the consultants had to alternate for expiration of tourist visa so the key users had to explain the current project status whenever new consultants arrived. Finally, the company did not consider the particular features of Valdarno business.

The undertaken corrective actions were adding human resource both in moving internal staff and engaging external staff. Furthermore, since the original project concerned two contemporaneous implementations both in Baoan and Valdarno sites, when the project was split into two parts, a rescheduling of the project was necessary.

Indeed the interviewees pointed out the few active support from the corporate top management and that, if they had to start the project over again and had the opportunity of managing the project, they would have increased the size of the team, would have involved the Valdarno top management in the planning phase and would have given more emphasis to the sponsors. This role was actually played by members of CIO but only the IT manager of the company went in Valdarno and only when the project was in its conclusive phase. Moreover, they would have focused more on gap analysis and system adaptability to Valdarno processes. They would have given more emphasis on BPR. Indeed, they said "it seemed the real goal was only to deploy the system to carry out a tool to control Valdarno site instead providing to Valdarno a useful tool to manage the business."

6.7.6 Risk Effects

E1 Budget exceed
The interviewees did not have visibility on the planned budget, but they consider about 20-30% of extra costs. The need of extra human resources was the main cause of the misalignment.

E2 Time exceed
The project did not respect the planned project time. The postponement was about 40% in respect to the planned schedule. The main reasons for this misalignment were the lacking human resources and the underestimated project complexity. The system had to cover all the business functions so that "the time planning was really unrealistic".

E3 Project stop
The project was not stopped: this possibility was not ever taken in regard by firm.

E4 Business performance
The ERP system implementation did not bring any sensible improvement of the operative parameters till now. The Italian site is still on undergoing adjustments so it is too early to have results in terms of operational improvements; however a greater visibility of data and reports was achieved.

E5 System reliability and stability
Some ERP modules are not used at 100% of their capability, probably because the Italian site is still in a settlement phase: some examples are Human Resource, Planning and Purchasing modules.. No replication of system modules occurred, that is no situation in which two modules are used to perform the same task.
Maintenance interventions are weekly made on the system. In the post Go Live two types of interventions mainly occurred: the first is aiming to solve the problems revealed during the testing phase; the second is related to the asked requests for new reports and customizations. Finally some maintenance was necessary for debugging reasons.
The interviewees evidenced an improvement in the coherence and completeness of the provided information, since before the Oracle system implementation they had to ask experts for specific reports. Although they noticed a decrease in the flexibility of the system.

E6 Organization process fitting
According to the interviewee's opinion, the ERP system brought to a misalignment between the company's own procedures and those imposed by the new system. Despite this, the ERP software did not create a gap between the roles previously covered in the company and the new ones tied to the new system.

E7 Low user friendliness
The interviewees were very critic regarding the Oracle system. They were very confident with the old system since it used acronyms and was very efficient (high speed, etc). They currently perceived a low efficiency and speed and judged the system efficiency, learn ability and satisfactory very low. In addition, they said "the legacy system allowed to have all the information you needed in a single screen while to get the same information with Oracle software you must open 3-4 windows" so it seem be less efficient.
The likelihood of committing errors was judged low, since the system is assisted and very constrained in the data entry process.

E8 Integration and Flexibility degree
According to the project manager's opinion, the ERP system cannot be easily integrated with the legacy system. It was also scarcely compatible (but also easily expandable) with the external software.

E9 Strategic goals fitting
The ERP implementation achieved the following objectives in order of amount: improvement of the information and decision quality, enhancement of the employers' skills and improvement of the processes quality.

E10 Financial and economical performance
A worsening was detected during February and March but it was due to business stabilization after the system implementation. Any assessment of performance improvements during ERP implementation was considered premature by the managers.

6.7.7 Risk Assessment Simulation

The interviewees were involved in a risk assessment simulation using the software we presented in chapter 4. Based on the information they provided about the probability of occurrence of each risk factor and the impact of the effects, the software calculated a risk factor ranking. Results were then shown to interviewees, in order to verify if, in their opinion, it was coherent with what really happened and their perception during the project implementation.
In the following table the outcoming ranking is shown (Figure 6.30). The Risk

RANK	ID	RISK FACTOR	SCORE	CLASS
1	R3	Low top management involvement	392.72867	A
2	R9	Bad managerial conduct	318.79828	A
3	R18	Ineffective strategic thinking and planning	198.55764	B
4	R14	Poor leadership	194.22971	B
5	R1	Inadequate ERP selection	127.95578	B
6	R2	Poor project team skills	104.09345	B
7	R7	Complex architecture and high number of implementation modules	95.506875	B
8	R4	Ineffective communication system	53.328773	C
9	R8	Inadequate BPR	28.946336	C
10	R15	Inadequate IT system issue	17.609375	D
11	R13	Ineffective consulting services	10.581052	D
12	R10	Ineffective project management techniques	9.4910966	D
13	R11	Inadequate change management	6.625	D
14	R6	Inadequate training and instruction	3.953125	D
15	R17	Inadequate IT system maintainability	0.5843125	D
16	R12	Inadequate IT supplier stability and performance	0.3907397	D
17	R5	Inadequate Legacy system management	0.28269	D
18	R16	Low key users involvement	0.2025	D
19	R19	Inadequate financial management	0.041	D

Figure 6.30: P1 Risk Ranking

Factor scores are clusterized according to K-Means algorithm with four clusters (A, B, C, and D). The result of this clustering is showed in Figure 6.29.

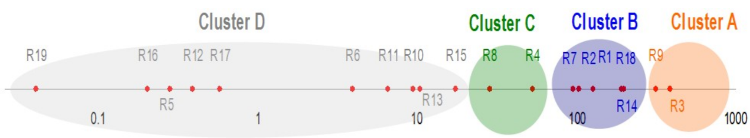


Figure 6.31: Risk factor clusters P1

The clusters are shown with logarithmic axis.

6.7.8 Usability and Utility

The interviewees believe the risk management methodology supported by this software would have enhanced the project results. They suggested the following benefits could be achieved by its adoption:

1. Better fulfilment of the planned objectives;
2. A clear determination of the project objectives;

3. Better schedule compliance;
4. Better budget compliance;
5. Enhancement of the productivity, both during and after the implementation;
6. Enhancement of the company organization.

The interviewees stated the suggested methodology and the presented tool would have achieved a better management of the ERP implementation project.
The tool appeared easily understandable and usable. It also appeared useful for the ERP implementation project: "if it was utilized during the planning phase to reflect and argument on the project issue, it could achieve a better project planning".
Lastly, the interviewees pointed out the tool should be more descriptive so that more information regarding the meaning of risk factors can be available to managers as well more instructions about how to fill in the tables.

6.8 Case Study D: S. Anna Ferrara University Hospital

6.8.1 Company Overview

S. Anna Ferrara University Hospital is a State Hospital sited in Ferrara, composed by Sant'Anna Hospital, with overall 2,700 employees and San Giorgio Hospital, specialized in rehabilitation, sited in Ferrara environs and counting 150 people overall. The Hospital is organized in eight wards: medical, specialist medical, surgical, specialist surgical, reproduction and growing, emergency, neurological and rehabilitation, radiology and clinical laboratory. There are also seven staff departments: planning and management, forensic medicine, information and informative system, communication, training and updating, quality and research and innovation, company's head office.
The Hospital includes 950 beds overall. In 2006, there had been effected more than 27,000 ordinary hospitalizations and 13,000 Day Hospital hospitalizations. The days of hospitalization was 223,000 overall. The outpatient treatments were 41,000,000 overall.
The hospital has an annual tournover of about 280 million euros. The Hospital has a departmental organization. Each department accounts for a homogeneous sector as medicine, surgery, etc. Each department has a manager, the chief

physician, who is under a managing director who, in turn, is under a general director.
The decisional system of firm is centralized for strategic issues, while it is decentralized for operational issues, such as clinical decisions that are obviously taken by doctors.
The Hospital provides services to customers and the production mix is high volumes/high mix.

6.8.2 The ERP Implementation Project

This is one of the more advanced projects existing in Italy and Europe for management and technological integration system in Hospitals. Many newspapers reported this implementation (such as “Il Sole 24ore”, “Milano Finanza”, “Sanità”) and largest firms (such as SAP AG, Roche, Noemalife) also gave emphasis to it. Staffs coming from other state institutions (such as S. Raffaele Milan Hospital, ASL 10 Florence, ASL Empoli and Pisa, Umbria Regional Government, S. Camillo Rome Hospital) visited S. Anna Hospital to know the project in detail. A S. Anna Hospital delegation was invited to participate to ERP 2007 convention and participations to other international conventions are expected.
The project was split into two parts to increase the chances of success. The first part concerned the administrative and health care issues while the second one concerned the clinical health issue.
At least at the beginning, splitting the project avoided the interface with the whole medical area. This type of project is very complex so that handle all the sides of the project at the same time means to increase the risk of failure. The health care issue concerned the acceptance and the control areas (front office area); the clinical health issue concerned everything that affected the patient such as surveys, checks up and drugs. The project started by accounting issue before handling the core business because it was the area with well known rules indeed.

The Hospital had to be divided into two parts: administrative and core business. It was the greatest challenge of the project. It could be faced through ERP system integrating these two worlds, otherwise a situation with several modules would have perpetuated.
The new setting allowed to nurses and doctors to discuss the billing process just at the first project phase. The first meetings on this topic were significant: the interviewees remembered “there were people who cried because the working method completely changed but the critical point was that the doctor or clinician understood what was generated by a buy order, an expense, an invoice, a bill...”. Therefore the whole hospital staff had to be informed about the process to

avoid troubles or shoddiness (such as taking goods without filling orders) with a consequent crisis of the system.

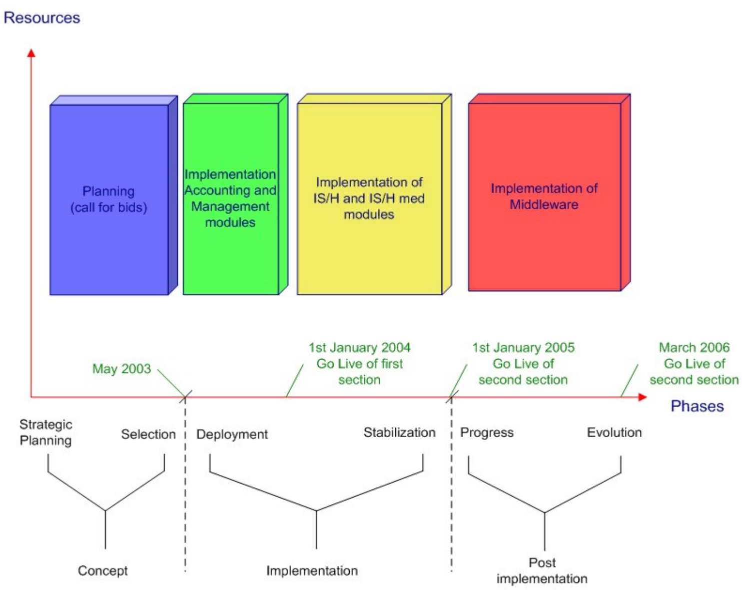


Figure 6.32: Hospital Project Life Cycle

The project started in March 2003 replacing the Hospital hardware (Figure 6.32). The first part of the project went in Go Live on the 1st January 2004. The second part went in Go Live on the 1st January 2005. The project respected the planned date of Go Live. The two Go Live phases were so far from each other because of the time needed to interact with 2,700 employees and map the processes and then train the all users. The project spent one year and eight months overall; the interviewees pointed out it was not so much time for this type of projects.
The ERP system uses the Italian language: the Hospital has all Italian users and it is not belonged to an international company.
SAP system consists of the accounting, controlling, supplying, purchasing and the assets managing modules then the ATD module manages the clinics so it allows to know the number of free beds there are and where their location.

The components of the project are shown in figure below (Figure 6.33). The technical components are hardware, IT infrastructure and system customizing. The business components are process analysis, change management, strategic decisions and operative involvement.

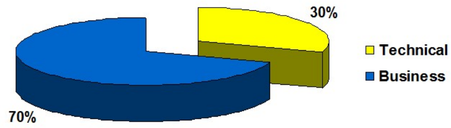


Figure 6.33: Project composition P1

6.8.3 An overall perspective by the IT manager

When the project started in 2003, the Information System office was joined to Computing System office. It was a challenge because they were usually split. Indeed, Informative System office usually supported the Computing System as a staff office. This allowed considering not only the technical issues but also the informative and informatics issues.

The organization size decreased thanks to outsourcing strategy. For instance, the IT department has nine employees while it usually has at least the double in a similar business size firm. The goal was outsourcing as much as possible to have clear and fixed costs.

The interviewees pointed out there were three key success factors in this type of project:

- Strong sponsorship of the top management. The top management may not always attend but has to be present during the most critical moments to take key decisions and obtain consensus from overall staff and users. Consultants skilled on company business: the interviewees pointed out that this type of project does not need of consultants with just IT skills, because these competences are of minor matter. Indeed, they needed consultants who used the medical jargon and who knew how a hospital worked with the organizational problems involved.

- Key user roles. Although at the beginning of the implementation process, the employees chosen as key users, did not agree with the introduction of the new system, then they began to understand the utility and contributed in carrying on the project.

6.8.4 The Interview

The interview was carried on talking to the local project manager who was involved in the project and a key user. The project amanger works in Ferrara Hospital since 1993 and covers the role of Information and Computer System manager since five years.
Before this implementation project, he already had experienced IT projects: every five-seven years an IT project was conduct in this firm to renovate the IT system because the hardware became obsolete and the IT solution inadequate for the changed needs.

This section covers each construct of the research model with summative findings.

Motivations There are several motivations that brought S. Anna Ferrara Hospital to decide to implement an ERP system.
The firm had substituted the legacy system with a UNIX system supported by an Ethernet network. That system had just achieved the end of its own life cycle, becoming inadequate because new departmental modules had been added and the several applications had to be integrated with the need setoff. In addition, the old system had a wrong practice because it often occurred that the same purchase order had to be carried out more times. Even the system hardware had arrived at end of the life cycle. Two options were available: modifying the hardware and the system interfaces without replacing the IT system or setting up a new IT system that would have affected the Hospital organization. The management decided to change the IT system. Indeed, the interviewees pointed out: "This type of implementation project has a small share of IT, that is easily buyable, and the rest of the mapping process is unknown to public administration."
The top management decided to implement a new system for the will and the need of a reorganization of the Hospital, turning the departmental administration into a general administration.
Summarizing, the interviewee said the motivations concerned the necessity of replacing the old IT system to improve the efficiency, have better management tool, increase customer satisfaction, reduce the number of applications and interfaces and meet the changed needs. The last one was due to the plan of a Hospital move. Currently, the operating rooms and outpatient departments are placed in Hospital without a specific logic because the Hospital's site is a building of 1910 so the rooms are inadequate. The future site of the Hospital will have an adequate framework; the physical organization will change so this project was considered an opportunity to start the changing. The database integrations and security were just warranted by the old IT system. The improving of external integration was not considered as a motivation because the

Hospital did not have any integration with suppliers. An attempt has just been made: the Hospital is getting on to some pharmaceutics firms to integrate the supply of drugs. These suppliers use SAP system so the integration would be easier. The aim is to be able to show suppliers the stock levels of drugs. Thus, the integrated suppliers could better manage their own level production plans. However, such integration means great efforts by supplier who demand their own benefits to invest on this project. Unfortunately, these benefits are very hard to assess so suppliers are not very interested to invest in these project. On the other hand, there is a problem with the Hospital staff because generally nurses have a lower sensibility to the problem of stocks and their management.

6.8.5 Risk factors

R1 Selection
The Hospital had to select an ERP system. The project team carried on a structured process of selection. Beeing a public firm, the law entails a European public call for bids in which the Hospital included the hardware, all licenses, consultant firm, maintenance and assistance for six years. The subjects involved in selection process were the chief physician, ward managers and a consulting firm required by top management. First of all, a market research was performed to find the possible firms that could provide what they were looking for. As result of this research, they found about ten competitors. Then they discarded the offers that did not fit the requests both in terms of characteristics of the system and tools, they had four firms in competition to gain the call for bids. These were Oracle, SAP, KPMG, and Accenture. It was not allowed to engage negotiations with these vendors because of the public call for bids. The vendors had to propose a plan for ERP system implementation. The call for bids included two types of assessment. The first assessed the technical issue of proposals: a Hospital chosen commission officially and individually summoned the vendor for a meeting where the vendor explained and handed its own proposals to the commission. In this meeting, the commission used a list of questions to collect the necessary information such as the responsibilities of the vendor; the vendor experiences; the vendor's level of knowledge about how a hospital worked; and how the vendor proposed to manage the Hospital treasury. The last issue concerned the different treasury management of a public firm; indeed, the Hospital treasury was completely managed by a designated bank. This feature was not usually contemplated by ERP system. The second type of assessment concerned the economical issue. Each bid, which included an own project schedule, had to be submitted in sealed envelopes. Finally, the commission gave a score for each proposal according to the two assessments. The proposal with the higher score won the call for bids. The selecting process spent about 3-4 months overall. SAP proposal won the call for bids because it gained the highest score in the

technical assessment and the second highest score in the economical assessment. It offered the best, clearest and most detailed plan than the others. Only the Oracle proposal had an equal detailed plan but it did not have any specific module for health care.
They had to budget 750,000 euros for the hardware components, 1,000,000 euros for the consulting service and 1,000,000 euros for six years of maintenance and assistance service. They would amortized this capital in six years so the annual depreciation charge was around 450,000 euros that for the characteristics of that IT system project was a reasonable amount of money.
SAP Italia Spa did not really have a consulting business unit but it had a few specialized figures for large companies like Telecom, ENI so the Hospital needed to find a consulting firm that could provide an adequate support for implementation. They chose to be supported by a SAP partner (Milleri and Company Srl) that had a specific expertise in health care because it had already deployed IT systems in hospitals since ten years. Indeed, they needed consultants who had a health care knowledge so they could understand the medical jargon and health care practises. Some advisers coming from SAP went also to the Hospital but they had great difficulty because of the different technical jargon used in comparison to the medical language. Only the consultants, who were able to interact with the hospital staff, stayed in Hospital to support the project.

R2 Project team skills
The project team had a defined structured. A steering committee was formed by a medical director, a nursing manager, two IT managers and a member of the internal audit team. Underneath the steering committee, there were several teams made up of thirty key users coming from different wards, according to necessity. Each team member had to know the whole project schedule. Three or four teams were simultaneously formed during the mapping process because of the complexity of the Hospital processes. Each team included one or two consultants according to the difficulties. In addition, under these teams, smaller and specialized groups were introduced in the project team.
The founding problems were pointed out and discussed during a meeting each fifteen days. The teams were structured for processes. As stated before, all wards were involved in the team, it was then necessary to map the whole Hospital processes.
The team members did not received any previous training and none structured process was not implemented neither the needs were filled.
The steering committee had experienced IT projects thanks to several previous IT projects carried out in this Hospital, while the key users were involved for the first time in this kind of project.

R3 Top Management involvement
The Top Management was involved in the decision making process and in the approvation of the achievement of goals. The Top Management involvement

was judged good by the interviewee: they attended in the crucial moments of the process allowing to overcome the difficulties of project.
The top management interacted with the project teams through monthly meetings, even though the formal meetings turned out to be about five in the whole project.
The project did not have a formal champion; this role was played by the IT managers.

R4 Communication system
Throughout the project life cycle the communication means used were meetings, calls, reports, mails, a mailing list and a web site. The site was hosted on the firm's intranet so that only the users could access it. It collected the user manual works so they could download the training aid they needed.
During the whole project life cycle, communication took place among the team members, the consultants, the ward managers and finally the all users.
The exchanged of information dealt with the project data, about the way the system worked, the decisions taken and the estimated charts of processes.

R5 Key users involvement
Key users were involved in the project since the beginning of the implementation, aiming to map the processes of Hospital. It was necessary they belonged to the whole different words to better achieve the target. The key users didn't participate in the definition and selection phase. They then carried out a "waterfall" training.

R6 Training
The key users made training on the job. The training involved more than 1,000 users for an amount of 6,000 hours. The training started just when it was possible to show a prototype system to the key users. Indeed, when the key users agreed on the process maps, a prototype of ERP system was set and it was possible to train them through simulations.
The key users mapped the processes without training but they could count on the consultants' support, on technical outside courses held by the vendor and on user manuals available on the web site.
It was not implemented a structured process to identify the key users' educational needs.
At the end of the training, no evaluation of the acquired skills was carried out.
Further training was necessary after the system Go Live: the consultants and the key users checked and supported users for a month after the Go Live.
Two SAP consultants stayed in Hospital to support the changes of processes and rules after the completion of the implementation. They gave support in solving problems on-site while the more complex requests were sent to SAP centre.
The planned duration of the training process was respected. The cost of the process had been budgeted in the call for bids. Indeed, together with their pro-

posal, vendors had to show a training plan in which they had to indicate the persons, hours and subjects involved.

R7 Architecture
Six modules have been implemented at the first step of the project started in 2003: BC (Basic Component), FI (Financial), CO (Controlling), MM (Material Management), PM (Plant Management) and HIS (Hospital Informative System) modules. The HIS module managed the sanitary issue as the number of available hospital beds.
After that, a second implementation concerning the HIS/med (Hospital Informative System medical) module that managed the clinic issue was put through. The structure adopted was a "one-site" type.
A customization of BC, CO, FI, MM and PM modules was conduct for a 10% overall. The process was necessary because the type of Hospital treasury was missing on SAP system. Also the HIS and HIS/med modules were customized since these modules were not suitable for the Italian background in SAP: the S. Anna Hospital was the first Italian hospital to implement the system. The customization mainly concerned the interfaces to make them easier to use. The customization was also due to the specific logics used in Hospital. It was 30% overall.
SAP system covered the administrative and health issue. There were also some dedicated applications for different wards (like radiology or anatomy), that continued to be used by users to operate with the legacy machines (Figure 6.34).
The ERP system solved just some interactions between wards such as check requests, surveys and result transmissions. The integration between SAP system and these ward legacy systems was achieved through a middleware (SAP Netweaver technology) after post Go Live. This middleware created a uniform jargon between hospital attendants. Each doctor had his own system interface and, using the digital firm, could access the own patient data and request checks. The middleware project started in 2005 and went in Go Live in March 2006.

At the end of 2007, a module for emergency ward always deployed by SAP went in Go Live. It allowed the update of databases when a hospitalization occurred. In the same period, the project concerning the internal ward patient started, while SAP system covered the day hospital part. This implementation was complex because there were 90 different surgeries with no mapping process in progress.
The number of users was about 1300 overall. Five hundred users used diskless PCs to avoid crashes because of the heavy loading of information. There were four different types of account. The system used client server architecture with a web access through the middleware.
Because of privacy issue, managers faced many difficulties in create a web access to the system, however the next version of SAP system will be more web oriented.

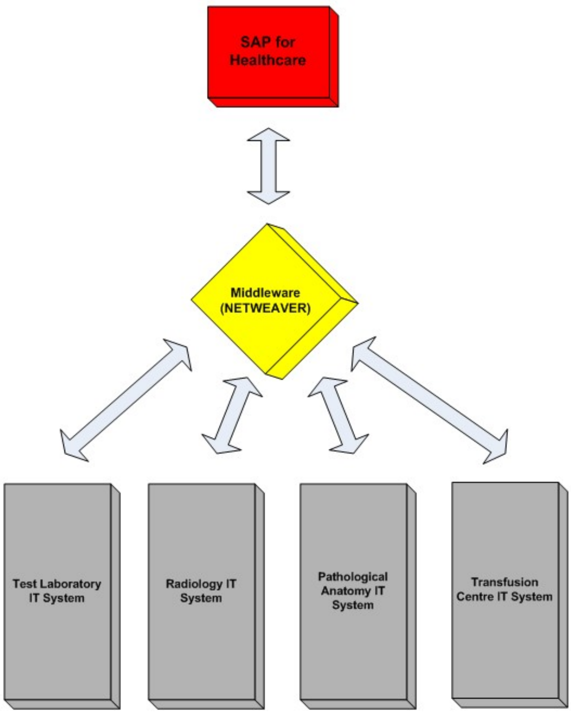


Figure 6.34: Hospital IT system architecture

R8 BPR

The company carried out a preventive analysis of the processes, in order to prioritize the working areas for the ERP system implementation: administration was chosen first.

The Business Process Reengineering process was performed during the development phase of the project life cycle. During the process mapping, the key user teams made a review of all the processes such as accounting, logistic, purchasing, maintenance, asset management, administration of wards and the services offered by laboratories and radiology, checking out if any change or updating was needed. The BPR process was not formally planned however it was always carried on.

All wards (key users) were involved in mapping the processes of Hospital. The practises of SAP system were compared with the ones of the Hospital: if a gap was found, the teams considered if it adopt the best practise or not. In addition, they could see that adopting the ERP system, some processes had become unnecessary. At the end of this analysis, the gaps found between TO BE processes and the SAP best practises were very few, and the teams judged the better practises always belonging to the new system.

Hospital has recently started with the application of the ISO certification procedures, that is unusual for a state-run firm in Italy. This certification has been carried on with the support of consultants and, among other things; it will lead to the formalization of all the informal processes as BPR. Since the BPR process was not formally planned before ISO, the information on its budget was not possible to assess. No gap analysis tools were used.

R9 Managerial Conduct

The project manager had to repeat many times the objectives throughout the project implementation. People, in fact, did not work full time on the project, so they often had to be reminded of the general objectives of ERP implementation project.

The policy adopted was a sponsorship. The team members and key users had full commitment on the project.

R10 Project management techniques

The risk analysis was run by the consultants using the company risk management logic, which has been formalized only during the last two years. The team members integrated their own risk management logic with consultant's one to face up to project risks.

