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Risk Mitigation in Project Management Theoretical Issues and Case Study

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Abstract – The objective of this article is to evaluate how the risk management process is used in the software development industry and how practitioners are managing risks in early stages of a project. Further, a description of how risk assessment might help to mitigate risks associated to events that could occur to different phases of a project life cycle will be presented. The core of the research is the theoretical approach for designing a simulation model to estimate costs prior to a project. In the application part, this model is implemented using a case study and the results of the estimation costs which are analyzed and simulated using the theoretical framework of Monte Carlo simulation model are presented. In the conclusions section the final recommendations are drawn up.

Keywords: risk management, project, software industry, Monte Carlo simulation, cost management

I. INTRODUCTION

Risk Management (RM) is a concept, which is used in all industries, from Information Technologies (IT) related business, automobile or pharmaceutical industry, to the software sector. Each industry has developed their own RM standards, but the general ideas of the concept usually remain the same regardless of the sector. According to the Project Management Institute (PMI) [30], project risk management is one of the nine most critical parts of project commissioning. This indicates a strong relationship between managing risks and a project success. While RM is described as the most difficult area within software management, its application is promoted in all projects in order to avoid negative consequences [6].
One concept, which is widely used within the field of RM, is called the Risk Management Process (RMP) and consists of four main steps: identification, assessment, taking action and monitoring the risks [7]. In each of these steps, there are a number of methods and techniques, which facilitate handling the risks.
Many industries have become more proactive and aware of using analyses in projects. Likewise, RM has become a timely issue widely discussed across industries. However, with regard to the software/IT industry "pays more lip service to risk management than it actually performs"' [11].
More software companies are starting consider RM, but most of them are not using scientific models and techniques in this field. This contradicts the fact that the industry is trying to be more cost and time efficient as well as have more control over projects. Risk is associated to any project regardless the industry and thus RM should be of interest to any project manager. Risks differ between projects because every project is unique. However, still many practitioners have not realized the importance of including risk management in the process of delivering the project. Even though there is an awareness of risks and their consequences, some organizations do not approach them with established RM methods [25].
The software industry operates in a very uncertain environment where conditions can change due to the complexity of each project [28]. The aim of each organization is to be successful and RM can facilitate it. However, it should be underlined that risk management is not a tool, which ensures success, but rather a tool, which helps to increase the probability of achieving success. Risk management is therefore a proactive rather than a reactive concept.
Many previous studies [16; 19; 34; 14] have been conducted within the field of RM but each presents a different approach to this concept. The research in this master thesis focuses on the software industry and how the subject is practiced in a project implementation. The concept of RM is presented in a systematized

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project life cycle approach to show differences between elements, aspects or issues in different project phases highlighting events that could affect the achievement of objectives [24; 15].

I.1. What are the benefits in introducing risk management principles and considerations into an early phase of a project?

Software developers tend to equate maturity in the IT with technical proficiency. They even have a fire-level scheme for measuring such maturity: the Capability Maturity Model. However, according to the English standard, the term “maturity” has nothing to do with technical proficiency. It is, rather a quality of grown-up-ness, an indication that a person or organism has reached its adult state [3; 8].

In retrospect, when project managers did not explicitly manage risks, they are acting as childlike. Considering only the rosy scenario and associate it into the project plan is real “kid stuff”. These is considered an immature approach, but this positively trumpeting the increased maturity due to improvements of the technical proficiency [11].

In a more realistic perspective, it is needed a “maturity way of thinking” by taking explicit note of the possible occur risks, and plan the projects accordingly to different scenarios of their evolution. That is what risk management consist of [11].

Experiencing risks in late phases during the projects within the company, have determined us to elaborate this article in order to support the project management team to adopt a preventive behavior and avoid waste, loses and delays during the project development.