There were two types of project risks. The first concerned the reaching of the milestones and it was managed by consultants; the second concerned the technical problems of the ERP system such as crashes, bugs, etc, and was managed through the Hospital's own risk management logic because they had just deployed it during the previous IT projects.

In addition, they had established contractual penalties with the vendors during

the call for bids, sothe project phases had been formally planned, both in terms of time and costs, as required.
The project was carefully controlled (real time control) and an evaluation of the system effectiveness in post Go Live phase was planned, carrying it out through an anonymous questionnaire edited by quality department and distributed among all users.
The project budget was determined by the top management and IT managers.

R11 Change management

The company did not carry any preventive evaluation of users' attitudes towards the change but the steering committee knew there would have been resistances from users. Furthermore a formal change management wasn't conduct by steering committee. Users had the possibility of writing their own opinions and doubts during the training courses. Also the impacts of the ERP system on the employees' careers were not communicated because in health's area the IT knowledge is not considered.
The top management communicated the benefits of the ERP systems to the employees and explained how the ERP system would have worked. These explanations were provided to the various subjects implementing a "waterfall" process.
The leaders of the most influential groups of the company were fully involved in the project.

R12 Legacy system management

The company ran a preventive analysis of the IT system, in order to define the priorities of the tasks and determine which components they had to maintain in the ERP system.
The legacy system functioning had been fully comprehended and both the documents concerning the old IT system and the expert employees were still in the company.
The treatment strategy adopted was the migration one. There was no gradual transitory phase, as a cut over was executed to pass from the old to the new system. The ERP system wrapped only the ward legacy systems through the middleware.
After the go-live, the legacy system was never used to cover applications the ERP system was meant to cover. However, they continued using the old IT system to calculate the interests on the arrears of the last fifteen years, since the accounting data of the old IT system could not be migrated to new one: it could only use data belonged to own processes logic while the old system had not used the same logic for data saving.

R13 Consulting service

The company made use of a consulting service, which was involved since the beginning of the project till the very end. The competences the company required

mainly concerned the hospital business. Indeed, they took the technical skills for granted because the consulting service was required in call for bids so the vendor had to include the consultant partner in own proposal and therefore the consultant had certainly the skills on SAP system. The responsibilities assigned to the consultants concerned the development, the operability, the costs and the duration of the project.
The consultants' performances were not assessed because they had to observe the signed agreements in call for bids not to have penalties and because they had a fixed remuneration. The key users carried out a selection of the consultant's staff: the consultants were not able to integrate with the key users were bundled off. The interviewee said: "There was a natural selection. The key users referred only with consultants that knew the hospital jargon". Indeed, twelve consultants came to support the implementation at the beginning of project but the selection reduced them to four persons. The integration between consultants and key users was judged excellent after this selection.
The means used to communicate with the team members were mails, meetings, reports and conferences.
Finally, the collaboration with the consultants increased the internal knowledge of the company: they held the training courses and improved the project management skills.

R14 Leadership
The project manager had competences both in business and IT fields and had had previous experiences as team manager during the previous Hospital's IT projects. The top management used an authoritative leadership style while the project manager used a leadership style that facilitated the exchange of opinions.

R15 IT system issue
The company carried out a structured process to define the functionalities and the performances the new system had to provide. The consultants, key users and IT managers were involved in this process.
The key users pointed out where the IT system had to change to fit the requirements and were involved in the approval phase of ERP system tests.
During the project implementation, periodical reviews of the system performances were ran, in order to verify the technical performances of ERP system as the response times. The functional performances were not reviewed because the interviewee said "If there were problems, they were coming out during the use. However, reviewing all the activities was not possible."
The ERP system is not scalable, indeed they are currently arrived to the limit of the system capacity so a change in the near future will be needed.

R16 IT system maintainability
The documents concerning the maintenance process were managed according to a structured technique; the company defined the procedures to follow for the

interventions. The same interventions were used by HP.
The agreement on the maintenance service was part of the call for bids. The agreement concerned the corrective and adaptive maintenance while the perfective maintenance was carried out according to necessities.

R17 IT supplier stability and performance
The Hospital established a partnership with the vendor, who provided upgrades and releases, as defined in the contract.

R18 Strategic thinking
The ERP implementation project is part of a long term IT plan, which involves the whole Hospital.
As the interviewee pointed out, the ERP project was seen as a mean to drive the change through the Hospital. It was considered an opportunity to modify the processes and the organization to optimize the services and the management.
The interviewee did not considered adopting the ERP system implicated rigid process to be bounded to.

R19 Financial management
The investment evaluation techniques adopted by the company were the ROI, Return On Investment. The ERP system allowed reducing the Hospital expenses giving real time control tools. The strategic option of the investment on the ERP system had been preventively considered by IT managers but not by the top management, who did not plan a transitory period of productivity drop.
The cost/benefit analysis was carried out comparing the overall hospital costs before and after the implementation of the ERP system, but the intangible ones were not included.
The Hospital did not meet unplanned costs. The potential unplanned costs would be paid by consultants.

Risk Management
The project team planned preventive actions through the call for bids, as already said. The budget could not be increased because of the agreements with the vendor and because the procedure to obtain a budget enhancement would have been taken about six-eight months, because of the roles applied to state firms.
The bigger matter, from the project risk management point of view, concerned the mapping process because they had not experience in this activity before. Whereas there were not problems concerning the technical aspects of the project.
If interviewee had to start the project over again, he would have better defined the consultant efforts.

6.8.6 Risk Effects

E1 Budget exceed
The interviewed manager claimed the budget wasn't exceeded. Indeed, the project was carried out according to public calls for bids so other all the costs were previously fixed.

E2 Time exceed
The project was on time according to the scheduling, underlining an aspect of the project success.

E3 Project stop
The project is still in progress.

E4 Business performance
The ERP system implementation has brought an improvement of the operative parameters. The interviewee said the average stock has certainly improved. Also the time to solve the loading of orders has decreased. It is also much improved, with the second part of the project, the waiting time for checks because there was not need of a person to go to bring the check's request and then to take back the results.

E5 System reliability and stability
The ERP modules were not used at 100% of their capability. Indeed, the maintenance module was partially used. Indeed, the clinic engineering could not use the ERP system to manage the maintenance of own instruments because of a signed agreement that constrained the use of a specific different software, so it was necessary to integrate the ERP system with that software to manage the inventory, the assets, etc
No replication of system modules occurred, that is no situation in which two modules are used to perform the same task, and onlt few maintenance interventions for hardware components had been necessary.
The Project management agreed to say the ERP system has brought an improvement of the completeness and coherence of information.

E6 Organization process fitting
According to the project management's opinion, the ERP system did not bring to a misalignment between the company's own procedures and those the system imposed. However, the ERP software created a gap between the roles used to be previously covered in the company and the ones requested by the system.

E7 User friendliness
The project management judged the system understandable, efficient and easily

memorisable, judging a low level of likelihood of committing errors, since the system provided on line assistance. The system was easily memorisable because it used the same interface for all the modules so once a user understood how working on a module he could use all the modules indeed.
Users satisfaction was different from user to user but it was judged good overall. The interviewees said the project had also had the approval of employees' association and this was unusual for a state-run firm.

E8 Degree of integration and flexibility
According to the project management's opinion, the ERP system can be easily integrated with the legacy system, with the external software and it is easily expandable. Lastly, the system can easily face exceptions and changes to the procedures, with preliminary planning and mapping of all interventions.

E9 Strategic goals fitting
The ERP implementation achieved the following objectives: improvement of the information and decision quality, enhancement of the employers' skills, improvement of the processes quality, improvement of customer satisfaction and customer focus and decrease of time service.

E10 Financial and economical performance
The interviewees pointed out that it was difficult to assess an economical/financial parameter improvement directly dealing with ERP system. However, the ERP system allows to achieve the optimization of use of resources. For instance, when a therapy was assigned to a patient, it was settled that every day the drugs had to arrive to the patient's ward in a entire box. As e consequence, the unused drugs were thrown away. With the new system, the wastes of drugs decreased using unitary doses: arriving to wards everyday according to the specific and daily necessities, this system was an advantage in terms of security, tracing and efficiency.

6.8.7 Risk Assessment Simulation

The interviewees were involved in a risk assessment simulation using the software we presented in chapter 4. Based on the information they provided about the probabilities of occurrence of each risk factor and the impact of the effects, the software calculated a risk factor ranking. Results were then shown, in order to verify if, in their opinion, it was coherent with what really happened and their perception during the project implementation.
In the following table the outcoming ranking is shown (Figure **??**).

The Risk Factor scores are clusterized according to K-Means algorithm with

RANK	ID	RISK FACTOR	SCORE	CLASS
1	R13	Ineffective consulting services	211.99	A
2	R14	Poor leadership	87.74	B
3	R2	Poor project team skills	72.25	B
4	R1	Inadequate ERP selection	22.87	C
5	R7	Complex architecture and high number of implementation modules	15.96	C
6	R8	Inadequate BPR	14.18	C
7	R17	Inadequate IT supplier stability and performance	8.33	D
8	R10	Ineffective project management techniques	7.64	D
9	R3	Low top management involvement	6.61	D
10	R4	Ineffective communication system	6.04	D
11	R11	Inadequate change management	5.01	D
12	R18	Ineffective strategic thinking and planning	4.33	D
13	R6	Inadequate training and instruction	3.50	D
14	R9	Bad managerial conduct	2.34	D
15	R5	Low key users involvement	1.14	D
16	R16	Inadequate IT system maintainability	0.16	D
17	R12	Inadequate Legacy system management	0.11	D
18	R15	Inadequate IT system issue	0.06	D
19	R19	Inadequate financial management	0.05	D

Figure 6.35: HOSPITAL Risk Ranking

four clusters (A, B, C, and D). The result of this clustering is showed in Figure **??**.

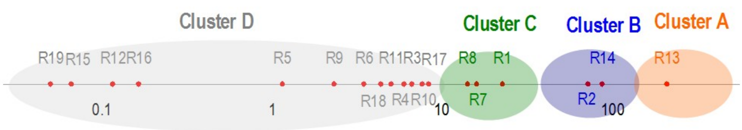


Figure 6.36: Risk factor clusters HOSPITAL

The clusters are shown with logarithmic axis.

The interviewee noticed the key users did not give problems neither to the change management nor to the project management. But he noticed that the change of the top management members during the project (a lot of consultants went away because they did not result suitable to the context) could represent a real problem for the process success, and that in particular circumstances the top management's participation have been essential. Therefore, the manager evaluated good the cooperation between all project's stakeholders. Finally the manager suggested: "it is better to loose an addition month so that users understand the positive aspects of the project than to force the users to finish earlier and risk loosing the following seven months after the Go Live".

6.8.8 Usability and Utility

The manager believes this tool allows a better understanding of the phenomena and risk factors occurring during project so that experts could draw on these to improve the system implementation effectiveness. In addition, the tool could help in choosing and in meeting the targets because it accents all the aspects of the project. The interviewee said "we have had to manage these risk factors during the implementation of the project, so that the tool would have stimulate us to meditate on these risk factors in the project planning phase and achieved a better management of the project." Generally, the manager considers the tool can give a greater emphasis on the factors which affect costs and efficiency of the project.

The manager didn't have any difficulty in using the tool also because he knew and experienced the meaning of reported risk factors. Overall, the tool appeared easily understandable and usable.

6.9 Case Study A: HR division of a TLC Service Company

6.9.1 Company Overview

The Company is a major world enterprise in telecommunication services. The Company is organized by business segment as follows:

- Domestic Business Unit: includes the domestic operations of Fixed Telecommunications (divided into Retail Telephone, Internet, Data business and Wholesale) and Mobile Telecommunications as well as the relative support activities;
- European BroadBand Business Unit: comprises Broadband services in Germany and the Netherlands;
- Brazil Mobile Business Unit: includes Mobile Telecommunications operations in Brazil;
- Media Business Unit: comprises Television and News activities;
- Computing Business Unit: includes activities for the manufacture of digital printing systems, ink-jet office products, ink-jet print heads and Micro Electro-Mechanical Systems (MEMS);

- Other Operations: include the financial companies and other minor companies not strictly related to the core business of the Group.

The Group has significant international profile: it operates in 7 countries (Figure 6.37).

Figure 6.37: HR TLC Markets

In Italy it provides telecommunication services for domestic market that has been facing increasingly stiff competition since 1998 from more and more competitors, following its full liberalization. Its domestic market is around 21 million fixed line, 71% market share. The company provides broadband services with 7.8 million broadband connections in Italy. It is also competing in mobile business with 36 million mobile lines, which represents more than 40% of the domestic Italian mobile market.

The Company is one of the largest mobile carrier in Brazil with 31 million mobile lines. Finally, it supplies over 2.5 million broadband lines in Germany and Holland.
The Brands are supported by a robust technological infrastructure consisting of an extensive national network that leverages leading-edge transmission tech-

nologies, from fibre optics to xDSL. The Group's networks consist of almost 107 million km of copper (for access) and 3.8 million km of fibre (trunk and access), augmented by a 55,000 km fibre optic European backbone.

Group media company is a competence center developing traditional and multimedia content through its brands. The company's brief is to develop and disseminate new interactive applications and to drive content synergies across the Group's various technology platforms (IPTV, DVBH, DTT and satellite), including online and via mobile phones. Analogue and digital TV, web and mobile telephony operations all draw upon a common asset base of heritage and know-how.

A Channel of company's media has established a new record audience share of 3.2%, and closed the half with an average of 3.1%. It has confirmed its unique reputation in Italy's TV industry for high-quality and innovative programming. The channel is known for sport (not just football but also sailing, rugby and superbike racing), news, current affairs and entertainment shows. The network's digital terrestrial offerings have recently benefited from an enhanced range of content.
The Media business unit offers a channel's digital pay-per-view service. It has extended its programming to appeal to the whole family by adding alternative sports, movies, music, animated cartoons and educational programs to its football offerings. Once the smart card has been activated, content can be acquired on a per-event basis, or via monthly and theme-based bundles.
Another channel has a focus on domestic and international politics, economic and finance. New services such as news delivered to mobile phones are helping to expand the company's customer base.

The Group have a historical Italian brand that offers office and systems solutions. This brand celebrates its centenary in 2008, it remains a standard-bearer of Italian technology and design around the world. Trading on 83 national markets, it is a leading world supplier of bank counter peripherals (with a 70% market share), and Italian leader in IT systems for lotteries and retail products. The company also operates in digital printing systems and ink-jet products. That firm is the only company in Europe - and one of just six worldwide - to have its own proprietary ink-jet technology.

The Group innovation is supported by an Italian Lab's ongoing research and expertise. The Labs played their part in defining the GSM and MP3 standards. Projects currently underway include fixed-line and mobile access network design and development, next generation transmission networks, platform and service development, trials of next generation handsets and, looking further down the line, sensoristics, which is all about translating information received from a world full of sensors into applications of interest in many fields, not least in road use. Group R&D led to 47 new patents in 2007. A further 11 patent applications are pending from the first half of 2008.

The Group's international presence is the result of a selective strategy focusing on high-growth markets: major markets in Latin America, and high-growth technologies like broadband.
The Group has also assured itself a prominent role as a Mediterranean Basin carrier, handling 50% of phone traffic between countries in this region through its extensive submarine cable ring.

6.9.2 The ERP Implementation Project

In 2002 the Company developed the ERP implementation project throughout Italy. It involved the corporate and around 30-40 other small companies related to the corporate.
Three main modules were implemented: Human Resources, Finance & Accountability and Purchasing. The project started at the end of 2002 and lasted almost three years, until 2005.
The project life cycle is shown in Figure 6.38. The strategic planning was a

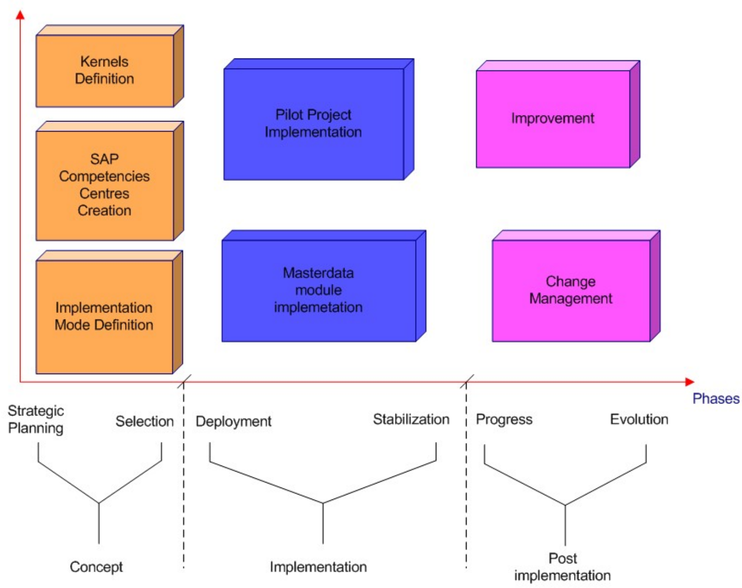


Figure 6.38: HR TLC Project life cycle

crucial phase of the project. For each module a "kernel" was defined: a set of the basic functioning rules for SAP. Interviews were carried out to understand which information had to be transferred to SAP and in which way. Implementation phases and mode were defined, and centres of SAP competencies were created.
In the implementation phase a small society was created to run a pilot project. Contemporary the masterdata modules were implemented.
The post implementation phase focused on improvement of the system and on change management.

6.9.3 The Interview

The interview was carried out talking to IT responsible for HR function. The manager worked for the company from 1996 to 2006 and before the ERP implementation project, he had already had experience in IT project. He was part of the project team and one of the leaders of the project.
The findings are mainly related to the HR function implementation project.

This section covers each construct of the research model with summative findings.

Motivations
There are numerous motivations that brought the company to decide to implement an ERP system.
First of all, the company had the necessity of replacing the old legacy system; then the objective was to improve the efficiency (for Finance function) and to have at their disposal better management tool (for HR function).
Moreover, the company had to reduce the number of the system employed and of the interfaces.
Lastly the ERP project was a decision imposed by the holding in order to achieve a better integration with the rest of the corporate which already had implemented SAP.

6.9.4 Risk Factors

R1 Selection
The company did not have the necessity of selecting any ERP package, since they had to implement the same system adopted by the holding, SAP. Numerous system integrators were employed, they were chosen by the holding company.

R2 Project team skills
The project team was composed by a SAP leader who had to communicate to the three function IT leader: HR, Finance and Purchasing.
The team member came both form IT, Finance, HR and Purchasing. They needed training but no structured process was carried out to identify their needs. Formative meetings were organised to align the team to SAP knowledge, held by SAP team members. The project team had competences about bit IT project management.

R3 Top Management involvement
The top management was directly involved in the control phases. The top management interacted with the project team through steering committees, which were organised once a month in the initial phase, it became less frequent in the development phase. In this phase normal organization communication ways were used.
The project had initially a champion, who was the IT responsible for the holding, who had to motivate the steering committee

R4 Communication system
In the first phase of the project life cycle, the communication means used were steering committees among project leaders. Moreover, meeting with member belonging to functions were organised, in order to involve the users. Afterwards typical normal organization communication means were used. The project manager pointed out to have used all the communication means and to have had around 180 meeting focusing on SAP.
The main information exchanged dealt with project results, ERP functioning modalities and project tasks.

R5 Key users involvement
Key users were involved since the planning phase, to elaborate the kernels. It was a company clear decision to involve them in this crucial phase. They belonged to the Finance, HR and Purchasing function.
They carried out a "waterfall" training and determined with SAP leaders the contents of the courses. They also adopted informal mean of diffusion such as meeting, emails and also using an e-learning center.

R6 Training
The key users were trained by the SAP team and the Function Leaders. None structured process was used for the identification of the formative needs of the key and final users. No formal evaluation of the acquired skills was carried out at the end of the training, but the project manager pointed out it was evident the key users were able to use SAP at the end of the course.
Further training processes were necessary after the go live, so that we can consider the planned duration of the training process as not respected. The cost of

the process had been budgeted.

R7 Architecture
Three main modules were implemented at the same time: Finance & Controlling, Human Resources and Purchasing. The structure adopted was a one site one: kernels were elaborated in order to avoid the multisite structure. It was a strategic decision.
There had been a 20% of customization for HR module. That was necessary because there were some processes which were not transferrable to SAP. Customization to obtain an internal control was also implemented. SAP in fact does not detect if there are some errors in the input.
The ERP system had to be integrated with the legacy system for some areas the software did not cover, such as a system which contained HR information integrated with market information.
For HR, the number of users was around 2000/3000. The ERP server was one and had four different interfaces. The system was a client server oriented.

R8 BPR
The company did not carry out a preventive analysis of the processes, in order to prioritize the areas on which working. They prioritized them following SAP experts' indications. No Business Process Reengineering process was performed.

R9 Managerial Conduct
The project manager had to clarify again the objectives throughout the project implementation. This was due mainly because of change management necessities. The project managers pointed out that "the change management is not a natural process", therefore it is necessary to continuously work on it.
Key uses were involved since the very early phases of the project, collaborating to identify the kernels. Meetings were organised every two days to involve them. The team manager had full commitment on the project.

R10 Project management techniques
The risk analysis was run following the company's own logic. The project phases had been formally planned, both in terms of time and costs. The project was controlled very carefully (real time control): the steering comitte's meeting focused mainly on this. The company had also planned an evaluation of the system effectiveness in the pos go-live phase. They ran an analysis of the economical value created by SAP, especially by the time and travel modules. The project budget was determined by the top management and the ICT.

R11 Change management
The company carried out an evaluation of the users' attitudes towards the change, but when the decision of the ERP implementation had already been taken by the top management.

The top management communicated the benefits of the ERP systems the employees but did not directly explain how the ERP system would have worked. These explanations were provided to the various subjects implementing a "waterfall" process, starting from the functions' leaders.
Leaders of the most influential groups in the company were fully involved in the project and the impacts of the ERP system on the employees' careers were clearly communicated.
Lastly, change management progresses were monitored throughout the project phases.

R12 Legacy system management
The company ran a preventive analysis of the IT system, in order to define the priorities of the tasks and determine which components to keep in the ERP system.
The legacy system functioning had been fully comprehended, but the documents concerning the old IT system were not available anymore because the expert employees were still in the company. The treatment strategy adopted was the migration one. There was no gradual transitory phase, as a cut over was executed to pass from the old to the new system. The two systems co-lived just in the last phase of the development (3 months), in order to check the ERP system's performance in comparison to the legacy system's ones.
After the go-live, the legacy system was never used to cover applications the ERP system was meant to cover

R13 Consulting service
The company made use of the consultant to develop the ERP system, which were involved since the very beginning of the project. The competences the company required were mainly technical, so that the responsibilities assigned to the consultants concerned the development of the system
The integration between the consultants and the employees was judged to be good. The means used to communicate with the team members were mainly mails and meetings. Finally, also in this case, the collaboration with the consultants increased the internal knowledge of the company: they made possible to pass from a group of 20 SAP experts to one composed by 100 people.

R14 Leadership
The project manager had competences both in business and IT fields and had had previous experiences as team manager. The leadership style used was a collaborative one, but the project manager stated that "decisions could not be questioned".

R15 IT System issue
The company carried out a structured process to define the functionalities and the performances the new system had to provide, but it was a top down decision.

Top management, ICT and functions' leaders were involved in this process.
During the project implementation, periodical reviews of the system's functionalities and performances were ran in order to verify they were aligned to what had been planned and to the current necessities.
The ERP system is scalable: the scalability was one of the very main project objectives.

R16 IT system maintainability
The documents concerning the maintenance process were managed according to a structured technique and the company defined procedures to follow for the interventions, in particular this was the case of the kernels' documents.
The project manager did not have any information about the agreement on the maintenance service.

R17 IT supplier stability and performance
The company did not create any partnership with the vendor. The vendor was involved anytime there is the necessity of an update or a new release.

R18 Strategic thinking and planning
The ERP implementation project is part of a long term IT plan, which involved the entire corporate. As the project manager pointed out, the ERP actually drove the change through the company but this was not a planned objective of the project.
The outcome objectives of the project were, for HR function, the unification of the database and the availability of integrated information. Moreover it had to enable a saving of the resources. The company carefully considered the fact that adopting the ERP system implicated rigid process to be bounded to.

R19 Financial management
The project manager did not have any information about the investment evaluation techniques adopted by the company. The strategic option of the investment on the ERP system had been preventively considered while any consideration on the productivity loss had been made.
The costs/benefits analysis was carried out comparing the cost linked to the costs of the legacy system and it maintenance costs to the costs aroused by SAP system. The analysis also included considerations on intangible benefits, as the possibility of integrating information.
The company experienced problems with a not perfect functioning of the system.

Risk Management
The company planned preventive actions to face problems, such as contractual penalties.
The biggest problem it had to be faced was related to the "refusal" of the workers to change. Therefore the action undertaken were intensive change management

process, effective communication obtained through frequent meetings and lastly "transparency": every decision was fully explained to the people working in the company.
The project manager pointed out that if he should start the project over again, he would work more on the reporting system development and close down all the servers (SAP needs just one server to work better). Finally he would spend more time on the project assessment starting just when everybody fully agrees on the subject and a global consensus was achieved.

6.9.5 Risk Effects

E1 Budget Exceed
The budget exceeded of a 10 to 20%. The main reason was due to a longer implementation of the modules than what planned.

E2 Time exceed
The project was 2 month late over a 3 years long project, due to a postponement of the cutover (decision taken as a precaution).

E3 Project Stop
The project was no stopped

E4 Business Performance
The ERP system implementation brought an improvement of the operative parameters; in particular it enabled faster data availability on the master data system

E5 System reliability and stability
The ERP modules were partially used, as they were not used at the 100% of their capability. There was no replication of them, where for replication it's meant the situation in which two modules where used to perform the same task.
The main bugs encountered dealt with data inaccuracy. These problems occurred mainly in the initial post cut-over phases.
The Project manager strongly agreed on the fact that ERP system brought to an improvement of the completeness and coherence of the information, since no enhancement was planned.

E6 Organization process fitting
According to the project management's opinion, the ERP system did not bring to a misalignment between the company's own procedures and those the system imposed. Moreover, the ERP software did not create a gap between the roles which used to be previously covered in the company and the one requested by

the system.

E7 User friendliness
The project management judged the system not very learnable, nor memorisable, while evaluated the efficiency and the users' satisfaction as high. The likelihood of committing errors was judged pretty high, since the system does not assist the data entry showing the errors.

E8 Degree of integration and flexibility
According to the project management's opinion, the ERP system cannot be easily integrated with the legacy system. He had no information about the capability of being integrated with external software's but he evaluates the system to be very easily expandable. Lastly, the system can manage exceptions and procedures' modifications, at acceptable timings and costs.

E9 Strategic goal fitting
The ERP implementation achieved the following objectives: improvement of the information quality, enhancement of the employers' skills, decrease of the time to market (here meant as a the time needed for information to flow) and improvement of the processes' quality

E10 Financial and economic performances
As a consequence of the ERP implementation, integration was achieved and this brought to direct financial and economic performances improvement.

6.9.6 Risk Assessment Simulation

The interviewees were involved in a risk assessment simulation using the software we presented in chapter 4. Based on the information they provided about the probabilities of occurrence of each risk factor and the impact of the effects, the software calculated a risk factor ranking. Results were then shown to them, in order to verify if, in their opinion, it was coherent with what really happened and their perception during the project implementation.
In the following table the outcoming ranking is shown (Figure 6.39).

The Risk Factor scores are clusterized according to K-Means algorithm with four clusters (A, B, C, and D). The result of this clustering is showed in Figure 6.40.

The clusters are shown with logarithmic axis.
The project manager agreed on the ranking but would put the key users involvement and training in higher positions.

RANK	ID	RISK FACTOR	SCORE	CLASS
1	R11	Inadequate change management	111	A
2	R15	Inadequate IT system issue	99.03	A
3	R18	Ineffective strategic thinking and planning	80.37	A
4	R1	Inadequate selection	76.21	A
5	R12	Inadequate legacy system management	72.46	A
6	R8	Inadequate BPR	70.17	A
7	R5	Low key user involvement	49.47	B
8	R7	Complex architecture and high number of implementation modules	49.13	B
9	R3	Low top management involvement	45.33	B
10	R2	Poor project team skills	42.92	B
11	R9	Bad managerial conduct	42.44	B
12	R16	Inadequate IT system maintainability	37	C
13	R17	Inadequate IT supplier stability and performances	32.18	C
14	R10	Ineffective project management techniques	32.03	C
15	R6	Inadequate training and instruction	30.03	C
16	R13	Ineffective consulting services	22.67	C
17	R4	Ineffective communication system	19.15	D
18	R19	Inadequate financial management	14.2	D
19	R14	Inadequate change management	9.58	D

Figure 6.39: HR TLC Risk Ranking

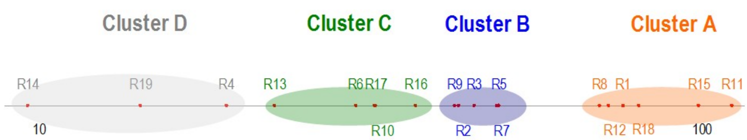


Figure 6.40: Risk factors cluster HR TLC

6.9.7 Usability and Utility

The managers did not consider the software to be able to improve the project management, but he thought it useful as a first approach for change management. They moreover agree with the purpose of a risk management methodology to assess the project. It might be submitted to the key users at the starting point of the project to understand the way they perceive the ERP system.
Globally the software appeared easily understandable and usable.

6.10 Conclusion

In this Chapter, the methodological framework of the case studies was illustrated. A number of case studies from firms in different sectors, recently involved in the introduction project of ERP systems, was selected and analyzed by in-depth interviews, ex-post evaluations on project performance and a simulation of the use of the methodology. A reconstruction was then presented for each project, from a risk management point of view.

Chapter 7

Results

In this chapter the main results from the case study analysis are reported. First of all, a comparative analysis of the ERP projects is presented. For each case study, project performances are analyzed in order to put gaps in evidence with the expected results; then the risk factors, revealed during the project implementation, are discussed. The most relevant risk factors from the ranking, simulated by the software, are also compared with the actions really planned by the managers in order to identify the potential causes of a superior or poor performance.

After that, the attention moves on the introduction of the methodology in firms. With this aim, a Risk Management Maturity Model, describing the evolutionary path from ad hoc, chaotic processes to mature, disciplined risk management process, is presented. The proposed framework also provides a conceptual structure for improving the risk management in a disciplined and consistent way. The case studies were analyzed and classified according to the RMMM; moreover the company Risk Management Maturity Model was put in relation with the performance obtained in the ERP project.

Finally, in the light of the emergent literature, some reflections are carried on.

The main outlines of this chapter are:

- Introduction;
- Case study discussion;
- Adoption of the methodology in firms:
  - o Risk Management Maturity Model;
  - RMMM analysis for the case studies;
- Conclusions and evidences from literature.

7.1 Introduction

After the previous "within-case" analysis, a cross-case analysis was assessed searching for patterns, in order to strengthen findings or conflicts that have to be deeply analyzed. We compared the experiences of the selected companies examining the results we had found for each indicator explained in Chapter 6. Three comparing tables reporting, for each case study, the main differences in project results, the risk effects dimensions, the assessment of the different risk factors and the adopted risk management practices were filled in. Data were then interpreted and re-coded, according to a pre-defined evaluation scale (evaluations were standardized in a five-point scale). Results were finally drawn in radar diagrams to achieve an easier interpretability, making it possible to easily compare the different projects.
Once data were divided by type across the all investigated cases, an in depth examination of each type of data was provided, and a classification of the different projects assessed, according to the risk effects and to the performances managers evaluated for each project success dimension, in order to identify the best ones. Then the potential causes of these results were searched in the way companies assessed the most relevant risk factors highlighted by the software simulations.
The main problems, revealed during the project and evidenced during the interviewees, were also analyzed. The discussion of the case study aimed to provide evidences for the applicability, utility and usability of the developed methodology.

7.2 Case study discussion

As we stated in the Chapter 6, the case selection is an important aspect in drawing conclusions. Our idea was to explore different markets in order to gather a broader view on ERP implementation projects and collect different experiences in terms of success dimension addressed during the project. Therefore, the selected companies were comparable in their profiles but operating in global and very different contexts and sectors (both manufacturing and services companies, competing in different markets, with different production processes). They were competing in the chemical, energy, paper, healthcare and telecommunication sector and operating in the Italian market.

The sector culture, the decisional style of companies, as well the peculiarities of the business and production processes could also affect the way company approach the ERP introduction problem.
In Figure 7.1, we report a classification of the selected companies according to their production type and volume/mix configuration. Finally, their motivation for the ERP implementation is also presented.

	Case A: Procter & Gamble	**Case B:** SCA	**Case C:** Power One	**Case D:** S. Anna Ferrara Hospital	**Case E:** HR - TLC Services
Sector class	Manufacturing	Manufacturing	Manufacturing	Service	Service
Sector	Chemical	Paper	Energy – Electronic - Electric	Healthcare	Telecommunication
Production flow	Continuous-in line	Continuous-in line	Job shop - Batch	Job shop	Job shop – real time
Production type	MTS	MTS - MTO	ETO - MTO	On demand	On demand
Manufacturing model	High volume – low mix	High volume – low mix	Low volume – high mix	High volume – high mix	High volume – low mix
Motivation for ERP	• Corporate integration; • Replacing the Legacy System; • Transaction efficiency; • Process alignment; • Standardization; • Decision making enhancement; • Information availability.	• Corporate integration; • Cost efficiency; • Data standardization; • Decision making enhancement; Information availability.	• Corporate integration; • Replacing the Legacy System; • Standardization;	• Replacing the Legacy System; • Operative efficiency; • Process alignment; • Standardization; • Decision making enhancement; • Information availability;	• Corporate integration; • Replacing the Legacy System; • Operative efficiency; • Process alignment; • Standardization; • Decision making enhancement; • Information availability.

Figure 7.1: Companiy profiles

After the within case analysis, in order to enable an easier interpretation and carry out the comparative analysis between the five case studies, three summarizing tables reporting the main differences and peculiarities of approach to the ERP project were filled in. The tables are here reported (Figure 7.2-7.8).

Starting from the summarizing tables and following the criteria defined in the questionnaire design, we synthesized a final evaluation of both the project performance and the way in which the single risk factors were approached by the companies. So a new codification of the case study was defined in order to enable a more effective interpretation of them.
Here we report the evaluation of the project performance from each case study,

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR - TLC Services
Overall Result	- On Budget; - 7% time exceed (One month late).	- 150% Budget exceed; - On time.	- 20-40% Budget exceed; - Three months late (30% time exceed).	- On budget; - On time.	- 10-20% budget; - 6% time exceed (two months late).
RISK FACTORS					
Selection	- Not required.	- Not required.	- Not required.	- Vendor and System Integrator selected through a public call for bids.	- Not required.
Project team skills	- Each team member involved in the implementation of all modules; - Vendor integrated in the team; - Training needs detected; - IT project competence.	- Team split up: one part focusing on AC module, the other on the FI one; - Vendor not integrated in the team; - Training needs not detected; - No IT project competence.	- A steering committee managed the implementation of all modules; other teams with key users was formed for each module; - System integrator integrated in the steering committee; - Training needs not detected; - IT project competence.	- A steering committee managed the implementation of all modules; other teams with key users was formed for each module; - Vendor integrated in the team; - Training needs not detected; - IT project competence.	- Each team member involved in the implementation of all modules; - Vendor integrated in the team; - Training needs not detected; - Poor IT competence.
Top management involvement	- Involved in decision making process when success criteria not met; - Assessment of budget and resources to the project; - One champion.	- Involved just in review and approval processes; - One champion.	- It gave completely proxy, just approving the postponement of Go Live; - Two champions (one for technical coordination, one for key users' coordination).	- Involved in the decision-making activities when indicators exceeded targets; - No champion.	- Involved in control phases; - One champion.
Communication system	- Mails, meeting, conferences, calls.	- Mails and meetings; - Workshops.	- Mails, conference calls; - Share point web site on intranet.	- Mails, mailing list, manuals, meetings; - Web site on intranet.	- 180 meetings, calls, mails.
Key users involvement	- Above all involved in BAT, cutover and post-cutover phases; - Detection of training needs.	- Involved throughout the project life cycle but passive role in the beginning.	- Very involved after planning phase and also after Go Live.	- Involved when a system's prototype was ready.	- Involved since the planning phase.

Figure 7.2: Summary of the main differences in risk factor dimensions, part 1

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR - TLC Services
Training and instruction	- Internal courses held by the vendor; - Detection of training necessities; - Acquired skills officially certified at the end of the training process; - No further training needed after the Go Live.	- Internal and external courses held by the corporate; - Detection of training necessities; - No evaluation of the acquired skills; - Further training needed after the go live.	- Internal courses held by the system integrator and internal courses held by process owner coming from other sites ; - No detection of training necessities; - Evaluation of the acquired skills; - Further training needed after the Go Live.	- Internal courses held by vendor and e-learning trough web site; - No detection of training necessities; - No evaluation of the acquired skills; - Further training needed after the Go Live.	- Internal courses held by SAP team and Function Leaders; - No detection of training necessities; - No evaluation of the acquired skills; - Further training needed after the Go Live.
Complex architecture	- Two different moment of modules implementation during project lifecycle; - Multi-site structure; - 0% customization; - No integration with external system; - 150 users; - Multiple database.	- Incremental strategy for modules implementation over the years; - Multi-site structure; - 5% customization; - Integration with EDI system; - 300 users; - Single database.	- All modules implemented at the same time; - Multi-site structure; - 10 % customization; - Integration with SCM system; - 300 users; - Single database.	- Two different moment of modules implementation during project lifecycle; - One-site structure; - 10% customization for first moment, 30% customization for the second one; - Integration with Legacy system of the wards; - 1300 users; - Single database.	- All modules implemented at the same time; - One-site structure; - 20% customization; - No integration with external system; - 2000/3000 users; - Not available.
BPR	- BPR performed in the development phase; - 4 months dedicated, 10 FTE people working on it; - 100 people in the BPR team.	- No BPR process implemented, just a blueprint edit; - Whole team involved.	- A hasty BPR performed, the BPR's result arrived late; - Whole team involved.	- A informal BPR performed; - BPR as continuous process; - Whole key users.	- No BPR process was performed; - Prioritizing according to SAP experts' indications.

Figure 7.3: Summary of the main differences in risk factor dimensions, part 2

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR - TLC Services
Managerial conduct	- Need of further clarification of the project objectives because of people working on different projects at the same time; - Team manager fully committed.	- Need of further clarification of the project objective because of problems with English language understanding; - Team managers very strict on allowing software's modifications; - Team manager 80% committed.	- Need of further clarification of the project objective; - Top-down managerial policy; - Team manager fully committed.	- Need of further clarification of the project objective; - Sponsorship policy; - Team manager fully committed.	- Need of further clarification of the project objective because of change management necessities; - Key users involvement policy; - Team manager fully committed.
Project Management techniques	- Adoption of the Vendor's risk management techniques; - Company's risk management techniques implemented; - Evaluation of the system effectiveness.	- Company's risk management techniques implemented; - Evaluation of the system effectiveness through assessment	- No risk analysis made; - Evaluation of the system effectiveness carried out by Valdarno's management through panel-discussions.	- Company's risk management techniques implemented; - Risk analysis made by consultants; - Evaluation of the system effectiveness through a questionnaire.	- Company's risk management techniques implemented; - Evaluation of the system effectiveness through analysis of economic value by SAP .
Change management	- Preventive evaluation of the users' attitudes towards the change through a "satisfaction survey"; - Change management performed during the beginning phases.	- No preventive evaluation of the users' attitudes towards the change; - No change management performed.	- No preventive evaluation of the users' attitudes towards the change; - No explanations of how ERP system works; - No change management performed.	- No preventive evaluation of the users' attitudes towards the change; - No change management performed.	- Evaluation of users attitudes towards the change after the decision of ERP implementation; - No explanations of how ERP system works; - Change management performed and monitored.
Legacy System management	- No full comprehension of the legacy system in the site; - Legacy system documents still available at the site; - Migration treatment strategy.	- Full comprehension of the legacy system in the site; - Legacy system documents not available at the site; - Migration treatment strategy.	- Full comprehension of the legacy system in the site; - Legacy system documents still available at the site; - Migration treatment strategy.	- Full comprehension of the legacy system in the site; - Legacy system documents still available at the site; - Migration and wrapping through middleware treatment strategy.	- Full comprehension of the legacy system in the site; - Legacy system documents not available at the site; - Migration treatment strategy.

Figure 7.4: Summary of the main differences in risk factor dimensions, part 3

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR - TLC Services
Consulting service	- HP personnel as consultants with technical competences; - Sufficient integration with team members in the site; - Fairly increaser of the company knowledge.	- Corporate personnel as consultants with business and technical competences; - Poor integration with site's team members because of language problems and lack of will; - Great increaser of the site's personnel knowledge.	- System Integrator with 70% technical competences and 30% business competences; - Excellent integration with team members in the site; - Fairly increaser of the company knowledge.	- Consultants with competences in SAP and business health; - Excellent integration with team members in the site; - Great increaser of the site's personnel knowledge.	- Consultants with IT competences; - Good integration with team members in the site; - Great increaser of the site's personnel knowledge.
Leadership	- P&G leadership style: inclusive, engaging and supportive.	- Corporate team manager had an authoritarian leadership style.	- Autocratic-participative leadership style.	- Top management used autocratic leadership style while the Project Manager used facilitator one.	- Collaborative leadership style.
IT system issues	- A structured process to determine the software functionalities and performances was performed; - Scalable ERP.	- A structured process to determine the software functionalities and performances was performed; - Rigid ERP structure: every modification has to be approved by the corporate.	- A structured process to determine the software functionalities and performances was not performed; - Scalable ERP.	- A structured process to determine the software functionalities and performances was performed; - No scalable ERP.	- A structured process to determine the software functionalities and performances was performed; - Scalable ERP.
IT system maintainability	- Vendor provided the adaptive and corrective maintenance.	- Vendor provides the last version of the ERP system.	- Vendor provides the maintenance of the modules not customized.	- Adaptive, corrective maintenance were included in call for bids.	- Not available the maintenance's agreements.
IT system stability	- Partnership with HP.	- Partnership with SAP.	- Partnership with System Integrator.	- Partnership with SAP.	- No partnership.
Strategic thinking	- ERP not seen as a way to change the company's vision but a way to enable the business.	- ERP not seen as a way to change the company but a way to integrate the sites.	- ERP not seen as a way to change the company but a way to integrate the sites.	- ERP seen as a way to change the company but a way to integrate the sites.	- ERP system changed the company but it was not a planned objectives.
Financial management	- Strategic option of the ERP implementation project considered; - Cost/benefits analysis carried out including the intangible benefits.	- Strategic option of the ERP implementation project not considered; - Cost/benefits analysis, not available.	- Strategic option of the ERP implementation project considered; - Cost/benefits analysis did not carry out.	- Strategic option of the ERP implementation project not considered by top management; - Cost/benefits analysis carried out.	- Strategic option of the ERP implementation project considered; - Cost/benefits analysis carried out including the intangible benefits.

Figure 7.5: Summary of the main differences in risk factor dimensions, part 4

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR - TLC Services
RISK MANAGEMENT					
Preventive actions	- Over dimensioned budget; - Backup budget; - Contractual penalties; - Communication plan for unforeseen issues.	- No preventive actions but the site team relied on the big experience of the corporate team.	- Not available.	- Contractual penalties.	- Contractual penalties.
Major issue	- Longer cutover than expected.	- Communication problems and low key users involvement.	- Team sizing.	- Business process mapping.	- Workers' resistance to change.
Corrective actions adopted	- Following the emergency plan.	- No corrective actions adopted.	- Rescheduling of implementation project; - Addition of human resources.	- Interventions of top management.	- Intensive change management process; - Effective communication.
Major aspect that should have been different	- Better plan of the initiation phase.	- More power to the site team.	- Top management involvement; - BPR deployment; - Business vision and not IT vision; - Team sizing.	- Major vendor's and users' involvement since at the beginning.	- The development of reporting system; - Achieving a complete approval before the project's start.

Figure 7.6: Summary of the adopted risk management practices

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR - TLC Services
RISK EFFECTS					
Budget	- On budget.	- 150% budget exceed.	- 20-40 % budget exceed.	- On budget.	- 10-20% budget exceed.
Time	- 6% time (One month late).	- On time.	- 30% time exceed (Three months late).	- On time.	- 6% time exceed (two months late).
Project Stop	- No occurred.	- No occurred.	- No occurred.	- No occurred.	- No occurred.
Business performance	- No improvement of the operational parameter.	- No improvement of the operational parameter; - Better data access.	- No improvement of the operational parameter.	- Improvement of the operational parameter.	- Improvement of the operational parameter; - Faster data availability.
System reliability and stability	- No bugs.	- Maintenance interventions for new requests because system's specifications were wrong.	- Some ERP modules were partially used; - Maintenance interventions for new requests, for wrong solutions and for bugs.	- Maintenance's module was partially used; - No bugs.	- ERP modules were partially used; - Maintenance interventions for data inaccuracy.
Organization process fitting	- No misalignment between company's processes and roles with the one required by the ERP system.	- Misalignment between company's processes and roles with the one required by the ERP system.	- Misalignment between company's processes with the one required by the ERP system.	- No misalignment between company's processes with the one required by the ERP system.	- No misalignment between company's processes and roles with the one required by the ERP system.

Figure 7.7: Summary of the main differences in risk effect dimensions, part 1

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR - TLC Services
User friendliness	- Not very efficient; - Easily learnable; - Easily memorisable; - Satisfactory; - Low probability of making errors.	- Efficient; - Not easily learnable; - Easily memorisable; - Satisfactory; - Low probability of making errors.	- Not very efficient; - Not very learnable; - Memorisable; - Low satisfactory; - Low probability of making errors.	- Very efficient; - Learnable; - Memorisable; - Satisfactory; - Low probability of making errors.	- High efficient; - Not very learnable; - Not very memorisable; - High satisfactory; - Pretty high probability of making errors.
Integration and flexibility	- Easy to be integrated; - Not easy to manage exceptions; - Expandable.	- Not easy to be integrated; - Easy to manage exceptions; - Expandable.	- Easy to be integrated; - Not easy to manage exceptions; - Expandable.	- Easy to be integrated; - Easy to manage exceptions; - Expandable.	- Not easy to be integrated; - Ability to manage exceptions; - Not easily expandable.
Strategic goals fitting	- Improvement of information quality; - Enhancement of users' skills; - Improvement of processes' quality.	- Improvement of information quality; - Enhancement of users' skills; - Improvement of processes' quality.	- Improvement of information quality; - Improvement of processes' quality; - Enhancement of users' skills.	- Improvement of information quality; - Improvement of processes' quality; - Enhancement of users' skills; - Enhancement of service's quality; - Customer focus improvement.	- Improvement of information quality; - Enhancement of users' skills; - Decrease of information's time to market; - Improvement of processes' quality.
Financial and economical performance	- Improvement of financial and economical performances mainly because of standardization.	- No improvement of financial and economical performances.	- It's too early to evaluate it.	- Not measurable.	- Improvement of financial and economical performances mainly because of achieved integration.

Figure 7.8: Summary of the main differences in risk effect dimensions, part 2

as assessed by the managers (Figure 7.9), while details about the coding sheet are given in appendix C. Due to problems with available space, the coding table concerning the risk factors is also reported in appendix C.

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR TLC Services
BUDGET	5	0	2	5	3
TIME	4	5	2	5	4
PROJECT STOP	5	5	5	5	5
BUSINESS PERFORMANCE	0	0	1	2	1
SYSTEM RELIABILITY AND STABILITY	5	4	3	4	3
ORGANIZATION PROCESS FITTING	5	0	2,5	2,5	5
USER FRIENDLINESS	4	4	2	5	2
DEGREE OF INTEGRAZION AND FLEXIBILTY	3,33	3,33	3,33	5	1,67
STRATEGIC GOAL FITTING	3	3	3	4	4
FINANCIAL/ECONOMIC PERFORMANCE	3	2	2	4	3

Figure 7.9: Evaluation of the project performance

In the following sub-sections the interpretation of the ERP introduction project is reported for each case study.

7.2.1 Case A: Procter and Gamble

The P&G project is one of the best performing in terms of overall success. The global mean of the different success dimensions is quite high Ma = 4.1; that is a very good evaluation for the project. The only exception is for the business process dimension: the evaluation is 0. This value is due to the negative evaluation the managers expressed about the causality between the system introduction and the improvement of an operative performance such as Productivity, Quality of product, Reliability of product, Service customer, Knowledge management. A possible reason may be that the firm performance in these issues was already very high, so no improvement was experienced.
In the following figure (Figure 7.10) the radar, reporting the evaluation for the 10 project success dimensions, is shown.

Looking at the output of the risk assessment simulation (Figure 7.11), and in particular to the most critic risk factors (Cluster A, B and C), it emerges that the most relevant risks addressed by managers during the simulation were R5, R2, R8, R17, R3, R9, R13, R4.

If we analyze the evaluations we codified for the different risk factor dimensions (Figure 7.12, we can notice that the company approached quite well to this dimensions. The overall mean of the judgement is 4, that is a very high evaluation

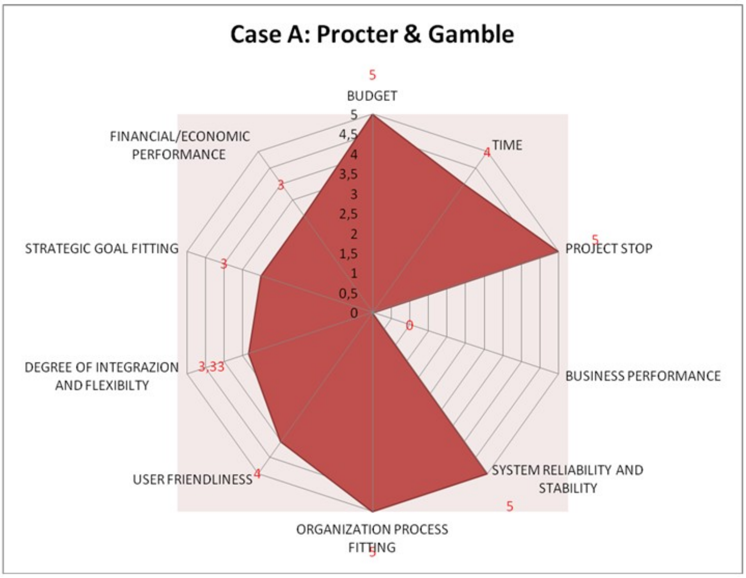


Figure 7.10: Evaluation of P&G project performance

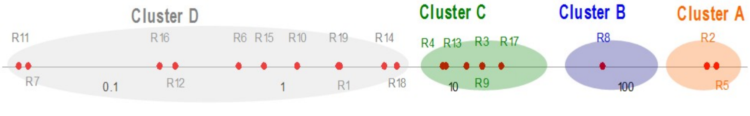


Figure 7.11: Ranking of P&G risk factors

for this issue, also considering that no structured apporach to risk management was undertaken during the project. Moreover, if we focus on the risk factors in

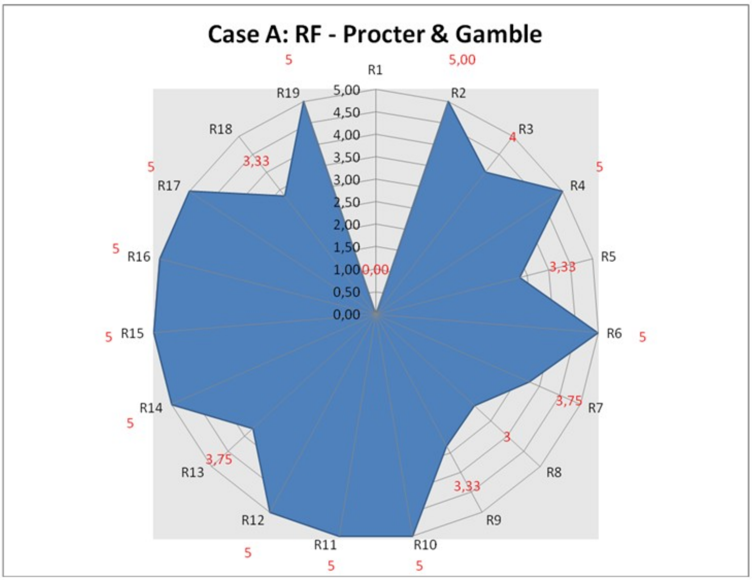


Figure 7.12: Evaluation of the P&G approach to the 19 risk factor dimensions

the top 3 risk clusters, we can observe that the evaluation of these dimensions is in line (a little bit higher Mc=4.2) with the overall mean of the project. This underpins the critic risk factors were well managed too, both according to the managers' opinions and to the criteria we selected from literature. In the following table the scores, the classes and the evalutations of the risk factors in the top 3 clusters are reported (Figure 7.13).