I.2. Research context and objective

The research described in this article was conducted together with the project management members from a small and medium size company from the IT field. This organization is aware of risks, but it do not use any specific structured methods to manage them. However, the organization’s management believes that a projects performance can be improved by implementing risk management methods. At the time when research was conducted, the company was involved in a new project that includes new hardware (module and software solution for connected audio systems, which is the case study in this article). The project was chosen in order to investigate the practices of risk management across the project organization.

Furthermore, the objective of this article is to evaluate how the risk management process is used in the software industry and how the practitioners are managing risks in early stages of a project. The theory of the risk management process will be compared to the actual practice in order to investigate similarities and differences. In other words, the main idea behind the research is to see if the software industry is working with risk management as it is described in the literature regarding the methods and techniques presented.

In order to achieve the research objective, the following questions have been formulated to support the proposed approach:

1. How are risks and risk management perceived in a software project?
2. How possible events and associated risks can affect project objectives?
3. What analysis tools help to reduce risks effectively?

The operative objectives of the research are to understand the concept of RM and the RMP, investigate how the IT sector’s manages risks and facilitate the use of RM focused on the software projects.

II. ANALYSIS AND DEBATE OF THE POSSIBLE EVENTS AND ASSOCIATED RISKS THAT COULD OCCUR DURING THE PROJECT PHASES

Risks are unavoidable and as such, the key challenge in engineering risk analysis is to identify the elements of the system or facility that contribute most to risk and associated uncertainties. One of the most useful outputs of a risk assessment is the set of importance measures associated with the main elements of the risk models such as phenomena, failure events, and processes [21]. These important measures are used to rank the risk-significance of these elements in terms of their contribution to the total risk (e.g. expected loss or hazard). Importance measures are either absolute or relative [1; 30]:

- The absolute measures define the contribution of each risk element in terms of an absolute risk metric (reference level), such as the conditional frequency of a hazard exposure given a particular state of the element.
- Relative measures compare the risk contribution of each element with respect to others. In most risk analyses, it is common to conclude that importance measures of a small fraction of risk elements contribute appreciably to the total risk.

II.1. Key principles for effective and efficient risk assessment

In order to yield meaningful results with minimal burden to the organization for the risk assessments, the following key principles should be considered [1; 30; 21; 29]:

- Governance over the risk assessment process must be clearly established [26]. Oversight and accountability for the risk assessment process is critical to ensure that the necessary commitment and resources are secured, the risk assessment occurs at the right level in the organization, the full range of relevant risks is considered, these risks are evaluated through a rigorous and ongoing process, and requisite actions are taken, as appropriate;

- Risk assessment begins and ends with specific objectives. Risks are identified and measured in relation to an organization's objectives or, more specifically, to the objectives in scope for the risk assessment [5]. Defining objectives that are specific and measurable at various levels of the organization is crucial to a successful risk assessment. Evaluating the risks relative to such objectives facilitates the reallocation of resources as necessary to manage these risks and best achieve stated objectives;
- Risk rating scales are defined in relation to organizations' objectives in scope [5]. Risks are typically measured in terms of impact and likelihood of occurrence. Impact scales of risk should mirror the units of measure used for organizational objectives, which may reflect different types of impact such as financial, people, and/or reputation. Similarly, the time horizon used to assess the likelihood of risks should be consistent with the time horizons related to objectives;
- Management forms a portfolio perspective on risks and this has to be considered for the decision making process, too. While risks are rated individually in relation to the objectives, they influence, it is also important to bring risks together in a portfolio perspective that pinpoints interrelationships between risks across the organization [14]. Correlations may exist, in which an increased exposure to one risk may cause a decrease or increase in another. Concentrations of risks may also be identified through this view. The portfolio view helps organizations understand the effect of a single event and determines where to deploy systematic responses to risks, such as the establishment of minimum standards;
- Leading indicators are used to provide insight into potential risks. Risk reports are most meaningful and relevant when they draw out not only past events but also forward-looking analysis. Historically, management has tracked Key Performance Indicators (KPIs) to help detect issues affecting the achievement of objectives. In recent years, organizations have also been developing key risk indicators (KRIs) to help signal an increased risk of future losses or an uptick in risk events. KPIs and KRIs are tactical in nature, can be collected at any time, reported on a regular basis or as requested by management (e.g., as part of a balanced scorecard), and typically include statistics and/or metrics (often financial) that provide insight into an organization's risk position. Capturing KPIs and KRIs on management dashboards remains necessary, but it is also important for organization leaders to prompt broader consideration of market issues that could potentially create risk to the organization. Leading indicators (those data points that signal a change in the environment) are central to anticipating these types of potential risks, but they are often difficult to capture since they tend to arise from a broad set of circumstances, often in the macro-environment, that may seem remote and initially disconnected from day-to-day operations [14; 20].