RANK	ID	RISK FACTOR	SCORE	CLASS	EVALUATION
1	*R5*	Low key users involvement	347	**A**	**3.3**
2	*R2*	Poor project team skills	304		**5**
3	*R8*	Inadequate BPR	75	**B**	**3**
4	*R17*	Inadequate IT supplier stability and performance	19	**C**	**4**
5	*R9*	Bad managerial conduct	15		**3**
6	*R3*	Low top management involvement	12		**3.3**
7	*R13*	Ineffective consulting services	9		**5**
8	*R4*	Ineffective communication system	8		**5**
				Average	**4.2**

Figure 7.13: Ranking of P&G risk factors

7.2.2 Case B: SCA

The overall performance of the SCA project can be considered medium-low. The global mean of the different success dimensions is medium Ma = 2.6; that is not a satisfying evaluation for the project. Even if the project does not experience any gap in schedule, a great over budged occurred. This was mainly due to communication problems and to a low involvement of the key users which lead to several reiterations of activities and the need of extra resources. A very negative performance is revealed also in the Business Performance and Organization Process fit dimensions.

Finally, no enthusiastic performance characterized the Financial, Strategic and IT areas.

In the following figure (Figure 7.14) the radar reporting the evaluation for the 10 project success dimensions is presented.

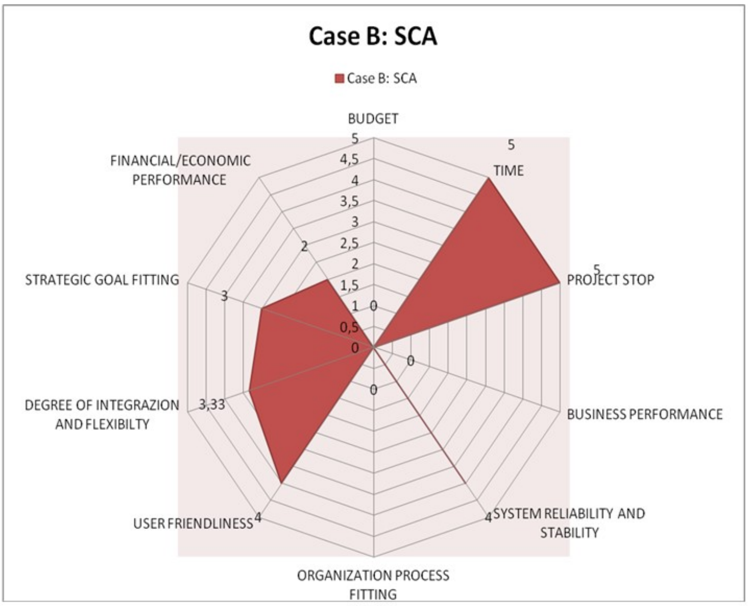


Figure 7.14: Evaluation of SCA project performance

Looking at the output of the risk assessment simulation (Figure 7.15), and in particular to the most critic risk factors (Cluster A, B and C), it emerges that the most relevant risks referred by the managers during the simulation were

R13, R3, R2, R14, R4, R9, R8.

Figure 7.15: Ranking of SCA risk factors

If we analyze the evaluations we codified for the different risk factor dimensions (Figure 7.16), we can notice that the company did not approach them at best. The overall mean of the judgement is 3.2, that is a middle evaluation for this issue.

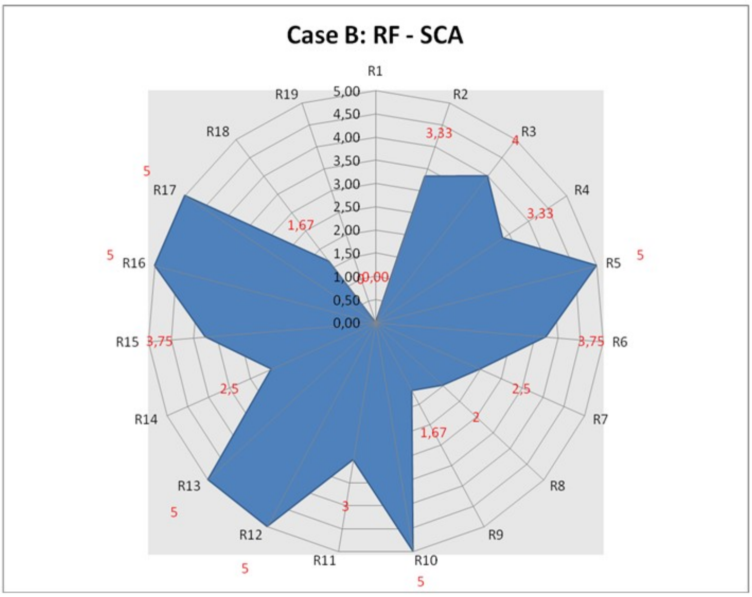


Figure 7.16: Evaluation of the SCA approach to the 19 risk factor dimensions

Moreover if we focus on the risk factors in the top 3 risk clusters, we can observe that the evaluations of these dimensions is in line (Mc=3.1) with the overall mean of the project. Furthermore, even if the first and second risk factor were correctly assessed (their judgments were respectively 5 and 4), the evaluation of the other risk factors is sensibly under the project mean.
This underpins that the critic risk factors in cluster A were all well managed

both according to the managers' opinions and to the criteria we selected from literature, but lower attention and resources were addressed to manage the critic risk factors in cluster B and C. This may be a cause of a globally unsatisfactory project performance.
In the following table the scores, classes and evalutations of the risk factor in the top 3 clusters are reported (Figure 7.17).

RANK	ID	RISK FACTOR	SCORE	CLASS	EVALUATION
1	*R13*	Ineffective consulting services	3224.13	*A*	*5*
2	*R3*	Low top management involvement	1963.22	*A*	*4*
3	*R2*	Poor project team skills	1181.58	*B*	*3.33*
4	*R14*	Poor leadership	858.60	*B*	*2.5*
5	*R4*	Ineffective communication system	676.11	*B*	*3.33*
6	*R9*	Bad managerial conduct	492.66	*C*	*1.67*
7	*R8*	Inadequate BPR	298.62	*C*	*2*
1	*R13*	Ineffective consulting services	3224.13	*A*	*5*
				Average	**3.1**

Figure 7.17: Ranking of SCA risk factors

7.2.3 Case C: Power One

The overall performance of the P1 project can be considered medium-low. The global mean of the different success dimensions was medium Ma = 2.5; that is not a very good evaluation for the project. Even if the project did not stop, it experienced a substantial gap both in budget and in schedule. The other success dimensions were not so satisfying, too; almost all of them did not exceed 3 in their final evaluation.
A particular negative outcome was revealed in the Business Performance. This could be due to the inadequate selection process and to the late BPR and late key users involvement the company experienced. Anyway, the company was still completing the ERP introduction when managers interviewed, so the natural learning process which is typical of any ERP project, could lead to a bias in the operative performance evaluation.

In the following figure (Figure 7.18), the radar reporting the evaluation for the 10 project success dimensions is presented.

Looking at the output of the risk assessment simulation (Figure 7.19), and in particular to the most critic risk factors (Cluster A, B and C), it emerges that the most relevant risks addressed by managers during the simulation were R3,

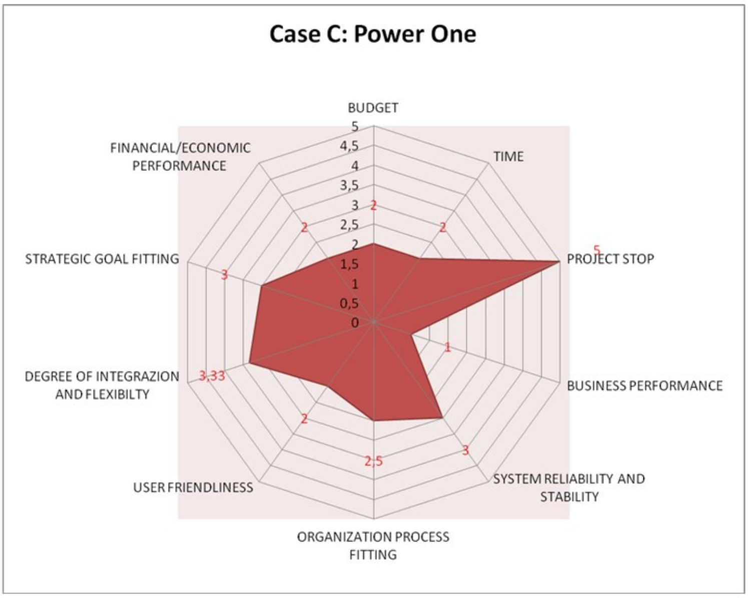


Figure 7.18: Evaluation of P1 project performance

R9, R14, R18, R1, R2, R7, R4, R8.

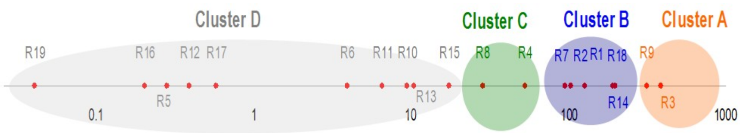


Figure 7.19: Ranking of P1 risk factors

If we analyze the evaluations we codified for the different risk factor dimensions (Figure 7.20), we can observe that the company did not approach this dimensions very well. The overall mean of the judgement is 2.5, that is a low evaluation for this issue. For example, an evident gap concerns factors R1 (Selection), R7 (System Architecture) and R11 (Change management).

Moreover, if we focus on the risk factors in the top 3 risk clusters, we can perceive that the evaluation for these dimensions is sensibly under the mean (Mc=1.9). Moreover two relevant factors (R1 and R7) appear in the ranking of the top 3 clusters since they were judged highly critical by managers and, instead, were completely undermanaged during the project management.

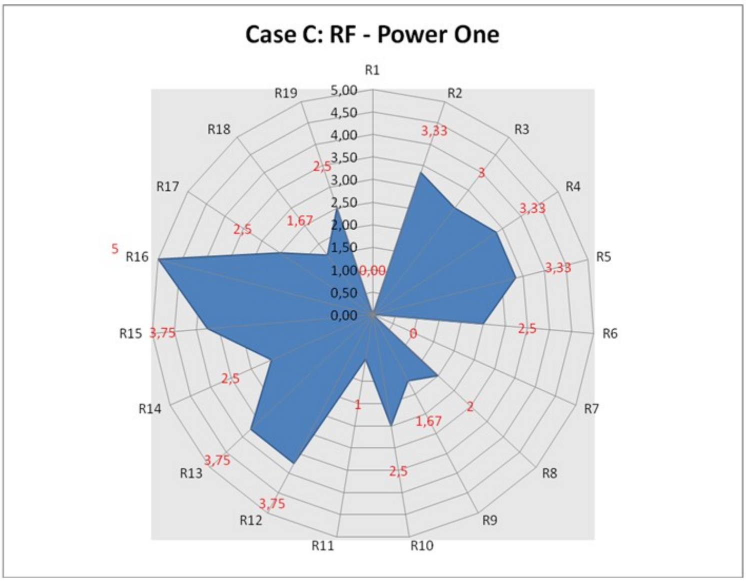


Figure 7.20: Evaluation of the P1 approach to the 19 risk factor dimensions

This evidence underpins that no priority was assessed in managing risk factors. Probably a risk assessment phase during the preliminary stages of the project would have been useful for managers to focus on the most critical areas needing extra attention and resources.

In the following table the scores, the classes and the evalutations of the risk factor in the top 3 clusters are reported (Figure 7.21.

Rank	ID	Risk Factor	Score	Class	Evaluation
1	*R3*	Low top management involvement	392.72	*A*	*3*
2	*R9*	Bad managerial conduct	318.79	*A*	*1.67*
3	*R18*	Ineffective strategic thinking and planning	198.55	*B*	*1.67*
4	*R14*	Poor leadership	194.22	*B*	*2.5*
5	*R1*	Inadequate ERP selection	127.95	*B*	*0*
6	*R2*	Poor project team skills	104.09	*B*	*3.33*
7	*R7*	Complex architecture and high number of implementation modules	95.50	*B*	*0*
8	*R4*	Ineffective communication system	53.32	*C*	*3.33*
9	*R8*	Inadequate BPR	28.94	*C*	*2*
				Average	*1.9*

Figure 7.21: Ranking of P1 risk factors

7.2.4 Case D: S. Anna Hospital

The S. Anna project is one of the best performing in terms of overall project success. The global mean of the different success dimensions is quite high Ma = 4.1; that is a very satisfying evaluation for the project. The only exception concerns the business process dimension and the organization process fit, with an evaluation of 2 and 2.5 respectively. These values are the most negative evaluations expressed by managers towards the project and they are primarily due to a misalignment between the old and the new processes imposed by the system. In fact the system introduction led to a great change in the organization processes: the low user attitude to the change was probably the cause of a transitory low operative performance.

In the following figure (Figure 7.22) the radar reporting the evaluation for the 10 project success dimensions is presented.

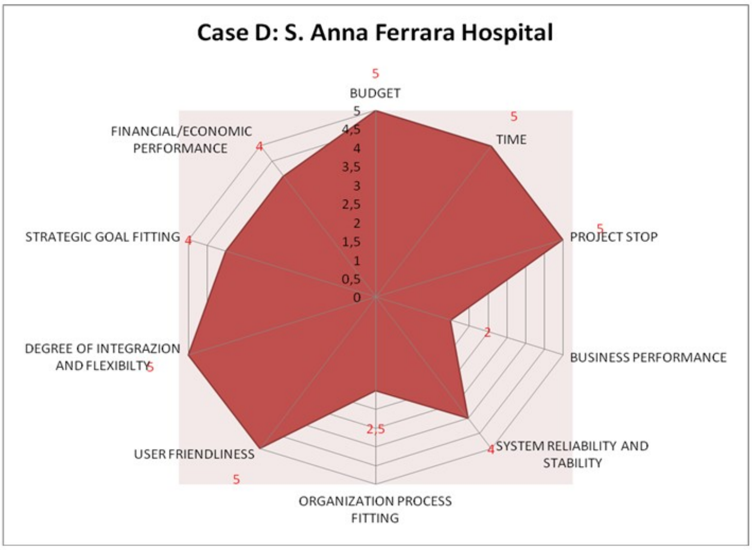


Figure 7.22: Evaluation of HOSPITAL project performance

Looking at the output of the risk assessment simulation (Figure 7.23), and in particular to the most critic risk factors (Cluster A, B and C), it emerges that the most relevant risks addressed by managers during the simulation were R13, R14, R2, R1, R7, R8.

If we analyze the evaluations we codified for the different risk factor dimensions

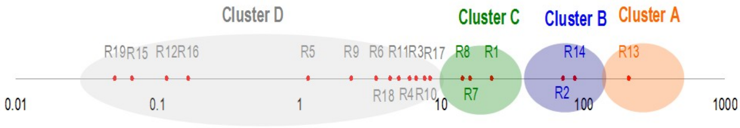


Figure 7.23: Ranking of HOSPITAL risk factors

(Figure 7.24), we can observe that the company approached this dimensions with a good performance. The overall mean of the judgements is 3.6, that is a medium-high evaluation for this issue. Some underperforming dimensions, in particular, concern with risk factors R6 (Training), R7 (System Architecture), R11 (Change management), R14 (Leadership) and R19 (Financial Management). However, differently from all the other selected cases, the hospital approached a structured selection process through a pubblic auction process.

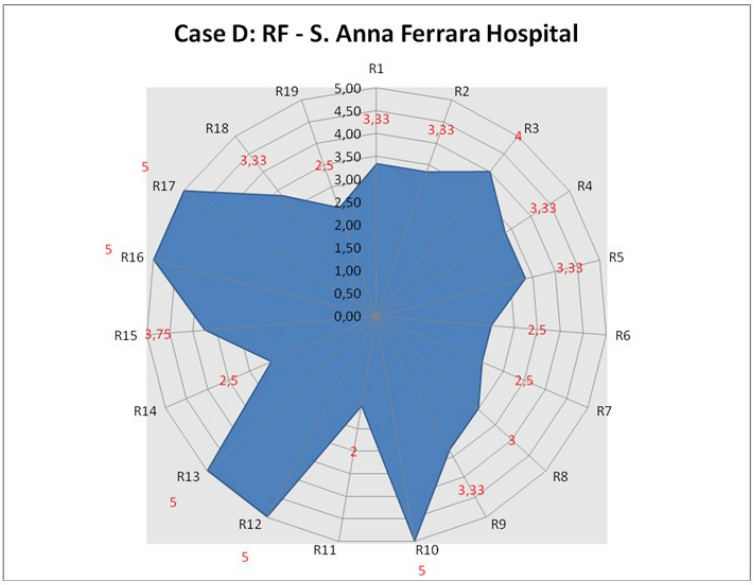


Figure 7.24: Evaluation of the HOSPITAL approach to the 19 risk factor dimensions

Moreover, if we focus on the risk factors in the top 3 risk clusters, we can perceive that the evaluation of these dimensions is under the project mean (Mc=3.3). Furthermore, even if the performance of the consulting firm was excellent, probably because of the long and structured selection process, the performance in managing the other critic factors does not appear so elevate and satisfying.

These evidences make presume that the great attention managers dedicated to the Vendors and Business Integrators selections both from a technical and a business process point of view led to a great result in terms of project management performance. This result was also enhanced by the outsourcing policy assessed by the company for the technical implementation of the system which was completely under the consultants' responsibility.

In the following table the scores, the classes and the evalutations of the risk factor in the top 3 clusters are reported (Figure 7.25).

RANK	ID	RISK FACTOR	SCORE	CLASS	EVALUATION
1	*R13*	Ineffective consulting services	211.99	*A*	*5*
2	*R14*	Poor leadership	87.74	*B*	*2.5*
3	*R2*	Poor project team skills	72.25	*B*	*3.33*
4	*R1*	Inadequate ERP selection	22.87	*C*	*3.33*
5	*R7*	Complex architecture and high number of implementation modules	15.96	*C*	*2.5*
6	*R8*	Inadequate BPR	14.18	*C*	*3*
				Average	*3.3*

Figure 7.25: Ranking of HOSPITAL risk factors

7.2.5 Case E: HR TLC service

The overall performance of the HR TLC project was not excellent but acceptable. The global mean of the different success dimensions is medium Ma = 3.2; that is a medium evaluation. Even if the project did not stop, some gaps were revealed both in budget and in schedule plan. Also the other success dimensions were not so satisfying.
A particular negative performance was revealed in the Business Performance and the Degree of integration and flexibility of the system, as well in user friendliness. This could be due to an inadequate selection process concerning the technical and the system requirements. The selection was in fact managed by the corporate and constrained by political reasons. One of the main problems was linked to the users resistance to change, so an intensive change management process had to be assessed.

In the following figure (Figure 7.26) the radar reporting the evaluation for the 10 project success dimensions is presented.

Looking at the output of the risk assessment simulation (Figure 7.27), and in particular to the most critic risk factors (Cluster A, B and C), it emerges that the most relevant risks addressed by managers during the simulation were R11,

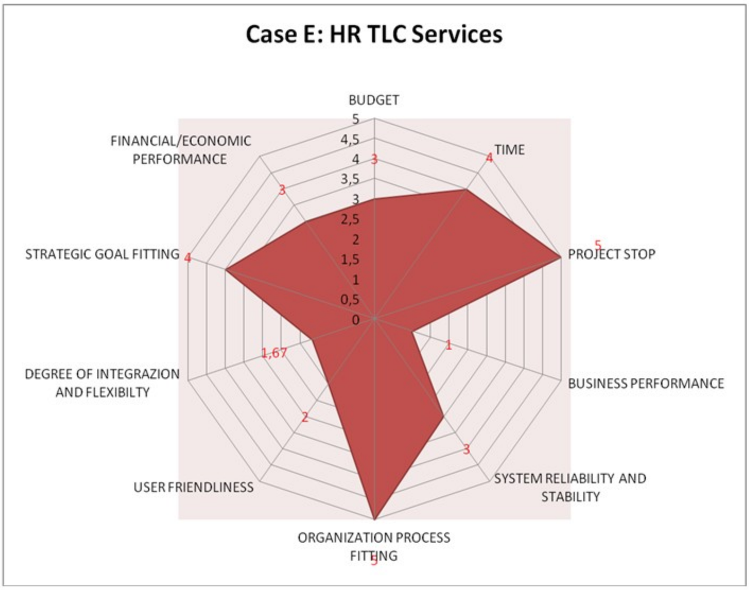


Figure 7.26: Ranking of HOSPITAL risk factors

R15, R18, R1, R12, R8, R7, R3, R2, R9, R16, R10, R17, R6, R13.

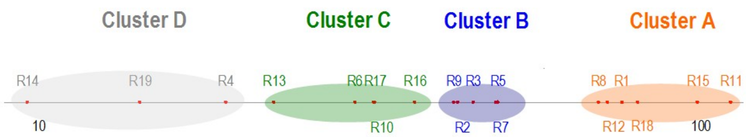


Figure 7.27: Ranking of HR TLC risk factors

It is evident that almost all the risk factors appear in the top 3 cluster: this is not intuitive and should lead to some investigations on the way the project risk assessment was carried on.

If we analyze the evaluations we codified for the different risk factor dimensions (Figure 7.28), we can notice that the company acceptably approached this dimensions. The overall mean of the judgement is 3.65, that is a middle-high evaluation for this issue. But this did not lead to a high performance in the overall project management.

Moreover, if we focus on the risk factors in the top 3 risk clusters, we can perceive that the evaluation of these dimensions is under the project mean (Mc=3.4).

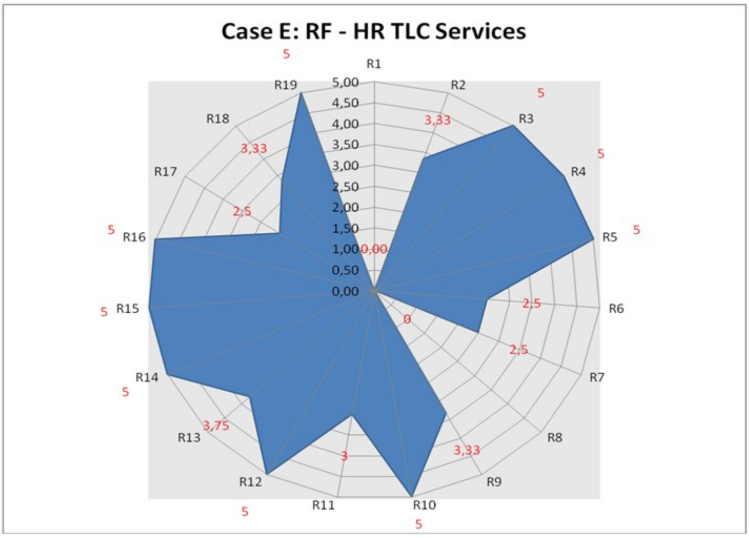


Figure 7.28: Evaluation of the HR TLC approach to the 19 risk factor dimensions

Moreover in cluster A, two relevant factors R1 and R8 were judged highly critical by managers, and that, instead, were not adequately managed during the project implementation.
This evidence underpins that no priority was assessed in managing risk factors. Probably a risk assessment phase during the preliminary stages of the project would have been useful for managers to focus on the most critical areas needing extra attention and resources.
These evidences make also presume that the under-managed factors in cluster A could have caused effects in the overall project, influecing its global performance.

In the following table the scores, the classes and the evalutations of the risk factor in the top 3 clusters are reported (Figure 7.29).

7.3 Drawing conclusion from case studies

On the basis of the feedbacks obtained from the interviewed managers and the comparative analysis of the case studies, it is possible to draw conclusions about three main aspects of the research: the conceptual validity of the proposed theoretical model, the applicability of the methodology and finally the utility and usability of the method and the software.

RANK	ID	RISK FACTOR	SCORE	CLASS	EVALUATION
1	R11	Inadequate change management	111	A	3
2	R15	Inadequate IT system issue	99.03	A	5
3	R18	Ineffective strategic thinking and planning	80.37	A	3.33
4	R1	Inadequate selection	76.21	A	0
5	R12	Inadequate legacy system management	72.46	A	5
6	R8	Inadequate BPR	70.17	A	0
7	R5	Low key user involvement	49.47	B	5
8	R7	Complex architecture and high number of implementation modules	49.13	B	2.5
9	R3	Low top management involvement	45.33	B	5
10	R2	Poor project team skills	42.92	B	3.33
11	R9	Bad managerial conduct	42.44	B	3.33
12	R16	Inadequate IT system maintainability	37	C	5
13	R17	Inadequate IT supplier stability and performances	32.18	C	2.5
14	R10	Ineffective project management techniques	32.03	C	5
15	R6	Inadequate training and instruction	30.03	C	2.5
16	R13	Ineffective consulting services	22.67	C	3.75
				Average	*3.4*

Figure 7.29: Ranking of HR TLC risk factors

As for the conceptual validity, we can infer that the risk factors and the risk effects, identified through the literature review, found verification in the projects. All the managers we interviewed agreed with the model we proposed.
Some of them (P&G) suggested that two further aspects should have been considered: the project duration and the impact on other company's initiatives (e.g. new product launches). Anyway, we considered these factors included in other more generic classes of risk. So we conclude that no further risk effect was detected. This proofs the proposed theoretical model (as concerning the identification of risk factors and effects) is valid and well grounded with real situations (this also supports the model applicability).

Moreover, looking simultaneously at the different project experiences, the following observations can be proposed. First of all, the two best performing companies (Case A and D) have appropriately managed the factors highlighted by the risk assessment simulation, while the other ones, with the exception of SCA (which presents a medium evaluation in the management of the risk factors), present a gap in managing risk factors included in the top 3 clusters (in particular factors of cluster A and B). This leads to the conclusion that a correlation could exist between an appropriate management of factors at the top of the risk assessment ranking (Figure 7.30) and the overall project performance.

These evidences give also a first confirmation about the methodology capability to highlight the main factors of the project and prioritize them.

As for the utility and usability of the methodology and the supporting risk

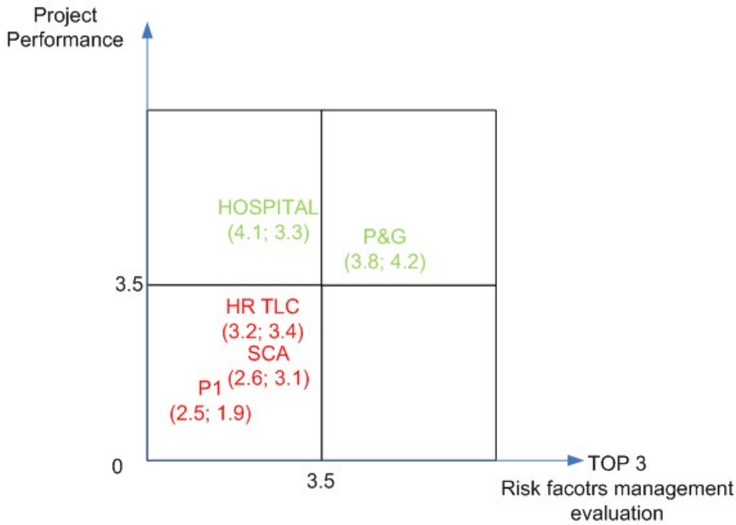


Figure 7.30: Case study comparison matrix

assessment software, the tool was considered very easy to use (usability) by the all managers, even if some of them (P&G) found the implementation too time consuming. They agreed on the tool utility in the first project assessment phase (utility and applicability) in order to discuss over the risk factors and the risk effects but not as to enable a better project management. They believed this tool could allow a better understanding of the phenomena and factors of a project so that managers could adequately consider the risk dimensions and reflect on them. The software could finally be considered a decision-making instrument, which could be used in the project planning phase.

Furthermore, very interesting feedbacks were provided by the under-performing companies. The interviewees believed the risk management methodology would have enhanced the project's results. They stated that the suggested methodology and the presented tool would have achieved a better management of the ERP implementation project and they suggested the following benefits could have been achieved through it:

1. a better fulfilment of the planned objectives;
2. a clear determination of the project objectives;
3. a better schedule compliance;
4. a better budget compliance;

5. enhancement of the productivity, both during and after the implementation;

6. enhancement of the company organization.

Lastly, the interviewees pointed out that the tool should be more descriptive so that more information regarding the meaning of risk factors could be available to managers as well more instructions about how to fill in the tables.

Concluding, the reported evidences make us quite optimistic about the applicability, utility and usability of the proposed methodology.

Another important consideration about the use of methodology in a real context concerns the risk treatment phase. If we analyze response actions which were planned by managers to face the possible problems, we just find contingent plans (Risk Acceptance Strategy) and contractual penalties/agreements (Risk Trasference Strategy) (Figure ??. A lot of further possible response actions were completely denied by the absence of a structured risk management methodology. This is obviously an evidence of the utility of the methodology in the field.

Company		Risk Response Strategy				
		Avoidance	*Mitigation*		*Transference*	*Acceptance*
			Likelihood	Effects		
Procter and Gamble	*A*	-	-	-	X	X
SCA	*B*	-	-	-	-	X
Power One	*C*	-	-	-	-	X
S.Anna Hospital	*D*	-	-	-	X	X
HR TLC services	*E*	-	-	-	X	X

Figure 7.31: Risk response strategies adopted by the companies

A final proposal for further investigation derives from the observation of the risk factor management evaluations of the underperforming companies. All of them, as evident by the following figures (Figure 7.32 - 7.34), present a clear gap in managing the risk factors categorized as BPR-Related Technological and Process issues (For more details, see Chapter 5).

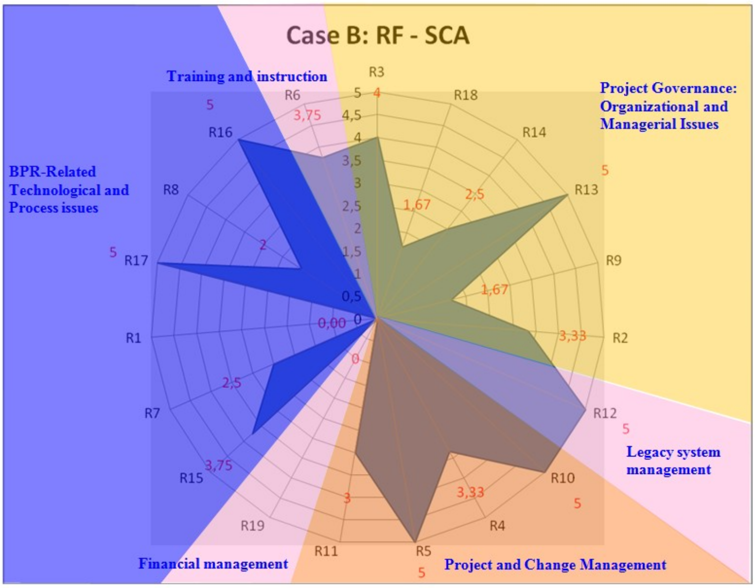


Figure 7.32: SCA RF management evaluation

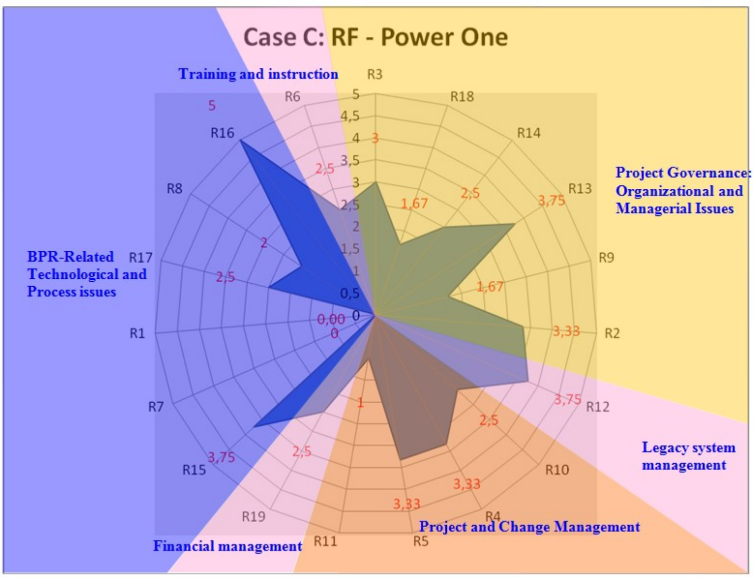


Figure 7.33: P1 RF management evaluation

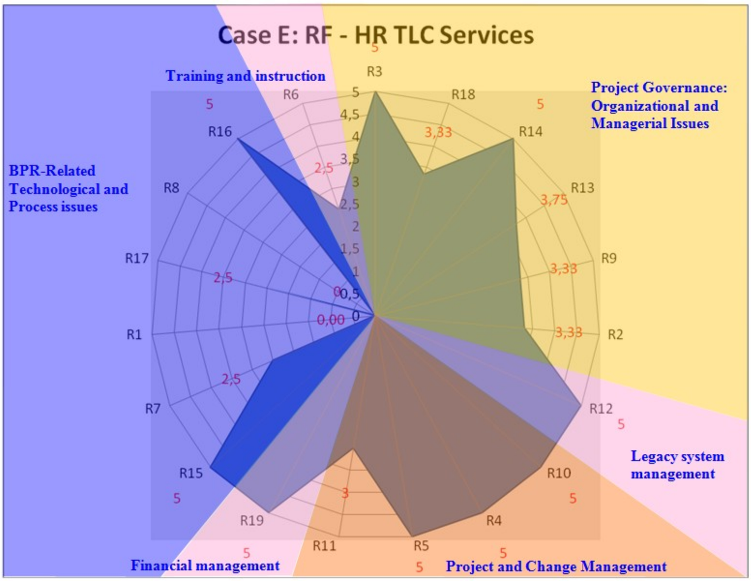


Figure 7.34: HR TLC RF management evaluation

7.4 Introducing the methodology in the company

7.4.1 Introduction

The introduction of a risk management approach in the company is not a simple task. It is mainly a cultural and strategic problem which companies should assess in order to follow their business strategy.
As we stated in Chapter 2, several methods and approaches to the project risk management exist in literature. Authors present several alternative of Risk Management Process frameworks. Useful and representative examples of this variety are SHAMPOO process (Simon et al., 1997), the PMBOK Guide (PMI, 2000), the RAMP Guide (Simon, 1998; see also Lewin, 2002), Australian Standard (1999) and SHAMPU (Shape, Harness, And Manage Project Uncertainty) process (Chapman and Ward, 2003), PRINCE2 manual (Bentley, 2002) and SAFE approach (Meli, 1998).
But knowing the methodological phases and steps for risk management is not enough in order to make the introduction in firm successful. What is important is the availability and knowledge of the effective techniques for the risk assessment (identification, analysis and evaluation) and treatment, supporting

the identification and the prioritization of risks and guiding the identification of the possible response actions.
This kind of approach is essential in order to associate a realistic value (weight) to each risk factor and obtain the top management approval for the risk management practice. Defining process metrics and indicators, in fact, is of low utility if we do not know what is the meaning of the values we are assessing. Valuable techniques and tools for the risk assessment should be based on realistic and quantitative data. For this reason and in order to achieve a reliable risk assessment, a company risk repository (database) reporting the main risk measures is indispensable.
However, as we already said, the adoption of a risk management methodology is first of all a cultural problem, so that the introduction process has necessarily to be gradual in order not only to achieve the consolidation of the adopted techniques but also to respect the natural time for change.

One of the most simple approaches to the introduction of the risk management is the "Growth model" which, following the general framework of the Capability Maturity Model (Cmm) presented by the Software Engineering Institute (Sei, 1993), suggests a gradual introduction process, consisting of 5 levels and aiming to an incremental improvement of the risk management culture in the firm.
Without an organized strategy for improvement, it is difficult to achieve consensus between the management and the professional staff on which are improvement activities to undertake first. To achieve the lasting results from the process improvement efforts, it is necessary to design an evolutionary path that increases an organization's software process maturity in stages.

The Software CMM is a descriptive model for the software process maturity, in the sense that it describes the essential (or key) attributes that would be expected to characterize an organization at a particular software maturity level. It is a normative model in the sense that the detailed practices characterize the normal types of behavior that would be expected in an organization doing large-scale projects in a government contracting context. The CMM intent is to provide a sufficient level of abstraction, so that it does not unduly constrain how the software process is implemented, but it simply describes the essential attributes of a software process. The CMM is not prescriptive; it does not tell an organization how to improve. The CMM describes an organization at each maturity level without prescribing the specific means for getting there.

The software process maturity framework orders these stages so that improvements at each stage provide the foundation on which build improvements undertaken at the next stage. Thus, an improvement strategy drawn from a software process maturity framework provides a roadmap for a continuous process improvement. It guides advancement and identifies deficiencies in the organization.

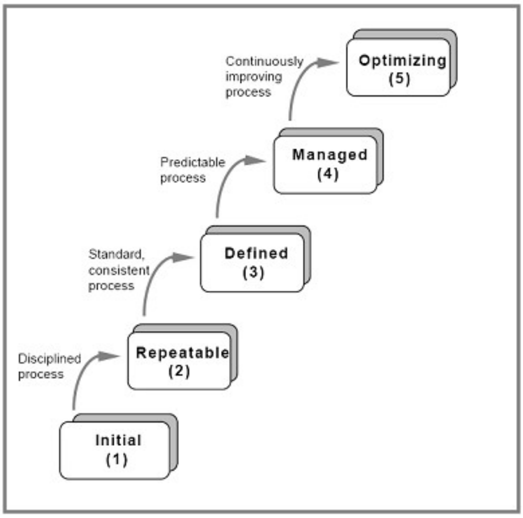


Figure 7.35: The five level of the software process maturity, Source: (SEI, 1993)

The following characterizations of the five maturity levels highlight the primary process changes made at each level (Figure 7.35):

1. Initial The software process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on individual efforts.

2. Repeatable Basic project management processes are established to track cost, schedule, and functionality. The necessary process discipline is in place to repeat success previously obtained on projects with similar applications.

3. Defined The software process for both management and engineering activities is documented, standardized, and integrated into a standard software process for the organization. All projects use an approved and tailored version of the organization's standard software process in order to develop and maintain the software.

4. Managed Detailed measures of the software processes and product quality are collected. Both the software processes and products are quantitatively known and controlled.

5. Optimizing Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

In the same way, a risk management process maturity model was defined (Hall, 1997; Hillson, 1997; DeLoach, 2000) in order to draw an evolutionary roadmap of the adoption of risk management in companies.
Two "risk maturity model" approaches (figure 7.36) are really relevant (Hillson, 1997; DeLoach, 2000). The first (DeLoach, 2000) is an adaptation of a capability maturity model for software engineering organizations developed by the Software Engineering Institute (SEI, 1993). It identifies five levels of maturity: initial, repeatable, defined, managed, and optimizing. The second (Hillson, 1997) is also influenced by the SEI maturity model, but it identifies just four levels of maturity: naive, novice, normalized, and natural. The author argues that some organizations may not neatly fit into specific maturity categories, but at the same time the four levels are "sufficiently different to accommodate most organizations unambiguously".

Here we adopt the DeLoack's model (2000) in order to classify the analyzed companies, identifying their position in the evolutionary model and suggesting action for improving their capabilities.

Example 1 (DeLoach, 2000)

description	*maturity level*				
	1 initial	*2 repeatable*	*3 defined*	*4 managed*	*5 optimizing*
capability	(*ad hoc*/chaotic) No institutionalized processes Reliance on competence of individual	(intuitive) Processes established and repeating Reliance on individuals reduced	(qualitative/quantitative) Policies, processes, and standards defined and uniformly applied across the organization	(quantitative) Risks measured and managed quantitatively and aggregated enterprise-wide Risk/Reward trade-offs considered	(continuous feedback) Emphasis on taking and exploiting risk Knowledge accumulated and shared

Example 2 (Hillson, 1997)

description	*maturity level*			
	1 naive	*2 novice*	*3 normalized*	*4 natural*
definition	No structured approaches for dealing with uncertainty Reactive crisis management Reliance on competence of individuals	Experimentation via nominated individuals and specific projects No effectively -implemented, organization-wide process	Generic risk policies and procedures fomalized and widespread	Proactive approach required to risk management in all aspects of the organization Common organization-wide understanding of activities, roles, and responsibilities for risk management Standard processes and tools tailored to specific applications Formal assignment of responsibility for risk management Organization-wide training

Figure 7.36: Comparing DeLoach and Hillson models, Source: (Chapman and Ward, 2003)

7.4.2 Risk Management process Maturity Model (RMMM)

The risk management process maturity is the extent to which a specific risk management process is explicitly defined, managed, measured, controlled, and effective. Maturity implies a potential for growth in capability and indicates both the richness of an organization's risk management process and the consistency with which it is applied in projects throughout the organization. The process is well-understood throughout a mature organization, usually through documentation and training, and the process is continually monitored and improved by its users.

The proposed framework describes an evolutionary path from ad hoc, chaotic processes to mature, disciplined risk management process. Without this framework, improvement programs may prove ineffective because the necessary foundation for supporting successive improvements has not been established.

The risk management process maturity framework emerges from an adaptation of the software process maturity model to the risk management context. The CMM is a very generalizable model that is useful for different context. In this context, it integrates the concepts of risk management process, risk management process capability, risk management performance, and risk management process maturity. As the CMM was designed to guide software organizations in selecting process improvement strategies by determining current process maturity and identifying the few most critical issues to software quality and process improvement, the Capability Maturity Model for Risk Management provides organizations with guidance on how to gain control of their processes to develop and maintain softwares and how to evolve them towards a culture of software engineering and excellence management. By focusing on a limited set of activities and working aggressively to achieve them, an organization can steadily improve its organization-wide software process to enable continuous and lasting gains in software process capability.

In figure 7.37 the five levels of the risk management process maturity are reported.

The maturity of an organization's Risk Management processes can be categorized into groups that range from those who have no formal process to organizations where the risk management is fully integrated into the all aspects of the organization. In order to reflect this, the Risk Management Maturity Model (RMMM) provides five levels of risk management maturity (Figure 1). Moreover several barriers can be found at each level of RMMM: the Organization has to face and overcome them to achieve the next level of risk maturity. Examples of the possible barriers are outlined below, together with some strategies suggested to overcome them.

Problem Solving
At the Initial Level, the organization does not typically provide a stable environment for risk management. There is no clear understanding of a formal risk management process, procedures and techniques, and even the language

RMMM Level	CMM level	RM Features	Enablers to the next level
1. **Problem Solving**	Initial/Ad hoc	Managing problems when they occur	Introduction of a methodology
2. **Mitigation**	Repeatable	The main risks are managed but in a not systematic way	Procedure definition and involvement of top management
3. **Prevention**	Defined	Systematic and documented risk management	Economic/Quantitative assessment of risks
4. **Anticipation**	Managed	Risk management based on an effective quantitative measures and indicators	Definition of effective metrics and Design of a Risk Database
5. **Opportunity**	Optimizing	Risk management is oriented to the business improvement	RM culture diffusion to all the company projects/processes

Figure 7.37: Risk Management Maturity Model

and terminology are unknown. There is no clear concept of the benefits that can be gained from a formal risk management, and the cost of implementing the process is not normally considered. The risk identification is not perceived as a valuable process and risk communication is completely absent during the project. So, when a crisis occurs, projects typically abandon the planned procedures and revert to ad hoc actions responding to the risen problems with no proactive thoughts.
Success in problem solving depends entirely on having an exceptional manager and a seasoned and effective team. Occasionally, capable and forceful managers can withstand the pressures to take shortcuts in the project; but when they leave the project, their stabilizing influence leaves with them. Even a strong planning process cannot overcome the instability created by the absence of sound risk management practices.
The organization's upper level management may be not receptive to anyone, internal or external, that is promoting risk management, since they are uninformed customers. Therefore, acknowledging that the organization's processes and projects are subject to uncertainty may be seen as an admission of weakness or lack of skills.
In this level companies ignore the risk management or, if they care, they use a very informal (chaotic) and subjective risk management approach.

Mitigation

In the Mitigation level the organization is aware, at some level, of the potential benefits of managing their project risks, there is no effectively implemented organization-wide process.
At this level, risk management is seen as an additional activity to be undertaken where necessary to minimize the cost of control and corrective actions. So any risk process used by various projects is unlikely to be used consistently or widely. The organization has a number of individuals (even only one person) able to effectively plan and apply the risk management procedures and techniques. The process capability can be summarized as disciplined because the risk management process start being defined, stable and can be repeated.
Some open gaps still remain:

- Lack of organizational-wide formal risk processes produces.

- Dependence on the skills of a few in-house staff could limit the overall effectiveness.
- Lack of support for those implementing the risk management.
- Limiting promotion of risk to the lone enthusiast can undermine the credibility of the risk process.
- Partial or inconsistent application of risk processes is unlikely to generate useful metrics that fully demonstrate the benefits of managing risk.
- There is therefore no auditable track record of what risk management can achieve.
- Poor use of risk assessment tools and risk information databases.

Companies in the Mitigation Level perform basic risk management activities somewhere in the project's or in the organization's implemented process. However, consistent planning and tracking of the performance is missing.

Prevention
At the Prevention Level, the standard process for risk management across the organization is documented and processes are integrated into a coherent whole, activities are well stable and repeatable. Policies for risk management and procedures to implement those policies are established. Planning and managing activities are based on experience with similar projects.

The objective is to institutionalize the risk management processes; an effective process can be characterized as practiced, documented, enforced, trained, measured, and able to improve.
An organization-wide training program is usually implemented to ensure that staff and managers have the knowledge and skills required to fulfill their assigned roles. A common organization-wide understanding of the activities, roles, and responsibilities exists.

Level 3, where the risk processes are internal to the organization, consistently and routinely applied to all (ore almost all) the projects, is probably sufficient for the majority of the (?) organizations. Open gaps are:

- The organization could fail in updating the risk management process with not taking account of changes in business needs.
- Lack of continued investments in the risk management process could result in reduced relevance or capability, as tools become obsolete, techniques become superseded and personnel skills are not maintained.

- Development of in-house expertise might result in risk management being seen as a specialist discipline that is undertaken by experts, with a consequent reduction in commitment and ownership by other people in the projects and the organization.

Companies in the Prevention Level, have implemented a formal risk management process into their routine business processes.

Anticipation
In the Anticipation Level, the organization sets quantitative goals for processes. Productivity and quality are measured among all the projects as part of an organizational measurement program. An organization-wide risk database is used to collect and analyze the data available from the projects. Processes are instrumented with well-defined and consistent measurements in order to achieve a quantitative assessment of risks.
The risk management process is well-defined and consistent measurements are available. These measurements establish the quantitative foundation to evaluate the project risk. The risk management process can be summarized as predictable because the process is measured and operates within quantitative-measurable limits, achieving to predict trends in process and product quality. When these limits are exceeded, actions are taken to correct the situation.
Companies in the Managed level set measurable process goals for each defined process and detailed measures are collected and analyzed. These data enable the quantitative understanding of the process and an improved ability in quantifying the risk. The organization has established a risk-aware culture that requires a proactive approach.

Opportunity
At the Optimizing Level, the entire organization is focused on the continuous process improvement. The organization has the means to identify the risk proactively, with the goal of preventing the occurrence of problems. Data are used to perform cost / benefit analyses and propose changes to the process. Organizations analyze risks to determine their causes, the processes are evaluated to prevent the known types of problems from recurring, and learned lessons are disseminated to other projects.
It is expected that to succeed in implementing a risk management process, a natural part of any organizational culture will require significant changes in determining how to apply the risk techniques throughout the business and proactively manage uncertainty (including both risks and opportunities) in order to maximize the benefits.
To achieve the process effectiveness and efficiency, companies at the Optimizing Level have established the quantitative, as well as the qualitative, goals based on the long-range business strategies and goals. Continuous process im-

provement towards the realization of these targets using timely, quantitative performance feedback has been established. Further enhancements are achieved by pilot testing of innovative ideas and the application of new technologies and methodologies.

7.4.3 Position of firms in the risk maturity model

The RMMM is a framework representing a path of improvements recommended for software organizations aiming to increase their risk management process capability. This approach is based on incremental and gradual actions which can be identified as key areas, enabling factors for the next maturity level. Each maturity level is decomposed into several key process areas indicating the risk management process, organization and implementation parameters on which an organization should focus to improve its risk management process; each area is then characterized by different dimensions representing key features.

In the following tabel (Figure 7.38) we codified the key process areas regarding the risk management maturity model and we detailed the key feature and the relevant characteristics of each level of the RMMM. Finally, we used the table in order to classify the analyzed companies, providing a brief description of their ERP introduction project according to the RMMM framework.

Here we report the description of the risk management process level for each case study.