II.2. Events that could affect the achievement of objectives

Events can have negative impact, positive impact, or both. Events with a negative impact represent risks, which can prevent value creation or erode existing value. Events with positive impact may offset negative impacts or represent opportunities. Opportunities are the possibility that an event will occur and positively affect the achievement of objectives, supporting value creation or preservation. Management channels opportunities back to its strategy or objective-setting processes, formulating plans to seize the opportunities [30; 1; 29; 14].

Based on the organization's objectives, the designated owners of the risk assessment should develop a preliminary inventory of events that could influence the achievement of the organization's objectives. "Events" refers to prior and potential incidents occurring within or outside the organization that can have an effect, either positive or negative, upon the achievement of the organization's stated objectives or the implementation of its strategy and objectives. Various taxonomies or libraries of common event types can help initiate the identification process [26].

A review of the external environment helps identify outside events that may have affected the organization's shareholder value in the past or may influence it in the future. Drivers to consider include economic, social, political, technological, and natural environmental events, which can be identified through external sources such as media articles, analyst and rating agency reports, and insurance broker assessments [24; 15].

A review of the organization's internal processes, people, technology, and data helps identify further events. Relevant information is often derived from internal sources such as business plans and budgets, prior risk assessments, financial performance, litigation, board and annual reports, loss-event databases (e.g., ORX and Fitch First), and policies and procedures. Both external and internal data sources should be considered. For example, an IT risk assessment should consider internal factors such as the number and length of systems failures, employee access controls, and protection of confidential data and information, as well as external factors such as the introduction of advanced software and hardware into the industry and incidents of cyber-crime within the previous year. Such information can be obtained through interviews, workshops, surveys, process flow reviews, documentation reviews, or a combination of such data-gathering techniques [14; 6; 29]. Through facilitated workshops, management can guide line management and cross-functional staff through the process of analyzing objectives, discussing past events that affected those objectives, and identifying potential future events. A survey approach can also be used to collect relevant insights by sending a questionnaire to a cross-section of management and staff. Techniques should be selected based on fit with current management practices and the type of output required [29; 6].

The identified events should be inventoried and "translated" into opportunities (positive events) or risks (as negative events). Opportunities should flow into management's strategy- and objective-setting processes, whereas threats should be further categorized and assessed [30; 14; 29].