<u>Case A: P&G</u>
The company assessed a quite informal risk management process during the project, identifying the main risks, performing a first no standard analysis of the main potential problems that achieved to plan several preventive ad hoc actions to face problems, such as an over dimensioned budget, an extra budget for emergencies, contractual penalties and communication plan to follow in case of unseen issues.
However, the corrective undertaken actions were mainly “emergency plans” previously set: all the plants were provided with these plans, and alternative procedures (ad hoc renewed) were fully documented. When the issue occurred, its communication immediately ran through all the plants and everybody knew exactly what they had to do. Risk communication occurred only to react to risen problems.
Managers had a basic knowledge of the risk management process and considered risks just during the project reviews, and in a not systematic way. The main people in charge of risk management were the project manager and his staff, who mainly operated through audits. Quantitative metrics for risks were

Key area	*Dimension*	*Problem Solving*	*Mitigation*	*Prevention*	*Anticipation*	*Opportunity*
Risk Management Process	*Context Analysis*	Ad hoc	Discussion	Documented	Documented and monitored	Documented, monitored and reviewed
	Identification	Not needed, it is a cost	Yes, for the main risks	Yes	Yes, all the potential ones	Yes, but also opportunities
	Analysis	If needed, Ad hoc	Ad hoc, no standard	Yes	Functional to quantification	Functional to ROI risk evaluation
	Evaluation	If needed, Ad hoc	No quantification	Quali/Quantitative	Quantitative	Quantitative/Value creation based
	Treatment	If needed, Ad hoc	Ad hoc	For the main risks	Structured and Documented	To follow opportunities
	Communication and Control	If needed, Ad hoc	Ah hoc	Internal to the project	Documented and continuous	Continuous feedbacks
Organization	*Policy*	No standard	Review discussion	Commitment on Risk management process	Commitment on metrics	On innovation and risk exploiting
	Culture	What you do not know do not matter	What you do not know can cause a damage	What you do not know damages you	You cannot manage what you do not measure	You do not know what you do not understand
	Communication	No risk communication	No vertical risk communication	Internal Project communication	Project team/customer	Project team/customer/ users/Supplier
	Commitment	Top management	Quality driven	Management	Overall Company	Diffused to customers and suppliers
	Resources	No	Minimized costs	Minimal Budget	Budgeted	Optimized Budget
	Training	No	Basic	Risk Management	Risk Quantification	Risk/Opportunity Treatment
Risk Management Process Implementation	*Participants*	Project Manager	Project Manager and Staff	Project team and Risk Project Manager	Project team and customer, more risk owners	Project team and customer, suppliers, more risk owners
	Procedures	Ad hoc	Informal	Documented	Standard	Continuously Updated
	Methods	Ad hoc	Audit	Risk taxonomy	Risk management	Metric based graphs
	Tools	Ad hoc	Report	Risk DB	Metrics	Automated
	Metrics	No	Defined	Stored in DB	Analyzed	Reported
	Report	Ad hoc	Main risks For managers	Main risks for managers and client	At milestone for main risks	Milestone, main risks for everybody

Figure 7.38: Key areas and features in RMMM

not defined and the most used risk tools were periodic project reports for the management.
In this light, regarding the application of Risk Management process to the ERP project, we can finally classify P&G in the Mitigation Level of the RMMM.

Case B: SCA
The company stated the risk analysis was run using the company's own risk management logic but they did not planned any preventive actions. Managers were considered very much experienced in this type of project, since the other implementations applied in different SCA's sites, so that other actions were not necessary.
We revealed that there was no clear concept of the benefits that can be gained from a formal risk management, so that problems were typically faced only when occurred with no standard procedures. The main detected problem in the implementation concerned the communication system; risk communications were obviously absent.
Managers had a very basic knowledge of the risk management process and it was not applied to the project, since a lack of top management commitment and sponsorship occurred. Quantitative metrics for risks were not defined and the most used risk tools were ad hoc reports for the management.
Since these evidences, as regard the application of Risk Management process to the ERP project, we can finally classify SCA in the Problem Solving Level of the RMMM.

Case C: P1
The company did not perform any risk management process and the project did not have any planned preventive actions. We revealed that there was no clear concept of the benefits that can be gained from a formal risk management. Problems were managed ad hoc when they occurred. The actions were mainly passive corrections related to human resource allocation, rescheduling of the project, extra budget allocation, etc.
Risk communication, as well as the knowledge of the risk management process, were absent; moreover a lack of top management commitment and sponsorship towards the risk management was found. Quantitative metrics for risks were not obviously defined and no risk tools used by managers.
Since these evidences, as regard the application of Risk Management process to the ERP project, we can finally classify P1 in the Problem Solving Level of the RMMM.

Case D: S. ANNA FERRARA HOSPITAL
The company used an own risk management logic but this was not formalized. To manage the project risks the managers integrated the own risk management logic with a consultant's risk management support view. They planned preventive actions during the ERP selection process but a formal risk manage-

ment process was not adopted. However, the in-depth analysis they carried on through the detailed selection process and the preliminary evaluation activities for the public auction substituted a preliminary risk analysis. These evaluation activities in fact involved both the software houses and the business integrators and concerned both technical and business issues.
The undertaken corrective actions were mainly related to delays due both to internal and external reasons. The top management and the consulting firm were actively involved in the monitoring and in the control of the activities. In addition, penalties were established during the selection process in order to guarantee the objectives.
Managers had a basic knowledge of the risk management process. The main people in charge of risk management were the project manager and his staff. Quantitative metrics were defined even if not expressly applied for risk management. The most used risk tools were periodic project reports for the management.
Since these evidences, as regard the application of Risk Management process to the ERP project, we can finally classify S. ANNA FERRARA HOSPITAL in the Mitigation Level (towards the Prevention Level) of the RMMM.

Case E: HR. TLC
The company ran a risk analysis following an own logic, supported by the consultants. Preventive actions to face problems, mainly based on contractual penalties, were planned.
The company assessed a risk management process during the assessment of the project, mainly from the consultant/business integrator perspective. This was addressed to define the budget and the resources. Identifying the main risk, they could also plan response actions, mainly extra budget for emergencies and contractual penalties.
Risk communication was integrated with the project management process. Managers were informed about the risk management logic and risks were considered only during the project reviews. The The main people in charge of risk management were the project manager and his staff, who mainly operated through audits. Quantitative metrics for risks were not defined and the most used risk tools were periodic project reports for the management.
In this light, as regard the application of Risk Management process to the ERP project, we can finally classify HR. TLC between the Problem Solving and (mainly) the Mitigation Level of the RMMM.

Basing on the project description provided, we classified the investigated companies according to the dimension in the different key areas. The achieved results led up to the definition of a RMM level for each company (Figure 7.39 and 7.40).

As figure 7.40 shows, the S. Anna Ferrara Hospital seems to be the most recep-

Key area	Dimension	Case A: *P&G*					Case B: *SCA*					Case C: *P1*					Case D: *HOSP.FE*					Case E: *HR. TLC*				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Risk Management Process	*Context Analysis*		x					x				x							x				x			
	Identification		x					x				x						x					x			
	Analysis		x				x					x							x				x			
	Evaluation	x					x					x					x					x				
	Treatment		x				x					x						x				x				
	Comm./Control		x				x					x						x					x			
Organization	*Policy*		x				x					x						x					x			
	Culture		x				x					x						x					x			
	Communication		x				x					x						x					x			
	Commitment			x			x					x						x					x			
	Resources		x				x					x						x					x			
	Training			x			x					x						x				x				
Risk Management Process Implementation	*Participants*		x				x					x						x					x			
	Procedures		x				x					x							x				x			
	Methods		x				x					x						x					x			
	Tools		x				x					x						x					x			
	Metrics	x					x					x						x				x				
	Report		x				x					x						x					x			

Figure 7.39: Case studies classification in the RMMM

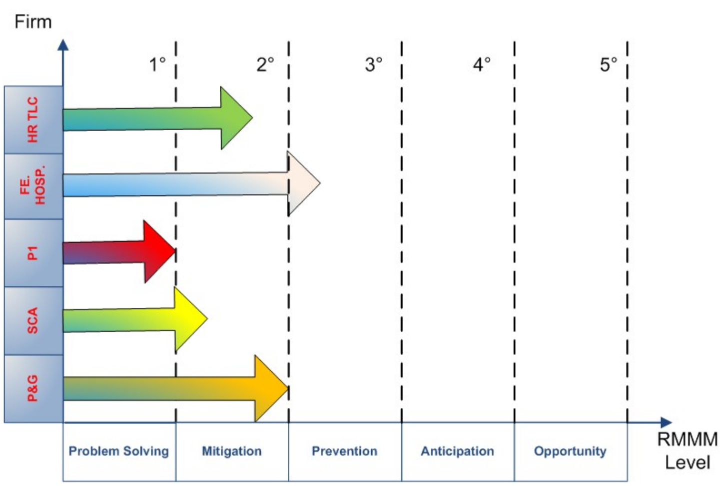


Figure 7.40: Companies classification graph in the RMMM

tive company in the use of a risk management approach. Even if they have not adopted a standard risk management process, the accurate selection logic of the Vendor and Business integration has followed the same principles. So that we can consider the process as a preliminary, not standard but well documented, risk analysis.
Some aspects such as the context analysis, the risk analysis and the documented procedure used in the selection phase, make it evident that the company, placed in the Mitigation Level, is moving on towards the next one. In taking this step forward, introducing a standard risk management methodology and a better knowledge of associated benefits is essential.
At the second level we also find P&G and HR TLC which adopted an informal risk management process. Both of them assessed an informal risk analysis before and during the implementation process. As well, some differences occur and both the lack of commitment training and the absence of a clear emergency plan make the P&G one step ahead the TLC company.
At the first level, instead, we find SCA and P1 which really adopted a problem solving approach in dealing with the ERP implementation. Even if a preliminary risk analysis was performed in SCA, this was neither relevant nor used for response action planning. A lack of risk management culture was clearly revealed in these contexts.

Linking these evidences with the project declared performance, it is evident that companies with a more advanced level in the RMMM are also the better performing both regarding the implementation process performance and the effectiveness of the ERP solution adopted. This rises a new research question, that is if a correlation exists between the RMMM level and the ERP project success.

The RMMM provides a conceptual structure for improving the management of risk in a disciplined and consistent way. A number of barriers to overcome to gain each level exists and normalizes the application of a risk management process across the organization. The RMM results identify the priority areas for improvement. Actions should be taken to increase the performance of the weakest attributes.

It should be noticed here that some organizations may choose to remain at an specific level, since it responds to their needs. There is nothing wrong with this approach. The transition to a higher level, in fact, should only be undertaken if the benefits are worth the cost and effort involved.

The methodology we have developed and proposed, expressly for the ERP project, provides managers with useful contributions for the development of the RMM level, both directly and indirectly.
Firstly, the methodology and tools presented in this work, contribute directly

in the Risk Management process key area, providing managers with tools and techniques used in the context analysis, risk identification, analysis and evaluation, suggesting a roadmap of possible risk response actions expressly defined for ERP project.
Then, this work participates to the diffusion of an overall risk management culture, indirectly contributing to the organization key areas. For this purpose, the methodology aims to obtain the management commitment to adopt risk management practices in ERP introduction process, motivating the resource allocation for risk identification, analysis, evaluation, treatment and control activities. At the same time we provided a base for training activities.

As for the risk management process implementation (key areas), the adoption of the methodology and tools, the definition of appropriate procedures and reports, as well the users involvement in the risk management process and the allocation of appropriate resources are held by the people inside the company. The top management commitment and the company culture are key factors in this sense.

7.5 Evidences from literature

Some interesting confirmations emerge in comparing our findings with those of other authors in literature. In fact, although, at the best of our knowledge, similar researches do not explicitly appear in literature, the results we found, particularly those related to the occurrence of specific risk factors, mainly confirm findings from other case studies examined by other authors.

For example, Scott and Vessey (2002) in their research about FoxMeyer and Dow Corning Companies stated that in ERP implementation projects it seemed vital to recognize the importance of organizational culture, foster an open culture and encourage open communications. From this point of view, SCA and P1 failures brought to severe consequences in the project implementation. Muscatello (2003) found that most of the time overrun on four analyzed projects was due to personnel and team problems and not related to technology. SCA and P1 teams experienced the same problems. The executive management and the divisional management should then focus on developing effective communication and team building skills in order to create a proper climate for these multi-layered project teams to thrive.

Moreover, it seems important to employ a strong project leader and a well-defined methodology to effectively manage the project, so that changes during the project realization are appropriately addressed. P&G "emergency plans" implemented for the longer cut-over are a perfect example (Scott and Vessey, 2002).

In their paper Motwany et Al. (2002) pointed out that, on the basis of the two run case studies, it could be inferred that projects that were autocratically mandate by the top management, without an organizational readiness and a proper change management (as also Sumner, 2000), was likely to lead to a troubled ERP implementation. This corresponds with our results in SCA and P1: the Italian project team felt ERP project as an imposition from the Corporate, it wasn't ready to deal with the corporate team (also because of language issues) and no change management was carried out.

Tchokoguè et al. analysis (2005) revealed that success was linked to the shared effort of all the stakeholders. A clear orientation of top management, an effective training and coaching structure, rigorous and detailed planning played key roles in the ERP implementation project. Moreover, the use of a prior version of SAP, a culture of change and a large number of dedicated players, facilitated the appropriation. P&G and S. ANNA HOSPITAL cases completely reflect these findings.

Finally Sumner (2000) highlighted the importance of redesigning business processes and following an enterprise-wide design supporting the integration of data across the organization. He stated "a unique challenge involved in ERP systems implementation is acquiring the necessary skills and building a project team with the appropriate balance of technical/business skills". Insufficient training and re-skilling of the IT workforce in new ERP technology, insufficient "internal" expertise, failure to mix internal and external expertise effectively and lack of "business analysts were all risks which could deeply impact on the final result". This aspect is in line with the low performance experienced by the companies which were low performing in the BPR-process dimension. Moreover the Team skill risk factor was also critical in the SCA and P1 projects.

7.6 Conclusion

Chapter 7 presented comparisons and discussions on the case studies according to a risk management point of view, and reported considerations about the introduction of the methodology in firms.
In the first part of the chapter, the projects were analyzed in order to provide a first verification of the conceptual validity, applicability, utility and usability of the model and methodology. Then the focus moved on the methodology introduction, authors classified the cases according to the Risk Management Maturity Model (RMMM) and showed how the proposed methodology could

enable the firm upgrade to a more advanced RMMM level.
In the light of the reported evidences, a new research question arises:

H1: Is there an existing correlation between the position of companies in the RMMM and the ERP project performance?

CHAPTER 8

Conclusions, Limits and Further Researches

In this last chapter, conclusions, limits and future directions of the research are reported.
After a brief summary of the main results, the chapter deals with the limits and the future developments of research in the field. In particular, after having discussed the limits, mainly due to the difficulty of risk quantification in that kind of project and to the retrospectives case studies, an action research is proposed in order to test the effectiveness of the methodology in a real case application. Other future developments concern the importance of a risk Database (DB), which could give the basis for a better quantification of risks and give relevance to the methodology efficiency for a practical application of the risk management process in real projects. As well, other research questions rise from this thesis, and in particular from the case observations, for example investigating on a possible correlation between the RMMM stage of firms and the performance obtained during ERP project.

In final remarks, some comments on the main contributions of the thesis are provided.

The main outlines of this chapter are:

- Conclusions;

- Limitations;
- Future researches:
  - Correlation between RMMM stages and project performance;
  - The risk DB;
  - Efficiency of the Risk Management process;
  - Methodology validation: Action research;
- Final remarks.

8.1 Conclusion

8.1.1 Introduction

In this work we have remarked the importance of the risk management for the ERP introduction projects through all the project life cycle and have suggested a risk management approach to manage this kind of projects. The thesis, in its attempt of identifying gaps and shortcomings in the ERP risk management area and developing an innovative risk management methodology customized for ERP projects, supporting managers in each phase of the risk management processes, contributes to both the academic research and the management practice. We have proposed and discussed new techniques and tools, while other existent ones have been adapted to the ERP project needs, to be used during the context analysis, risk identification, risk analysis, risk evaluation, risk treatment and control phases, in order to help managers both during the early project assessment stage and during the implementation process.

The addressed information provides managers and researchers with advices and suggestions along all the phases of the risk management process and customized on a typical ERP project.

In a more detailed way, valuable information belong to the following outcomes:

- a review of the state of the art about project risk management in ERP field;
- a more in-depth knowledge of risks in ERP introduction projects (risk factors identification, homogenization, contextualization and analysis are dealt in the previous stages of the work);

- proposals of tools and techniques (new and existent ones which have been customized for ERP project needs), to be used for an innovative and more effective management of the risk identification, assessment, treatment and control stages during these projects;
- evidences from retro-perspective tests on the field through the analysis of different relevant case studies in companies recently involved in ERP introduction projects.

8.1.2 Main results

To briefly sum up the main results, we report again the thesis architecture we showed in the introduction (Figure 8.1). Afterward we report and discuss the outcomes from each chapter.

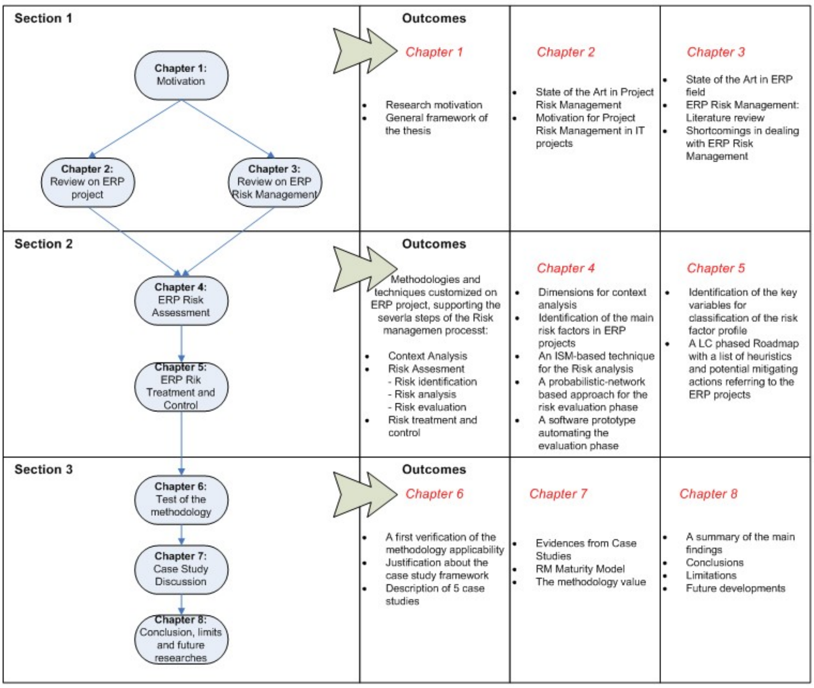


Figure 8.1: Thesis Outcomes

Chapter 2 and 3 from *Section 1* set the context of the research, matching the Project Risk management point of view together with the ERP literature, and open a new research area. Chapter 2 clarified the meaning of uncertainty, risk and risk management, setting definitions and terminology used in this field. It mainly focused on project risk management providing readers with the state of the art, and with an excursus of the several existent approaches. Then, the attention moved on the peculiarities of ERP introduction projects. Chapter 3, instead, focused on the ERP field, providing the rationale to this research. It set the background and the main definitions of the ERP systems illustrating the characteristics of the ERP introduction process. An extended literature review (130 peer-reviewed articles were collected and 75 selected for the analysis) was then presented in order to clarify which approach was used in ERP research field and identify areas needing of further deployment. The different research approaches were compared from a risk management point of view to highlight the key risk factors and their impact on the project. The review concluded with a list of the most critical risk factors prioritized by the frequency they appear in literature. Furthermore it evidenced that despite the great importance reserved to the factors linked to risk, project and change management areas, only a few articles explicitly dealt with them. This provided evidences of a lack of contributions explicitly dealing with risk management in ERP introduction projects. The few existent ones, both from academic and practitioner world, were deeply analyzed and shortcomings were discussed.

Section 2, in the aim of developing a suitable and effective model for ERP risk management, faced the shortcomings discussed in Chapter 3. Following a general risk management framework and in order to develop a specific risk management approach for ERP introduction projects, this section suggested innovative methodologies/techniques supporting the different risk management phases, and adapted the other (existent) ones to the ERP context.
Chapter 4, in particular, presented a proposal for the methodologies regarding the context analysis and the risk assessment phase. For each phase (context analysis, risk identification, risk analysis and risk evaluation) it both illustrated the objectives and the state of the art in the field, and actively proposed innovative techniques. The main contributions of the chapter are:

- The identification of the main dimensions (control-ability, detect-ability, project life cycle, responsibility and dependence) to be used by managers for a preliminary context analysis and during the risk analysis in ERP projects;
- The identification and classification of the main risk factors in ERP projects (19 Risk factors were identified, homogenized and analyzed by an extended literature review);
- The definition of the meaning of success in ERP projects. This leads also to the identification of the main failures and risk effects (10 effects were

isolated);

- The use of an ISM (Interpretive Structural Modelling)-based technique supporting the risk analysis phase, which enables a more structured analysis of interdependencies among risk factors and between risk factors and effects.

- The use of a probabilistic-network-based methodology together with a structured elicitation process for managing the risk evaluation phase (in risk quantification) in order to simultaneously take into account risk factor dependences, their probability of occurrence and their impacts on the project effects.

- The proposal for a software prototype implementing the previous reported techniques, which automates the evaluation phase.

Chapter 5 discussed a proposal for the Risk Treatment and Control phases. In the first part, a brief literature review of the Risk Treatment and Control processes and peculiarities around the ERP project case are reported. After that, an innovative methodological guide is presented in order to enable the selection of suitable and timely risk response strategies and control procedures. Suitable strategies are then explained in relation to the project life cycle, the risk factor profile and the impacts on the project. Literature evidences and heuristics derived from semi-structured interviews to practitioners were used to draw a roadmap of the possible actions managers might undertake in order to face each risk factor.

Section 3 provided evidences on the applicability, utility and usability of the proposed methodology in a real context, opening the way to potential model refinements. It proposed an empirical verification by retrospective case studies. In Chapter 6, the framework for the case study verification was illustrated. A number of case studies from firms, in different sectors, recently involved in the introduction project of ERP systems was selected and analyzed by in-depth interviews, ex-post evaluations of project performance and a simulation of use of the methodology. A description, according to a risk management point of view, was presented for each ERP introduction project.
Finally, Chapter 7 presented comparison and discussion of the case studies mentioned above, and reported considerations about the introduction of the methodology in firms, classifying the cases according to the Risk Management Maturity Model (RMMM) and showing how the proposed methodology could enable the firm upgrade to a more advanced RMMM level.

In the end, on the basis of the feedbacks obtained from the interviewed managers and of the comparative analysis of the case studies it is possible to draw some observations about the proposed theoretical model and its applicability, utility and usability in real projects. Firstly, we can infer that the risk factors and the risk effects, identified through the literature review, found verification in all the projects, as the managers we interviewed agreed with the model we proposed. This encourage us in sustaining the proposed theoretical model (as concerning the identification of risk factors and effects), since it seems valid and well grounded with real situations (this also support the model applicability).

As for the utility and usability of the methodology and the supporting risk assessment software, the tool was considered very easy to use (usability) by all the managers, even if some of them (P&G) found the implementation too time consuming. They agreed on the tool utility in the first project assessment phase (utility and applicability) in order to discuss over the risk factors and the risk effects but not as to enable a better project management. They believed this tool could allow a better understanding of the phenomena and factors of a project so that managers could adequately consider the risk dimensions and reflect on them. The software could finally be considered as a decision-making instrument, which could be used in the project planning phase.

Interesting results were also found in the risk management techniques implemented by the companies. The different approaches and their different positions in the Risk Management Maturity Model rose reflections on the existence of a correlation between the RM maturity and the project performance.

Concluding, the reported evidences make us quite optimistic on the future developments of the proposed methodology.

8.2 Limitations

Some observations can also be moved on the potential limitations concerning this research as well. We present these shortcomings in the order they appear in the thesis.

First of all, a first observation concerns the semi-quantitative approach used in risk quantification. The lack of quantitative data does not allow estimating the frequencies of the events, their correlation and impacts on the project; this introduces a bias mainly due to the subjective judgment of the experts. In Chapter 2 we already discussed on the uniqueness of risk management in ERP projects, addressing in particular the quantification problem. In similar software projects, in fact, it is very difficult in practice to estimate the probability of occurrence and the impacts of many risk factors. While it may be

possible to generate metrics of low-level processes that enable the probabilistic quantification of some important risk factors, there is likely to be many other critical "soft" project risk factors that cannot be probabilistically assessed, i.e. risk factors such as "top management involvement" or "inadequate managerial conduct". Both the risk analysis and the risk evaluation phases (included in the risk quantification phase) clash with the difficulty of the probabilistic assessment of the risk factors. That is why they are assessed by semi-quantitative scale using evaluations from managers and experts of the field. The lack of a quantitative base of data, as well as the nature of some risk factors, makes it difficult to choose a different strategy for risk analysis and evaluation. As we already know, semi-quantitative analysis may not properly differentiate among risks, particularly when either consequences or likelihood are extreme.
These issues reflect an unresolved question about whether the management of risk is a science, an art, or some combination of both (Bernstein, 1996) and if the best decisions are based on quantification and numbers, determined by the patterns of the past, or they are better based on more subjective assessments of the uncertain future. Our effort in this purpose was in proposing strategies, structured methodologies and tools in order to minimize the bias due to a subjective assessment. If this was not possible as regarding the data input process, since quantitative and historical data are not jet available in this field; we tried anyway to contribute in another aspect of the assessment process i.e. the methodological one. This work, in fact, introduces a more systematic and structured assessment process, supporting all the phases of the risk assessment.

Another important aspect concerns the verification of the methodology applicability. A multiple case study approach was used in order to provide evidences of the methodology applicability, utility and usability. A retrospective description was assessed for each case study in order to investigate on the expected results, the occurred performance, the revealed risk factors and the approach to risk management in the project. After that a risk assessment simulation was completed together with managers and key users reproducing a new start of the ERP project. The retrospective nature of the case studies and of the simulation, which was constrained from the limited time and resources, obviously carries out some limitations and induces a bias into the observations.

Finally, another limitation is due to the sample size and to the profiles of companies where the ERP was implemented. The five analyzed case studies, in fact, are not a very large sample and despite they confirm the methodology applicability and highlight the positive perception of the methodology utility and usability in quite all the cases, they do not allow any kind of generalization of the results.
Moreover four out of five cases represent companies which did not assessed any kind of active selection process, since they were forced to the implementation by contextual factors and the software, as well the Vendors and Business Inte-

grators, was already chosen. This issue could relevantly affect the results and lead to the conclusion that our verification findings may not be fully observable in or applicable to other companies.

8.3 Future researches

The future directions of this work firstly come out from its current limitations (as an improvement to what is currently proposed) and from new research questions risen by the analysis of the case studies.

First of all, an important aspect concerns the validation of the methodology effectiveness. In the present thesis, a first empirical verification of the methodology conceptual applicability is assessed, as shown in figure 8.2. Obviously the extension of the sample is a first and immediate dimension of the research verification improvement. Mainly due to the short time available, empirical tests on the real effectiveness of the methodology and its impact on the project performance were not carried on. So this is a prior direction to follow for the future works. An Action Research could be a valid way to validate the methodology in a real project.