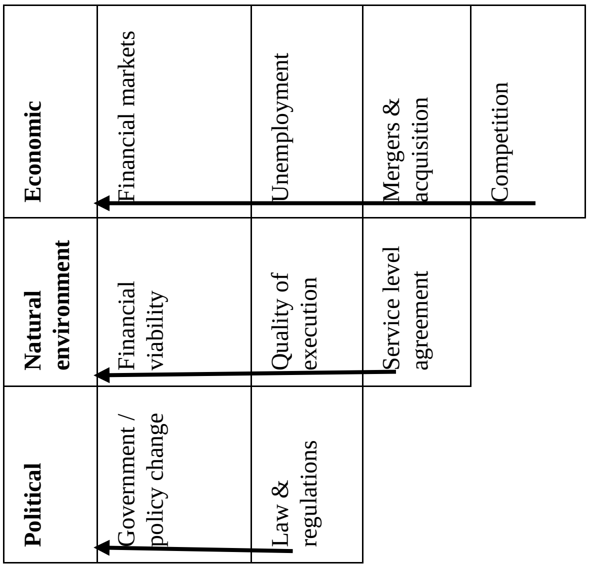
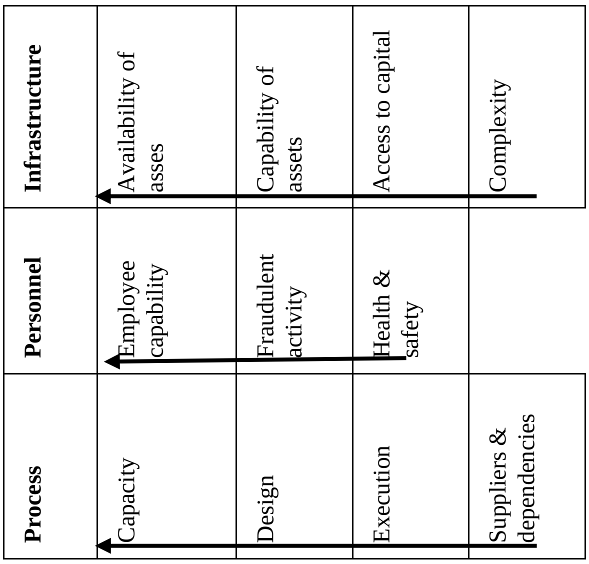


Figure 1. Event categories - considering internal factors



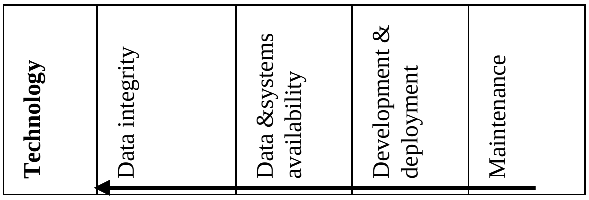


Figure 2. Event categories - considering internal factors

Events can be categorized in a variety of ways. For example, they may be brought together in a matrix, with horizontal columns capturing categories of root risk causes and vertical rows representing lines of business or functional areas. All applicable areas of risk are then marked accordingly. Another approach consists of capturing all relevant event types and linking these to broader categories, as illustrated in Figures 1 and 2.

The identification of event types should be periodically refreshed and is only as complete as the sources of input, which should involve all relevant business lines and functional areas. Such participants vary according to the type of risk assessment being performed. For example, for a fraud risk assessment, it may be critical to gain the perspective of members of the accounting, procurement, and corporate security divisions, whereas these may not be the right parties to provide input into a market risk assessment [29; 6].

A. Change of stakeholders

A stakeholder can be broadly defined as any individual or group that either can influence or is influenced by the proposed change. These parties often reside within the organization, but can also include important external players such as key customers, suppliers, channel partners, governmental bodies, and, depending on the issue, local community groups [10]. Effectively assessing your stakeholder portfolio is not only critical to the core change roadmap, it also affects associated work streams, such as communication plans, risk management efforts, and commitment planning. Analysis of best practice research suggests accurate stakeholder identification, prioritization, and engagement are vital for completing change programs and realizing targeted benefits [31]. Therefore, before embarking on a change project, it is important to understand who is with you, who is not and why [18; 14; 29; 31].

When building a business case for change, it is important to first look at the project from an objective, organizational lens. It is important to manage stakeholders in change. In doing so, one of the things that have to be done is to segment them according to their needs, their importance and by considering their future "treatment" [12; 31].

a. Identify stakeholders

It is critical for project success to identify the stakeholders early in the project or phase and to analyze their levels of interest, their individual expectations, as well as their importance and influence [10]. This initial assessment should be reviewed and updated regularly.

Most projects will have a diverse number of stakeholders depending on their size, type, and complexity. While the project manager’s time is limited and should be used as efficiently as possible, these stakeholders should be classified according to their interest, influence, and involvement in the project, taking into consideration the fact that the affect or influence of a stakeholder may not occur or become evident until later stages in the project or phase. This enables the project manager to focus on the relationships necessary to ensure the success of the project [32; 10].

Upon reviewing these results, project managers can align stakeholders to one of three categories depending on their anticipated outlook of the change event [32; 13; 10; 31].

- Champions are individuals or groups who will openly support the proposed change;
- Missionaries are folks who will roll up their sleeves and actively help you make change happen;
- Opinion Shapers or informal group leaders are individuals who have considerable informal influence on stakeholders from the other two categories. Understanding their placement in relation to the other groups is vital.

There are multiple classification models used for stakeholders analysis, power/interest grid presented in Figure 3 is grouping the stakeholders based on their level of authority (“power”) and their level or concern (“interest”) regarding the project outcomes [31]:

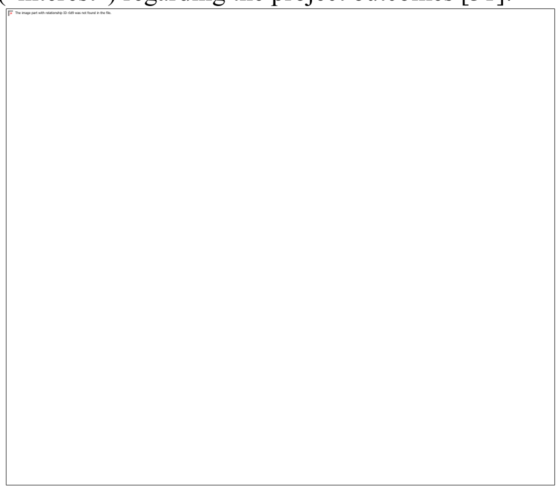


Figure 3. Example Power/Interest grid with Stakeholders

Practitioners often call out “Leadership” as a distinct forth category. While top-level buy-in is the key, it is also important to understand that people, regardless of placement within the organization, experience change events the same way, and thus will fall naturally into one of the categories noted above. Remember, you need to have champions, missionaries, and opinion shapers working with you at each level in the hierarchy that is affected by the change [13; 10; 31].

An underlying area into which you can dig when exploring and understanding stakeholders are their driving interests. Interests include general areas and specific items that motivate people in a number of different ways. If you can identify these underlying interests of the stakeholder, you can more effectively work to address the deeper drivers that are motivating them [14; 29; 31].

Seek to find the root cause of any problems that they offer (these are sometimes called presenting problems). For any effect, there is a cause, which itself may be caused by another cause. If you can follow the chain of causes until you can go no further, and if addressing this cause will resolve the problem, then you have found the root cause. Ask “What is causing this?” or “Could you tell me more about that?” The ideal is to simply ask “why”, but used, as a direct question can be rather harsh, so more indirect methods are often better [14; 29; 31].

b. Change control

PM-BOK defines change control as the process of reviewing all change requests; approving changes and managing changes to deliverables, organizational process assets, project documents, and the project management plan; and communicating their disposition. It reviews all requests for changes or modifications to project documents, deliverables, baselines, or the project management plan and approves or rejects the changes [29; 31]. The key benefit of this process is that it allows for documented changes within the project to be considered in an integrated fashion while reducing project risk, which often arises from changes made without consideration to the overall project objectives or plans [12; 31].

The change control process is conducted from project inception through completion and is the ultimate responsibility of the project manager. The project management plan, the project scope statement, and other deliverables are maintained by carefully and continuously managing changes, either by rejecting changes or by approving changes, thereby assuring that only approved changes are incorporated into a revised baseline [31; 34].