Action Research fits well with the final aim of the research which targets to provide a really effective and practical methodology for Risk Management in this specific kind (ERP) of projects. On the contrary of positivist science, it focuses on knowledge in action. Accordingly, the knowledge gained from positivist science is universal while the one gained through Action Research is particular, situational and out of praxis. The idea here, is to apply the methodology in a real ERP introduction process from the previous stages through all the project life cycle monitoring the project performance. This could enable to finally validate the model applicability, and to collect relevant feedback on the field about the utility and usability. This type of research will also allow us to collect primary information about the effectiveness of the different risk management phases (risk identification and, more in general, risk assessment, the effectiveness of the planned response actions and so on). More iterations will be needed to demonstrate a correlation between this two issues.
Then, other contributions to research will broaden the number of analyzed case studies. This will allow us to compare other firms operating in the same or, as well, in different markets, to examine their risk management approach, and finally validate the proposed methodology in order to draw the overall conclusions about its effectiveness.
Together with the Action Research, the problem of the methodology efficiency also emerges. The validation of the methodology effectiveness is not the only

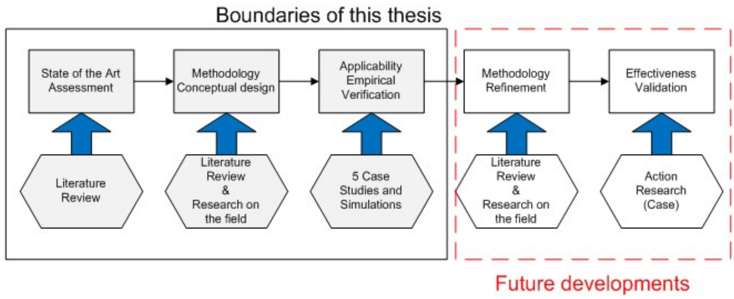


Figure 8.2: Future developments

question to investigate, the efficiency in project risk management is also essential in order to motivate and encourage the adoption of the methodology. All the risk management processes consume valuable resources and can themselves constitute a risk to the project that must be effectively managed. The level of investment in risk management within projects must be challenged and justified on the level of expected benefits to the overall project. We know, in fact, that the transition to a more advanced level in RMMM, as well as the adoption of any methodology or managerial practices is undertaken only if the benefits are worth the involved costs and efforts. Some gaps still exist in this topic, so that the notion of risk efficiency can be a central theme for further developments.

Another important aspect for future improvements concerns the availability of data for a better risk quantification. The proposed methodology provides managers and researchers with innovative techniques supporting the different stages of the risk management process; these techniques are valuable in the effort to structure, systematize and automate the risk quantification process in order to simultaneously take into account all the selected inputs. However, as also Ward and Chapman (2003) confirm, more emphasis should be addressed on recording information in a suitable format for the estimations and in order to guide subsequent refinement of analysis and understand the root uncertainties.
Further contributions assisting this topic might include for example a risk Database (DB). The risk management database would help in documenting and communicating risk information and support the estimation of probabilities, correlation and other aspects of the risk management process. The Database could enable the Risk Management Methodology to be effectively utilized within an organization which operates and is involved in projects spread across different sites and countries. The Risk Register Database System can be considered as a strategic part of the Risk Management Methodology since it allows the information to be utilized to give a static picture of the project at a particular point in time supporting the estimations of frequencies of the events and the entity of the

impacts. It provides a means of tracking the riskiness of the project as well as the post audit trail to determine how effective the identification and the active management of the risks have been. The system also enables risks in a project to be easily added, updated and modified in a dynamic way.
In order to achieve the storage of project risk data, new problems concerning the relevance of data, their structures and available sources, rise. A set of more quantitative indicators for risk factors (or proxy variables) should be defined especially for the soft risk factors which are more difficult to measure. Another attempt is related to the standardization of the data structures, as well the information sharing. This kind of projects is not frequently assessed by companies, so a third subject, such as a consulting firm, with multiple contacts and experiences in the field, could probably facilitate and accelerate the process.

Finally, as for the new research questions, as usual, case study research leads researchers to the observation of behaviours and phenomena and induces to the formulation of new questions and hypotheses. Among all the observations occurred in the case study analysis of this work, we would like to remark the following one:

H1: Is there any existing correlation between the position of companies in the RMMM and the ERP project performance?

This observation is aligned with the final aims of this research, i.e. providing a risk management methodology to improve the ERP introduction success rate. So it represents a natural development of our research topic.

8.4 Final remarks

Closing the loop of this thesis, we report and comment the shortcomings and the main gaps in the past ERP Risk Management approaches, as discussed in Chapter 3, in the light of the achieved results.

1. *Unclear motivation for the RMP.*
   An extended literature review (Chapter 2 and 3) covering both the Project Risk Management and the ERP system topic was provided. It clarifies the state of the art in these fields providing evidences on the gaps in literature and motivating the need of an ERP risk management methodology.

2. *Attention to the Project Life Cycle.*
   Project Life Cycle dimension is central in the proposed methodology both

in the assessment and in the risk treatment and control phase, where specific response actions are identified and reported according to the ERP PLC.

3. *Wrong or superficial risk analysis.*
   A panel of useful attributes for studying the identified risk factors was proposed in order to enable a more objective and detailed risk analysis. It is functional both to the evaluation and to the treatment phase since it provides a classification structure for sources of uncertainty, associated risk and responses, and it assesses a pre-analysis of risk factor profiles and enables a more accurate selection of suitable response actions.

4. *Forgetting interdependence among factors.*
   An ISM-based technique for the analysis of interdependencies among the risk factors and between the risk factors and the effects was introduced in the risk analysis phase to enable a more systematic analysis of their causal links and with potential effects.

5. *Lack of contractual arrangements for managing uncertainty.*
   Specific contract arrangements and penalties were suggested as part of a wider risk transference strategy.

6. *Evaluating dependencies.*
   The evaluation, in risk quantification phase, keeps into account the ISM output (risk analysis) and combines the different uncertainties capturing crucial dependences in order to provide a more objective quantification of the risk of each risk factor, to develop effective responses and to demonstrate the robustness of choices.

7. *Absence of Iteration.*
   The process iteration is vital in any risk management phase. Our suggestions include structured and iterative procedure for the evaluation of the risk management effectiveness in the Risk Control phase. Moreover, the software automation of the risk quantification phase widely facilitates this issue.

8. *Efficiency.*
   An estimate phase that is costly but not cost-effective, resulting in biased estimates that are usually highly conditional on scope and other assumptions that are lost sight of. The efficiency of the whole methodology, as we said, still remains an open issue.

As regard managerial implications, we remark suggestions and evidences from this research for a right approach to Risk Management in ERP introduction project. As managers put in evidence during the interviews, the main benefits gained from using Project Risk Management techniques are not only linked to a better project management and resource allocation but also the contribution in developing a risk oriented culture in the organization. Examples of the potential benefits are:

- an increased understanding of the project, which in turn leads to the formulation of more realistic plans;
- an increased understanding of the risks in a project and their possible impact, which can lead choose the best available risk response strategy (both in the choice of a project partner, an assurance, a more suitable type of contract or any other king of managerial action):
- more efficient and effective management of the risks.

Moreover, the methodology we have developed and proposed, expressly for the ERP project, provides managers with useful contributions for the development of the RMM level, both directly and indirectly. Firstly, the methodology and tools presented in this work, contribute directly in the Risk Management process key area, providing managers with tools and techniques used in the context analysis, risk identification, analysis and evaluation, suggesting a roadmap of possible risk response actions expressly defined for ERP project.
Then, this work participates to the diffusion of an overall risk management culture, indirectly contributing to the organization key areas. For this purpose, the methodology aims to obtain the management commitment to adopt risk management practices in ERP introduction process, motivating the resource allocation for risk identification, analysis, evaluation, treatment and control activities. At the same time we provided a base for training activities.

Finally, as for the risk management process implementation (key areas), the adoption of the methodology and tools, the definition of appropriate procedures and reports, as well the users involvement in the risk management process and the allocation of appropriate resources are held by the people inside the company. The top management commitment and the company culture are key factors in this sense.

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Code of the risk evaluation software

Appendix B: software risk evaluation

Program version:
o?Python (2.5.2 o succ.) - www.python.org
o?GraphViz (2.16.1 o succ.) - www.graphviz.org

The program is commented in italian language

Supporting modules: package RiskMgm (directory .):

__init__.py

```
from risk import *
from effect import *
from funlib import *
```

effect.py

```
oggetto Effetto
class Effect(object):
def __init__(self, name=“”, next=[], weight=1):
self.name=name
self.next=next
self.weight=weight
```

```
def __str__(self):
return self.name
def __repr__(self):
return self.name
def setName(self, name):
self.name=name
def setWeight(self, W):
self.weight=W
```

funlib.py

```
funzioni di supporto
trova tutti i cammini dal nodo 'start' al nodo 'end'
http://www.python.org/doc/essays/graphs.html
def FindPaths(graph, start, end, path=[]):
path=path+[start]
if start==end:
return [path]
if not graph.has_key(start):
return []
paths=[]
for node in graph[start]:
if node not in path:
newpaths=FindPaths(graph, node, end, path)
for newpath in newpaths:
paths.append(newpath)
return paths
verifica che un grafo sia un DAG
algoritmo e implementazione:
http://www2.toki.or.id/book/AlgDesignManual/BOOK/BOOK2/NODE70.HTM
https://networkx.lanl.gov/
def isDAG(graph):
if TopologicalSort(graph) is None:
return False
else:
return True
def TopologicalSort(graph):
def _dfs(graph, seen, explored, v):
seen[v]=1
for w in graph[v]:
if w not in seen:
if not _dfs(graph, seen, explored, w):
return
elif w in seen and w not in explored:
```

```
return False
explored.insert(0,v)
return v
seen=
explored=[]
for v in graph.iterkeys():
if v not in explored:
if not _dfs(graph, seen, explored, v):
return
return explored
trova il ciclo all'interno di un grafo se lo stesso non è un DAG
def FindCycle(graph):
def _dfs(graph, seen, explored, v):
seen[v]=1
for w in graph[v]:
if w not in seen:
if not _dfs(graph, seen, explored, w):
cycle.insert(0,w)
return
elif w in seen and w not in explored:
return False
explored.insert(0,v)
return v
seen=
explored=[]
cycle=[]
for v in graph.iterkeys():
if v not in explored:
if not _dfs(graph, seen, explored, v):
return cycle
return explored
```

risk.py

```
oggetto Fattore di Rischio
class Risk(object):
def __init__(self, name="", next=[], PCond=, PR=1):
self.name=name
self.next=next
self.PCond=PCond
self.PR=PR
def __str__(self):
return self.name
def __repr__(self):
```

```
return self.name
def addNext(self, R, PC):
self.next.append(R)
self.PCond[R]=PC
def showNext(self):
for R in self.next:
print R
def showPCond(self):
for R, PC in self.PCond.iteritems():
print str(R)+" : "+str(PC)
def setName(self, name):
self.name=name
def setPR(self, PR):
self.PR=PR
```

Programma main (directory .:

main.py

```
from RiskMgm import *
import string
import sys
print
print "ERP intro project — Risk assessment framework"
print
print "Lettura dati di input ... ",
RRf=open("input.txt","r")
RR=[]
RInput=RRf.readlines()
RRf.close()
for i in RInput:
if i[0]!='':
i=i.replace("˚","")
i=i.replace("","")
RR.append(i)
del RRf
del RInput
for i in RR:
if len(RR)!=len(i.replace(" ","")):
print "-¿ Errore nel file RR.txt"
print
sys.exit()
del i
```

```
REf=open("input.txt","r")
RE=[]
EInput=REf.readlines()
REf.close()
for i in EInput:
if i[0]!='':
i=i.replace("˚","")
i=i.replace("","")
RE.append(i)
del REf
del EInput
if len(RE)!=len(RR):
print "-¿ Errore nel file RE.txt"
print
sys.exit()
for i in RE:
if len(RE[0].replace(" ",""))!=len(i.replace(" ","")):
print "-¿ Errore nel file RE.txt"
print
sys.exit()
del i
numR=len(RR)
numE=len(RE[0].replace(" ",""))
PRf=open("input.txt","r")
PR=[]
PRInput=PRf.readlines()
PRf.close()
for i in PRInput:
if i[0]!='':
i=i.replace("˚","")
i=i.replace("","")
PR.append(i)
del PRf
del PRInput
if len(PR)!=numR:
print "-¿ Errore nel file PR.txt"
print
sys.exit()
del i
WEf=open("input.txt","r")
WE=[]
WEInput=WEf.readlines()
WEf.close()
```

```
for i in WEInput:
if i[0]!='':
i=i.replace("̊","")
i=i.replace("","")
WE.append(i)
del WEf
del WEInput
if len(WE)!=numE:
print "-¿ Errore nel file WE.txt"
print
sys.exit()
del i
PCf=open("input.txt","r")
PC=[]
PCInput=PCf.readlines()
PCf.close()
for i in PCInput:
if i[0]!='':
i=i.replace("̊","")
i=i.replace("","")
PC.append(i)
del PCf
del PCInput
del i
print "OK"
Color=[]
j=0
for i in range(len(PC)):
Color.insert(0,"grey"+str(j))
j=j+20
del i
del j
R=[]
for i in range(numR):
R.append(Risk())
del i
E=[]
for i in range(numE):
E.append(Effect())
E[i].name='E'+str(i+1)
E[i].next=[]
E[i].weight=int(WE[i])
del i
```

```
for i in range(numR):
R[i].name='R'+str(i+1)
R[i].PR=float(PR[i])
R[i].next=[]
R[i].PCond=
p=0
for j in RR[i].replace(" ",""):
if int(j)!=0:
R[i].addNext(R[p],float(PC[int(j)]))
p=p+1
p=0
for j in RE[i].replace(" ",""):
if int(j)!=0:
R[i].addNext(E[p],float(PC[int(j)]))
p=p+1
del i
del j
del p
print "Creazione grafo ... ",
graph=
for i in range(numR):
graph[R[i]]=R[i].next
for i in range(numE):
graph[E[i]]=E[i].next
del i
print "OK"
print "Creazione grafo per GraphViz ... ",
j=0
for i in PC:
PC[j]=float(i)
j=j+1
del j
del i
GVf=open("output.gpv","w")
GVOutput=GVf.write("digraph Risk ")
for i in R:
for j in i.next:
c="[color="+Color[PC.index(i.PCond[j])]+"];"
GVOutput=GVf.write(c)
s=""+str(i)+" -¿ "+str(j)+";"
GVOutput=GVf.write(s)
GVf.write("")
GVf.close()
```

```
del GVOutput
del GVf
del c
del s
del PC
del Color
del i
del j
print “OK”
print “Controllo grafo - DAG ... ”,
if isDAG(graph)==False:
print “Errore”
print “-¿ La matrice di incidenza RxR non rappresenta un DAG”
print “ -¿ Ciclo : ”, FindCycle(graph)
print
sys.exit()
print “OK”
print “Calcolo percorsi da Ri a Ej ... ”,
paths=
for i in range(numR):
for j in range(numE):
paths[R[i],E[j]]=FindPaths(graph,R[i],E[j])
del i
del j
print “OK”
z=0
for i in paths.values():
z=z+len(i)
print “ Numero di percorsi totali : ”, z
print “Calcolo probabilita’ percorsi ... ”,
PC=
for i in range(numR):
for j in range(numE):
if paths[R[i],E[j]]!=[]:
pp=0
for k in paths[R[i],E[j]]:
p=1
for a in range(1,len(k)):
p=p*k[a-1].PCond[k[a]]
pp=pp+p
PC[E[j],R[i]]=pp
if paths[R[i],E[j]]==[]:
PC[E[j],R[i]]=0
del i
```

```
del j
del k
del p
del a
del z
del pp
print "OK"
print "Calcolo indici di rischio ... ",
PF=
for i in range(numR):
for j in range(numE):
PF[E[j],R[i]]=R[i].PR*PC[E[j],R[i]]*E[j].weight
del i
del j
print "OK"
Rank=
for i in range(numR):
Rank[R[i]]=0
for j in range(numE):
Rank[R[i]]=Rank[R[i]]+PF[E[j],R[i]]
del i
del j
Ranking=sorted(Rank.iteritems(), key=lambda (k,v): (v,k), reverse=True)
print
print "Ranking dei fattori di rischio :"
print
print "Ri*E"
print "—-͡-"
for i in Ranking:
for j in i:
print j, ""͡,
print
del i
del j
print "—-͡-"
print
```

EXE For Microsoft Windows (directory .:
start.bat

```
@pause
@
@
```

```
@

@
@echo Creazione immagine grafo ...
@%PathToGraphviz%exe -Tpng output.gpv -o output.png
@del output.gpv
@
@echo.
@pause
```

Survey Questionnaire

In the next pages the last version of the questionnaire is reported.

UNIVERSITÀ DI PISA

ERP Implementation Survey

Date:

Company:

Supervisor:

Introduction

Thank you for your participation to our survey.

The survey consists on three sections. Our test is meant to last three hours circa.

The object of this survey is to obtain information on your experience about the ERP implementation in order to validate a Risk Assessment tool applicable to this kind of projects. I therefore ask you to kindly give me any kind of information that you think might be useful and to ask me for any clarification if you find that questions are unclear.

At the end of the survey I will show you the results obtained with our tool and I will ask you to express comments on them in order to let us prove its validity.

PART 1

Section about the interviewed person.

1. **Name of the interviewed people**

2. **Title, role (cio, vicepresident)**

3. **Since when have you had this role in the firm?**

4. **Since when have you worked in this firm?**

5. **Had you already had any experiences in IT projects?**

6. **How would you describe your involvement in the ERP implementation?**

   - ☐ You were an executive sponsor of the project
   - ☐ You were the project leader
   - ☐ You were a project team member
   - ☐ You supported the project as an expert
   - ☐ You were partially involved
   - ☐ You weren’t directly involved

Section about the firm

1. **Name of the firm**

2. **Market field**

3. **Total number of the branch the ERP was implemented in**

4. **Total number of branches, including the one which are abroad (indicatin their locations)**

5. **Implemented languages**

6. **Branch turnover**

7. **Organizational type of the firm (divisional structure, matrix structure, pure project structure in which the project manager has the complete authority on the project and on the resources…)**

8. **Decisional system of the firm (centralized, decentralized at corporate level but centralized at decisional level, decentralized at corporate level and divisional where some decision are taken at the low operative levels and some other are taken at the corporate and divisional level..)**

9. Production type

- ☐ Produce to forecast/deliver from stock
- ☐ Configure/customise to order
- ☐ Assemble to order
- ☐ Engineer to order
- ☐ Produce to customer order
- ☐ Design to order
- ☐ Other

10. How would you describe the production system of the firm (referring to the most important production line)?

- ☐ Project
- ☐ Job Shop
- ☐ Batch
- ☐ Line
- ☐ Continous

11. How would you describe the production mix of the firm (referring to the most important production line)?

- ☐ High volumes/ high mix
- ☐ Low volumes/ high mix
- ☐ High volumes/ low mix
- ☐ Low volumes/ low mix

Section about motivations

1. **Motivation which led to choose to implement an ERP system**

- ☐ To substitute the old Legacy System
- ☐ Increase efficiency (e.g. To reduce costs, to increase transactions and processes speed..)
- ☐ To have the use of better management tools (e.g. To improve the decision-making process, to improve the planning ability, to obtain better information, to have a fast access to information..)
- ☐ To increase customers satisfaction
- ☐ To face a change in the needs/processes (e.g. A reorganization, a new strategic vision..)
- ☐ To face a firm structure change (e.g. mergers, acquisitions..)
- ☐ To face millennium bug problem
- ☐ To face Euro introduction
- ☐ Forced by parent company
- ☐ To improve databases integrations and security
- ☐ To reduce the number of used systems and interfaces, in order to reduce complexity and improve system management and maintainability
- ☐ To improve the external integration
- ☐ Other reasons (to specify)

PART 2

Risk Factors section

- *Selection*

1. **Could you please indicate the activities you implemented in the various phases of the project life cycle?**

2. **Did you implement a structured process to select the ERP package and the vendor?**

    - How did you choose it (at the same time VS one after the other)?
    - Which variables did you use to choose?
    - Which technique did you use to choose (experienced-based choice VS structured techniques e.g. AHP)?

3. **Did you implement a structured process to choose the system integrator?**

    - Which variables did you use to choose?
    - Which technique did you use to choose (experienced-based choice VS structured techniques e.g. AHP)?

4. **Who was involved in the selection process?**

☐ Top Management	☐ ICT
☐ Managers	☐ Key Users
☐ Consultants	☐ Other

- *Project team skills*

5. Could you give me any documents related to the project team organization?

6. How were the project team structured? (process/modules/functions, type of interface with the external enviroment…)

7. Which function did the team member belong to?

- ☐ IT
- ☐ Logistics
- ☐ Marketing
- ☐ Finance
- ☐ Purchases
- ☐ Design
- ☐ Production
- ☐ Selling
- ☐ External staff (to indicate)
- ☐ R&S
- ☐ Human resources
- ☐ Other

8. Did you implement a structured process to detect the project team training needs?

9. If you did, how did you fill up the knowledge gap?

- ☐ No gap detected
- ☐ No action implemented
- ☐ External education
- ☐ Internal education
- ☐ External staff hired
- ☐ Outsourcing of the educational course
- ☐ Other

10. Did the team have any complex IT projects management competence (for complex projects I mean those projects which have impacts over the organization)?

- *Top management involvement*

11. What kind of responsibilities did the top management have?

- ☐ Directly involved in checking phases
- ☐ Involved in review and approval phases

- ☐ Involved in the decision-making activities when indicators exceeded targets
- ☐ Complete delegation to the team
- ☐ Other

12. How did the top management interact with the project team?

- ☐ Mails
- ☐ Meetings
- ☐ Conferences
- ☐ Reports
- ☐ Other

13. How frequently did the top management interact with the project team?

14. Was there a project champion?

- Which function did he/she belong to?
- Which were his/her responsibilities?

- *Communication system*

15. Referring to the life cycle scheme, could you please indicate for each project phase the internal communication means used? (mail, report, meetings…)

16. Referring to the life cycle scheme, could you please indicate for each project phase the subjects (both internal and external) who interact with each other in each project phase?

17. Referring to the life cycle scheme, could you please indicate for each project phase the type of information mainly exchanged (project data, ERP functioning modalities, ERP benefits…)

- *Key users involvement*

18. In which phase of the life cycle project were the key users involved?

19. Which function did the key users belong to?

- ☐ IT
- ☐ Logistics
- ☐ Marketing
- ☐ Finance
- ☐ Purchases
- ☐ Design
- ☐ Production
- ☐ Selling
- ☐ External staff (to specify)
- ☐ R&S
- ☐ Human resources
- ☐ Other

20. Did the key users spread the acquired knowledge?

- ☐ They didn't spread the acquired knowledge
- ☐ They directly trained the staff
- ☐ They used informal diffusions methods
- ☐ other

- *Training*

21. Which type of training was carried out?

- ☐ E-learning
- ☐ On site courses held by the system integrator
- ☐ On site courses held by the vendor
- ☐ Out of the offices courses
- ☐ Other

22. Was implemented a structured process do identify the key users' educational needs?

- ☐ Yes
- ☐ No
- ☐ It was held by the partner who was responsible for the training process
- ☐ Other

23. **Did you evaluate and verify the key users' acquired skills at the end of the training process?**

24. **Was it necessary further assistance to use the ERP system after the training? Which kind of assistance did you need? (remote help desk, user manuals…)**

25. **Did you respect the planned duration of the key users training process?**

- ☐ Yes we did
- ☐ No, the training process lasted longer than planned because….
- ☐ No, the training process lasted less than planned because….

26. **Did you budget the training cost?**

- *Architecture*

27. **Which ERP modules did you implement?**

- ☐ Accounting
- ☐ Management control
- ☐ Human resources management
- ☐ Warehouse management
- ☐ Production management
- ☐ Selling management
- ☐ Distribution management
- ☐ Plant maintenance management

Oracle

- ☐ Oracle Business Suite
- ☐ Oracle CRM
- ☐ Oracle Financials
- ☐ Oracle HRMS
- ☐ Oracle Logistics
- ☐ Oracle Mobile Supply chain Applications
- ☐ Oracle Order Management
- ☐ Oracle Transportation Management
- ☐ Oracle Warehouse Management Systems

Sap

- ☐ BC Basic component
- ☐ FI Financial

- ☐ CO Controlling
- ☐ MM Material Management
- ☐ SD Sales and Distribution
- ☐ PP Production and Planning
- ☐ PS Project System
- ☐ PM Plant Management
- ☐ HR Human Resources

28. Which ERP modules did you implement at the same time?

- ☐ Accounting
- ☐ Management control
- ☐ Human resources management
- ☐ Warehouse management
- ☐ Production management
- ☐ Selling management
- ☐ Distribution management
- ☐ Plant maintenance management

Oracle

- ☐ Oracle Business Suite
- ☐ Oracle CRM
- ☐ Oracle Financials
- ☐ Oracle HRMS
- ☐ Oracle Logistics
- ☐ Oracle Mobile Supply chain Applications
- ☐ Oracle Order Management
- ☐ Oracle Transportation Management
- ☐ Oracle Warehouse Management Systems

Sap

- ☐ BC Basic component
- ☐ FI Financial
- ☐ CO Controlling
- ☐ MM Material Management
- ☐ SD Sales and Distribution
- ☐ PP Production and Planning
- ☐ PS Project System
- ☐ PM Plant Management
- ☐ HR Human Resources

29. Did you use a one-site or a multi-site structure?

30. Which was the system customization percentage? Why did you have the necessity of the customization?

31. Did you have to integrate the ERP system with other systems?

- ☐ SCM

- ☐ CRM
- ☐ BI
- ☐ Legacy system for areas not covered by the ERP
- ☐ Multivendor solutions
- ☐ Other

32. Could you please indicate the number of the ERP system users?

33. Could you please indicate the number of the ERP system servers?

34. Could you please indicate the number of ERP system interfaces?

35. Could you please tell me if the ERP system is a client-server type?

36. Could you please tell me if you just one database or if there is more than one?

- BPR

37. Did you run a preventive analysis of the processes in order to prioritize the areas to work on after the ERP system implementation?

38. In which phase of the project life cycle did you implement the BPR?

39. How many people were involved in the BPR?

40. Which percentage of the total project time was dedicated to the BPR?

41. Which percentage of the budget was dedicated to the BPR?

42. Which functions did the BPR team members belong to?

- ☐ IT
- ☐ Logistics
- ☐ Marketing
- ☐ Finance

- ☐ Purchasing
- ☐ Design
- ☐ Production
- ☐ Selling
- ☐ External staff (to specify)
- ☐ R&S
- ☐ Human resources
- ☐ Other

43. Did you use any tool to run the gap analysis?

- Managerial Conduct

44. Did you have to clarify gain the objectives during the project implementation?

45. Which was the managerial policy you adopted?

46. Which was the key users and the team members involvement?

47. Your commitment during the project was continuous?

- Project Management techniques

48. How did you make the risk analysis?

- ☐ No risk analysis made
- ☐ Firm own risk analysis method
- ☐ Risk analysis made by consultants
- ☐ Models proposed by the vendor
- ☐ Other

49. Did you make a formal time and cost plan of the project progress phases?

50. Who was involved in the project budget definition?

- ☐ Top Management
- ☐ ICT
- ☐ Managers
- ☐ Consultants
- ☐ Key Users
- ☐ Other

51. Did you implement a real time check of the project?

52. Did you plan an evaluation of the system effectiveness in the post go-live phase?

- *Change Management*

53. Did you carry out a preventive evaluation of the final users' and other subjects' attitude towards the change?

54. Did the top management communicate the benefits related to the ERP system implementation?

55. Did the top management explain to the subjects involved in the implementation how the ERP system works?

56. Did you obtain the commitment of the leaders of the most influent groups of the firm?

57. Did you supervise the change management progresses?

58. Did you clearly explain the impact of the system implementation on the involved subjects' careers?

- *Legacy system management*

59. Did you carry out a preventive analysis of the IT system in order to define the interventions priorities and the components to keep during the ERP system implementation?

60. Which IT system treatment strategy did you adopt? (migration, wrapping…)

61. Had you deeply understood how the IT system worked when you started the ERP system implementation?

62. Were the IT system documents still available when you started the ERP system implementation?

63. Did the employers with the IT system expertise still belong to the firm's staff when you started the ERP system implementation?

64. How did you manage the transition from the old system to the new one?

a) Was there a gradual transitory phase?

b) Was there a period in which the two system co-lived?

c) Was it necessary to use the old IT system after the go-live for application that should have been covered by the ERP system ?

- *Consulting service*

65. In which project phase were the consultants involved?

66. Which kind of consultancy competences did you look for?

67. Which responsibilities the consultant had?

68. Were the consultants performances measurements related to the fulfilment of the objectives? Did you plan any penalty?

69. How would you evaluate the integration between the internal staff and the consultants?

- ☐ Low quality
- ☐ Sufficient
- ☐ Good
- ☐ Excellent

70. How did the consultant communicate with the team members?

- ☐ Mail
- ☐ Meetings
- ☐ Reports
- ☐ Conferences
- ☐ Other

71. Did the collaboration with the consultant increased the internal knowledge?

72. Had the PM business and IT competences?

73. Had the PM team management experience?

74. Which leadership style was adopted by the top management and the PM?

- IT system issue

75. Did you implement a structured process to determine the software functionalities and performances?

76. Who was involved in determining the software functionalities and performances?

- □ Top Management
- □ ICT
- □ Managers
- □ Key Users
- □ Other

77. During the project implementation, did you review the software functionalities and performances in order to verify their alignment with the plans and with the current necessities?

78. Is the system "scalable", is it possible to resize it according to the firm's necessities?

- System maintainability

79. Did you use a structured technique to manage the maintenance interventions documents?

80. Did you define any procedure to follow for the maintenance interventions?

81. Which kind of agreement did you stipulate with the vendor referring to the ERP system maintainability?

Which kinds of maintenance services are provided? (i.e. corrective, adaptive, perfective)

- ***Supplier stability and performances***

82. Did you have a partnership with the vendor?

83. What kind of support does the vendor offer referring to upgrades and releases?

- Strategic thinking and planning

84. Does the ERP system implementation project belong to a long term IT plan which involves the entire corporate?

85. Was the ERP system implementation project considered an opportunity to start a firm's change?

86. Did you set any outcome objectives? Which one? (performance VS financial objectives)

87. Did you consider the fact that adopting an ERP system would had led the firms to be bound to rigid processes?

- *Financial management*

88. Which technique did you use to evaluate the investment?

89. Did you consider the strategic option of the ERP system investment?

90. Did you plan a transitory period of productivity drop?

91. How did you carry out the costs/benefits analysis?

92. Did you include also intangibles benefits? Which ones?

93. What kind of unforeseen costs did you detect?

Risk Management Section

94. Did you plan an preventive action?

- □ Over budget
- □ Penalties
- □ Formalized communication procedures
- □ Other

95. Which were the major problem you detected in the ERP system implementation?

96. Which corrective actions did you adopt?

97. If you should start again the project implementation, what would you mainly change?

Risk Effect

-Budget Exceed

98. Did you respect the initial budget?

- ☐ Yes
- ☐ Less than 10% excess
- ☐ Between 10% and 20% excess
- ☐ Between 20% and 40% excess
- ☐ Between 40% and 60% excess
- ☐ Between 60% and 80% excess
- ☐ More than 80% excess

99. Which aspect did mainly exceed the budget?

- *Time exceed*

100. Did you respect the planned project times?

- ☐ Yes
- ☐ Less than 10% excess
- ☐ Between 10% and 20% excess
- ☐ Between 20% and 40% excess
- ☐ Between 40% and 60% excess
- ☐ Between 60% and 80% excess
- ☐ More than 80% excess

101. Which was the main reason for the time exceed?

- *Project stop*

102. Was the project interrupted?

- □ Yes
- □ No

103. Which was the main reason for the project interruption?

- *Business performance*

104. After the ERP system implementation, did you detect an operative parameters improvement ? (LT, number of shipping without errors, average stock level, average order evasion time…)

- □ Yes
- □ No

105. Which parameters did mainly improve?

- *System reliability and stability*

106. Were some modules partially used (modules not used at 100% of their capacity)?

- □ Yes
- □ No

107. Were some modules duplicated (two modules accomplishing the same function, ERP module co-living with legacy system..?

- □ Yes
- □ No

108. Which was the main cause of the maintenance interventions?

109. How frequently maintenance interventions occur?

110. How much would you agree with the following statement: " After ERP system implementation it has been detected an improvement in the coherence and completeness of the provided information"

- □ Strongly agree
- □ Agree
- □ Don't know
- □ Disagree
- □ Strongly disagree

- *Organization process fitting*

111. How much would you agree with the following statement: " After ERP system implementation it has been detected an misalignment between the firm's own procedures and the ones requested by the system"

☐ Strongly agree ☐ Disagree

☐ Agree ☐ Strongly disagree

☐ Don't know

112. How much would you agree with the following statement: " After ERP system implementation it has been detected an misalignment between the roles previously covered by the firm and the ones requested by the system "

☐ Strongly agree ☐ Disagree

☐ Agree ☐ Strongly disagree

☐ Don't know

113. How would you evaluate the following ERP system characteristics:

a) Learnability (How easy is for the user to accomplish his tasks the first time he uses the system)

☐ Very much

☐ Enough

☐ Don't know

☐ Not much

☐ Absolutely not

b) Efficiency (how fast users can accomplish their tasks)

☐ Very much

☐ Enough

☐ Don't know

☐ Not much

☐ Absolutely not

c) Memorability (how easy is for a user to use again the system after a period of lack of practise)

☐ Very much

☐ Enough

- ☐ Don’t know
- ☐ Not much
- ☐ Absolutely not

d) Errors (How likely is to make mistakes)

- ☐ Very much
- ☐ Enough
- ☐ Don’t know
- ☐ Not much
- ☐ Absolutely not

e) Satisfaction (how satisfying if users to use the system)

- ☐ Very much
- ☐ Enough
- ☐ Don’t know
- ☐ Not much
- ☐ Absolutely not

- *Degree of integration and flexibility*

114. How much would you agree with the following statements:

a) The ERP system implemented is easy to integrate with other systems already existing (Legacy System)

- ☐ Strongly agree
- ☐ Agree
- ☐ Don’t Know
- ☐ Disagree
- ☐ Strongly Disagree

b) The ERP system implemented is easy to integrate with external software (e.g. vendor’s ones)

- ☐ Strongly agree
- ☐ Agree

- ☐ Don’t Know
- ☐ Disagree
- ☐ Strongly Disagree

c) The ERP system implemented is easy to expand

- ☐ Strongly agree
- ☐ Agree
- ☐ Don’t Know
- ☐ Disagree
- ☐ Strongly Disagree

d) The ERP system implemented allows to easily manage exceptions and to modify

- ☐ Strongly agree
- ☐ Agree
- ☐ Don’t Know
- ☐ Disagree
- ☐ Strongly Disagree

- Strategic goals fitting

115. How coherent the ERP implement was with the following objectives?

- ☐ Decisions quality improvement
- ☐ Information quality improvement
- ☐ Selling increase
- ☐ Market share increase
- ☐ Employers’ skills improvement
- ☐ Time to market decrease
- ☐ Customer focus improvement
- ☐ Quality and processes improvement

- ***Financial/ economical performances***

116. After the ERP system implementation did you detect an improvement of the economical /financial parameters (directly imputable to the system)?

PART 3

The third part of the questionnaire consist in a risk assessment simulation and it's divided in three phases:

1. Risk factors correlation evaluation
2. Risk factors occurrence probabilities evaluation
3. Risk effect relevance evaluation

1. I kindly ask you to evaluate, on a scale that goes from 1 to 7, the correlation grade between the risk factors listed in the table. The question you should answer when evaluation the generic x-y combination is :" Which is the probability that if the x risk factor occurs, then the y risk factor is going to occur too?"

1. Almost null	< 0.1%
2. Very low	0.1% - 1%
3. Low	1% - 10%
4. Medium	10% - 25%
5. High	25%- 50%
6. Very high	> 50%
7. Almost certain	≈100% (0.9)

	1. Inadequate selection	2. Poor project team skills	3. Low top management involvement	4. Ineffective communication system	5. Low key user involvement	6. Inadequate training and instruction	7. Complex architecture and high n° of implementation modules	8. Inadequate BPR	9. Bad managerial conduct	10. Ineffective project management techniques	11. Inadequate Change management	12. Inadequate legacy system management	13. Ineffective consulting services	14. Poor leadership	15. Inadequate IT system issue	16. Inadequate IT system maintainability	17. Inadequate IT supplier stability and performances	18. Ineffective strategic thinking and planning	19. Inadequate financial management
1. Inadequate selection	■	■	■	■	■	■		■	■	■	■	■	■	■				■	■
2. Poor project team skills		■	■				■						■		■	■	■		
3. Low top management involvement		■	■		■	■	■			■		■	■	■	■	■	■		
4. Ineffective communication system	■	■	■	■		■	■		■	■		■	■	■	■	■	■	■	■
5 Low key user involvement.		■	■	■	■		■		■	■			■	■	■	■	■	■	■
6. Inadequate training and instruction	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■
7. Complex architecture and high number of implementation modules	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■	■	■
8. Inadequate BPR	■	■	■	■	■	■	■	■	■	■	■		■	■		■	■	■	■
9. Bad managerial conduct	■	■	■				■		■			■	■	■	■	■	■	■	
10.Ineffective project management techniques	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	
11.Inadequate change management	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
12.Inadequate legacy system management		■	■	■	■	■		■	■	■	■	■	■	■			■	■	■
13.Ineffective consulting services		■	■				■	■					■		■	■	■		
14. Poor leadership	■	■					■			■		■	■	■	■	■	■		■
15. Inadequate IT system issue	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■
16. Inadequate IT system maintainability	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
17.Inadequate IT supplier stability and performances	■	■	■	■	■		■	■	■	■	■	■	■	■			■	■	
18. Ineffective strategic thinking and planning		■	■	■	■	■	■			■	■		■	■		■	■	■	
19.Inadequate financial management	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

2. Let's suppose to go back to the initial phase of the project and to forget about the outcome. On the base of firm culture, the working way, the organizational procedures, the used methodologies and the people involved in the project team, we kindly ask you to estimate the occurrence probability of the following risk factors.

1. *Almost null*	< 0.1%
2. *Very low*	0.1% - 1%
3. *Low*	1% - 10%
4. *Medium*	10% - 25%
5. *High*	25%- 50%
6. *Very high*	> 50%
7. *Almost certain*	≈100% (0.9)

RISK FACTOR	**Probability**
1. *Inadequate selection*	
2. *Poor project team skills*	
3. *Low top management involvement*	
4. *Ineffective communication system*	
5. *Low key user involvement*	
6. *Inadequate training and instruction*	
7. *Complex architecture and high number of implementation modules*	
8. *Inadequate BPR*	
9. *Bad managerial conduct*	
10. *Ineffective project management techniques*	
11. *Inadequate change management*	
12. *Inadequate legacy system management*	
13. *Ineffective consulting services*	
14. *Poor leadership*	
15. *Inadequate IT system issue*	
16. *Inadequate IT system maintainability*	
17. *Inadequate IT supplier stability and performances*	
18. *Ineffective strategic thinking and planning*	
19. *Inadequate financial management*	

3. Did you detect other risk factors that are not quoted?

4. In your opinion, which is the risk factor one should consider the most important?

5. Based on your project objectives, could you please distribute 100 points on the following entries, in relation to their importance?

RISK EFFECT	Score
1. Budget exceed	
2. Time exceed	
3. Project stop	
4. Poor business performance	
5. Inadequate system reliability and stability	
6. Low organization process fitting	
7. Low user friendliness	
8. Low degree of integration and flexibility	
9. Low strategic goals fitting	
10. Bad financial/economic performance organization	

6. Did you detect other effects that are not quoted?

Ranking section

1. **Do you agree with the ranking suggested by the program? If not, what would you modify?**

2. **How this tool would have enhanced the results you obtained?**

   □ Schedule compliance
   □ Budget compliance
   □ Better system performance
   □ To enhance business in the long term perspective
   □ To enhance the company organization
   □ To enhance productivity, both during and after the implementation
   □ To fulfil the planned objectives
   □ To determine the project objectives
   □ To determine the strategy and the policy to adopt for the implementation

- Usability

3. **Could the tool allow to better manage the ERP implementation project?**

4. **Do you think the tool is easy to under stand?** *(easy to understand how to use it, how it works, which kind of output data provides..)*

- Utility

5. **Do you think the tool might be useful for the ERP implementation projects management? Above all, for which aspect (cost, time, efficiency)**

6. **How do you think this tool could be used in practice?**

7. **Do you have any comment to make about the tool?**

8. **Do you find any criticality or enhancement possibility?**

Coding tables

In the next pages the table we used for the comparative analysis of the case studies are reported.

	Evaluation Scale	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR TLC Services
BUDGET EXCEED						
Percento in Budget exceed	0- >100% 1- >50% 2- >25% 3- >10% 4- Till 10% 5- No exceed	0% 5	150% 0	20/40% 2	0% 5	10/20% 3
TIME EXCEED						
Percent in Time exceed	The same of Budget	6% 4	0% 5	30% 2	0% 5	6% 4
PROJECT STOP						
Yes/No	Yes -1 / No -0	1	1	1	1	1
NORMALIZED		**5**	**5**	**5**	**5**	**5**
BUSINESS PERFORMANCE						
Productivity improvement	Yes -1 / No -0	0	0	0	0	0
Quality improvement of product	Yes -1 / No -0	0	0	0	0	0
Reliability of product	Yes -1 / No -0	0	0	0	0	0
Service customer	Yes -1 / No -0	0	0	0	1	0
Knowledge management	Yes -1 / No -0	0	0	1	1	1
TOTAL		**0**	**0**	**1**	**2**	**1**
SYSTEM RELIABILITY AND STABILITY						
Complete use of the modules	Yes -1 / No -0	1	1	0	0	0
Not parallel using of Legacy System	Yes -1 / No -0	1	1	1	1	1
Maintenance	Yes -1 / No -0	1	0	0	1	0
Completeness data improvement	Yes -1 / No -0	1	1	1	1	1
Coherence data improvement	Yes -1 / No -0	1	1	1	1	1
TOTAL		**5**	**4**	**3**	**4**	**3**
ORGANIZATION PROCESS FITTING						
Process fitting	Yes -1 / No -0	1	0	0	1	1
Role fitting	Yes -1 / No -0	1	0	1	0	1

TOTAL		**2**	**0**	**1**	**1**	**2**
NORMALIZED		**5**	**0**	**2,5**	**2,5**	**5**
USER FRIENDLINESS						
Learnability	Yes -1 / No -0	1	0	0	1	0
Efficiency	Yes -1 / No -0	0	1	0	1	1
Memorability	Yes -1 / No -0	1	1	1	1	0
Errors	Yes -1 / No -0	1	1	1	1	0
Satisfaction End Users	Yes -1 / No -0	1	1	0	1	1
TOTAL		**4**	**4**	**2**	**5**	**2**
DEGREE OF INTEGRAZION AND FLEXIBILTY						
System integrability	Yes -1 / No -0	1	0	1	1	0
System management exceptions	Yes -1 / No -0	0	1	0	1	1
System expansibility	Yes -1 / No -0	1	1	1	1	0
TOTAL		**2**	**2**	**2**	**3**	**1**
NORMALIZED		**3,33**	**3,33**	**3,33**	**5**	**1,67**
STRATEGIC GOAL FITTING						
Internal/External communication benefits	Yes -1 / No -0	1	1	1	1	1
Customer demand response improvement	Yes -1 / No -0	0	0	0	0	0
Empowerment	Yes -1 / No -0	1	1	1	1	1
Customer/Supplier relationship improvement	Yes -1 / No -0	0	0	0	1	1
Business learning	Yes -1 / No -0	1	1	1	1	1
TOTAL		**3**	**3**	**3**	**4**	**4**
FINANCIAL/ECONOMIC PERFORMANCE						
Brand value	Yes -1 / No -0	1	0	0	1	1
Reducing cost	Yes -1 / No -0	0	0	0	1	0
Increasing revenues	Yes -1 / No -0	0	0	0	0	0
New market value	Yes -1 / No -0	1	1	1	1	1
Impact on financial improvement	Yes -1 / No -0	1	1	1	1	1
TOTAL		**3**	**2**	**2**	**4**	**3**
NORMALIZED		**3**	**2**	**2**	**4**	**3**

Table 1. Coding table for effects

	Case A: Procter & Gamble	Case B: SCA	Case C: Power One	Case D: S. Anna Ferrara Hospital	Case E: HR TLC Services
SELECTION					
Structured process of vendor selection	0	0	0	1	0
Structured process of system integrator selection	0	0	0	1	0
Involved roles	0	0	0	0	0
Total	**0**	**0**	**0**	**2**	**0**
NORMLIZED	**0**	**0**	**0**	**3.33**	**0**
PROJECT TEAM SKILLS					
Involvement of different functions	1	1	1	1	1
Training needs detection	1	0	0	0	0
Clear and shared job assignment modality	1	1	1	1	1
Total	**3**	**2**	**2**	**2**	**2**
NORMLIZED	**5**	**3.33**	**3.33**	**3.33**	**3.33**
TOP MANAGEMENT INVOLVEMENT					
Type and frequency of the interaction	1	1	1	1	1
IT project experiences	1	1	1	1	1
Commitment exhibition	0	0	0	1	1
Responsibility of the top management	1	1	0	1	1
Use of Project Champion	1	1	1	0	1
Total	**4**	**4**	**3**	**4**	**5**
NORMLIZED	**4**	**4**	**3**	**4**	**5**

COMMUNICATION					
Means	1	1	1	1	1
Involved subjects	1	1	1	1	1
Type of exchanged information	1	0	0	0	1
Total	**3**	**2**	**2**	**2**	**3**
NORMLIZED	**5**	**3.33**	**3.33**	**3.33**	**5**
KEY USERS INVOLVEMENT					
Phase in which key users are involved (1 all, 0 after planning)	0	1	0	0	1
Involved functions	1	1	1	1	1
Active role of key users in knowledge diffusion	1	1	1	1	1
Total	**2**	**3**	**2**	**2**	**3**
NORMLIZED	**3.33**	**5**	**3.33**	**3.33**	**5**
TRAINING					
Training mode	1	1	1	1	1
Dedicated resources	1	1	0	1	1
Formative needs identification	1	1	0	0	0
Evaluation of the acquired skills	1	0	1	0	0
Total	**4**	**3**	**2**	**2**	**2**
NORMLIZED	**5**	**3.75**	**2.5**	**2.5**	**2.5**
ARCHITECTURE					
Project divided in steps	1	1	0	1	0
Centralized or decentralized structure	0	0	0	1	1

Compatibility/ integration with other software	1	0	0	0	1
Customization extension	1	1	0	0	0
Total	**3**	**2**	**0**	**2**	**2**
NORMLIZED	**3.75**	**2.5**	**0**	**2.5**	**2.5**
BPR					
Preventive analysis of Process business value and performance	1	1	1	1	0
Life cycle phase in which BPR was implemented	1	0	0	1	0
Dedicated resources	1	0	0	0	0
Supporting Tools	0	0	0	0	0
Involved roles	0	1	1	1	0
Total	**3**	**2**	**2**	**3**	**0**
NORMLIZED	**3**	**2**	**2**	**3**	**0**
MANAGERIAL CONDUCT					
Clear objectives and goal	0	0	0	0	0
Top management, key users and team member involvement	1	0	0	1	1
Project Manager Commitment	1	1	1	1	1
Total	**2**	**1**	**1**	**2**	**2**
NORMLIZED	**3.33**	**1.66**	**1.66**	**3.33**	**3.33**
PROJECT MANAGEMENT TECHNIQUES					
Risk Management approach	1	1	0	1	1
Formal plan of project phases	1	1	1	1	1

Real time control	1	1	1	1	1
Post Go Live Assessment of ERP system efficiency	1	1	0	1	1
Total	**4**	**4**	**2**	**4**	**4**
NORMLIZED	**5**	**5**	**2.5**	**5**	**5**
CHANGE MANAGEMENT					
Preventive evaluation of users' attitude towards change	1	0	0	0	1
Explanation of the benefits and functioning modes of ERP by top management	1	1	0	1	0
Influential group involvement	1	1	1	1	1
Monitoring of change progresses	1	0	0	0	1
Management of user expectations	1	1	0	0	0
Total	**5**	**3**	**1**	**2**	**3**
NORMLIZED	**5**	**3**	**1**	**2**	**3**
LEGACY SYSTEM					
Preventive analysis of the system	1	1	0	1	1
Treatment strategy adopted	1	1	1	1	1
Transition from the old to the new system	1	1	1	1	1
Legacy system comprehension	1	1	1	1	1
Total	**4**	**4**	**3**	**4**	**4**
NORMLIZED	**5**	**5**	**3.75**	**5**	**5**
CONSULTING SERVICE					
Stage	1	1	1	1	1
Required competences	0	1	1	1	0

Responsibilities	1	1	0	1	1
Integration extent with internal personnel	1	1	1	1	1
Total	**3**	**4**	**3**	**4**	**3**
NORMLIZED	**3.75**	**5**	**3.75**	**5**	**3.75**
LEADERSHIP					
Business and technical competence required for project managers	1	1	1	1	1
Leadership style adopted	1	0	0	0	1
Total	**2**	**1**	**1**	**1**	**2**
NORMLIZED	**5**	**2.5**	**2.5**	**2.5**	**5**
IT SYSTEM ISSUE					
Structured process for preventive needs identification	1	1	0	1	1
Role of the person defining objectives and needs	1	1	1	1	1
Review of the new system functionalities during the implementation	1	1	1	1	1
Scalability	1	0	1	0	1
Total	**4**	**3**	**3**	**3**	**4**
NORMLIZED	**5**	**3.75**	**3.75**	**3.75**	**5**
IT SYSTEM MAINTANANILITY					
Structured technique for document management	1	1	1	1	1
Structured maintenance process	1	1	1	1	1
Vendor responsibilities	1	1	1	1	1
Total	**3**	**3**	**3**	**3**	**3**

NORMLIZED	**5**	**5**	**5**	**5**	**5**
IT SUPPLIER STABILITY					
Partnership with vendor	1	1	0	1	0
Vendor’s support for updates and new modules	1	1	1	1	1
Total	**2**	**2**	**1**	**2**	**1**
NORMLIZED	**5**	**5**	**2.5**	**5**	**2.5**
STRATEGIC THINKING AND PLANNING					
Clear comprehension of ERP potentialities	0	0	0	1	0
Outcome objectives definition	1	0	0	0	1
Awareness of ERP rigidity	1	1	1	1	1
Total	**2**	**1**	**1**	**2**	**2**
NORMLIZED	**3.33**	**1.66**	**1.66**	**3.33**	**3.33**
FINANCIAL MANAGEMENT					
Investment evaluation	1	0	1	0	1
Clear and complete identification of costs and benefits	1	0 (not available)	0	1	1
Total	**2**	**0**	**1**	**1**	**2**
NORMLIZED	**5**	**0**	**2.5**	**2.5**	**5**

Table 2. Coding table for risk factors