Any stakeholder involved within the project may request changes. Although changes may be initiated verbally, they should be recorded in written form and entered into the change management and/or configuration management system. Change requests are subject to the process specified in the change control and configuration control systems. Those change request processes may require information on estimated time impacts and estimated cost impacts [12; 34].

Every documented change request needs to be either approved or rejected by a responsible individual, usually the project sponsor or project manager. The responsible individual will be identified in the project management plan or by organizational procedures. When required, the change control process includes a Change Control Board (CCB), which is a formally chartered group responsible for reviewing, evaluating, approving, delaying, or rejecting changes to the project, and for recording and communicating such decisions. Approved change requests can require new or revised cost estimates, activity sequences, schedule dates, resource requirements, and analysis of risk response alternatives. These changes can require adjustments to the project management plan and other project documents. The applied level of change control is dependent upon the application area, complexity of the specific project, contract requirements, and the context and environment in which the project is performed. Customer or sponsor approval may be required for certain change requests after CCB approval, unless they are part of the CCB [31; 34].

Configuration control is focused on the specification of both the deliverables and the processes; while change control is focused on identifying, documenting, and approving or rejecting changes to the project documents, deliverables, or baselines.

Some of the configuration management activities included in the Change Control process are as follows [12; 31]:

- Configuration identification. Identification and selection of a configuration item to provide the basis for which the product configuration is defined and verified, products and documents are labelled, changes are managed, and accountability is maintained.
- Configuration status accounting. Information is recorded and reported as to when appropriate data about the configuration item should be provided. This information includes a listing of approved configuration identification, status of proposed changes to the configuration, and the implementation status of approved changes.
- Configuration verification and audit. Configuration verification and configuration audit ensure the composition of a project's configuration items is correct and that corresponding changes are registered, assessed, approved, tracked, and correctly implemented. This ensures the functional requirements defined in the configuration documentation have been met.

All of the Monitoring and Controlling processes and many of the executing processes produce change requests as an output. Change requests may include corrective action, preventive action, and defect repairs. However, corrective and preventive actions do not normally affect the project baselines - only the performance against the baselines [12; 31].

Change requests are processed according to the change control system by the project manager, CCB, or by an assigned team member. The disposition of all change requests approved or not, will be updated in the change log as part of updates to the project documents. A change log is used to document changes that occur during a project. These changes and their impact to the project in terms of time, cost, and risk, are communicated to the appropriate stakeholders. Rejected change requests are also captured in the change log [31; 34].

Changes to baselines should only show the changes from the current time forward. Past performance may not be changed. This protects the integrity of the baselines and the historical data of past performance [12].

c. IT stakeholders

"If we told the truth, our stakeholders would be too scared to do the project, so we have to lie to them" [11]. Tom DeMarco and Timothy Lister presented stakeholders in "Managing risks in software projects" book as not mature enough to face up the risk.

In the early days of the software industry, the stakeholders were often clerks and managers of clerical departments. That was because the first functions we tended to automate were clerical. These stakeholders were low-level, relatively powerless, and not informed well about automation. The typical systems analyst on such a project was usually paid a lot more than most of the stakeholders he or she interacted with. During this period, IT often affected a paternalistic, "we know best" attitude. Maybe this even worked, on occasion, to help useful systems be built.

Today stakeholders, however, are different. They are typically more powerful than their IT counterparts are, and they have been around a while. They are perceptive about automation. Most of all, they have good memories. These days, risk-taking is becoming the norm on more than just IT projects. "Your stakeholders are being encouraged to take risks of their own, completely outside the realm of IT. They know about risk. They also know about being lied to. Concealing risk from them is a pretty inconvenient tactic" [11].

B. Economic exposures

The overarching risk considerations in international business and multinational financial management has been the potential influence of changes in foreign exchange rates on future corporate cash flows and the related effects on long-term competitiveness. In addition to this, there have been frequent discussion of political, sovereign and country risk associated with international funds transfer and cross-border investments [1].

Many historical events illustrate the potential effects of fluctuations in foreign exchange rates and volatile financial market prices, in general. When companies borrow money to invest in commercial activities, hey expose themselves to changes in the credit terms and conditions offered by financial market participants and at the same time fall victim to the changing returns and playback periods offered in turbulent business environments. These exposures are associated with the underlying volatility of various market prices. When corporations trade overseas and operate in the international financial markets, they become sensitive to changes in foreign exchange rates as receivables and payables are executed in other currencies than that of the home market that typically constitutes the company's currency of accounting. Changes in interest rates affect the value of corporate dues on accounts payable and various loan obligations and cause comparable changes in the real terms for receivables, loan extensions and commercial cash flows. Similarly, the development of commodity prices can have significant influences on earnings in corporations that depend on steady supplies of productive inputs and raw materials, including agricultural products, metal, energy, etc. Given the at times extreme variance in different market price, these corporate exposures can be of high significance [1].

Many different market prices, including interest rates, foreign exchange rates, energy prices, commodity prices, consumer prices, etc. pertain to financial and commercial assets traded and exchanged between counterparts operating across numerous interacting national economies. Some of these prices trends are obviously more important than others are, in a specific corporate context. That is, it is necessary to determine the market price developments that exert the highest influence on operating profit and consider ways to manage fluctuations in these prices. When market prices vary in unpredictable directions over time, they can have significant influences on corporate earnings and may affect longer-term competitive conditions. The classical stories of Caterpillar and Volkswagen provide ample evidence of these risks factors (Caterpillar – the dollar foreign exchange rate and Volkswagen – the euro foreign exchange rate [1].

In the case of Caterpillar, major swings in the value of the US dollar during 1980s affected the margins commanded by the company when selling its products in overseas markets, as most of the manufacturing took place in the domestic US market. Hence, a strong dollar during the early 1980s made the company’s products relatively costly and hence less competitive overseas, whereas the subsequent weakening dollar had the opposite effect, while causing some conspicuous accounting losses and gains. This eventually urged the corporate executives to establish a specialized group dedicated to the management of the company’s currency exposures. Volkswagen gained quite comparable experiences because of periodic appreciations of Deutschmark in the early 1990s and a decade later in connection with a surge in the value of the euro that caused corporate management to adopt policies that are more conservative hedging against major currency exposures [1].

a. Foreign exchange rate exposures

Foreign exchange rate exposures arise when there is a mismatch between the currency denomination of corporate receivables and payables (Figure 4).

To the extent that such a mismatch exists, there is a high degree of uncertainty as to what the resulting net future cash flows, will be when converted to the home currency [1]. In terms of practical risk management considerations, it is important to identify, analyze and monitor the structure of the implied currency cash flows with different maturities to assess potential short- and long-term effects of changing foreign exchange rates.

This can be accomplished by developing periodic cash flow projections and calculating the currency mismatch for different future time intervals, for example. This type of monitoring system provides the basis for evaluating the size of potential loss effects from particular foreign exchange rate developments and determines appropriate gapping positions in view of expected market uncertainties and the corporate ability to withstand potential losses [1].

b. Interest rate exposures

Interest rate exposures arise when there is a mismatch between the interest rate basis of corporate assets and liabilities (Figure 5). To the extent that such a mismatch exists, there is a high degree of uncertainty as to what the resulting future cash flows from interest payments will be. In principle, the interest rate mismatches should be considered for each of the currencies in which the corporation has major assets and liabilities [1].

In practice, the organization may identify, analyze and monitor the implied periodic re-pricing gaps that exist between assets and liabilities in different currencies over alternating future time intervals. This allows corporate management to assess the potential effect of changes in the level of interest rates with different maturities. Interest rates may change across the board or there may be changes in the interest rate structure where changes in short- and long-term interest rates differ. The potential losses associated with changing interest rate scenarios can be evaluated in view of the corporate capacity to withstand external market shocks of this nature [1].

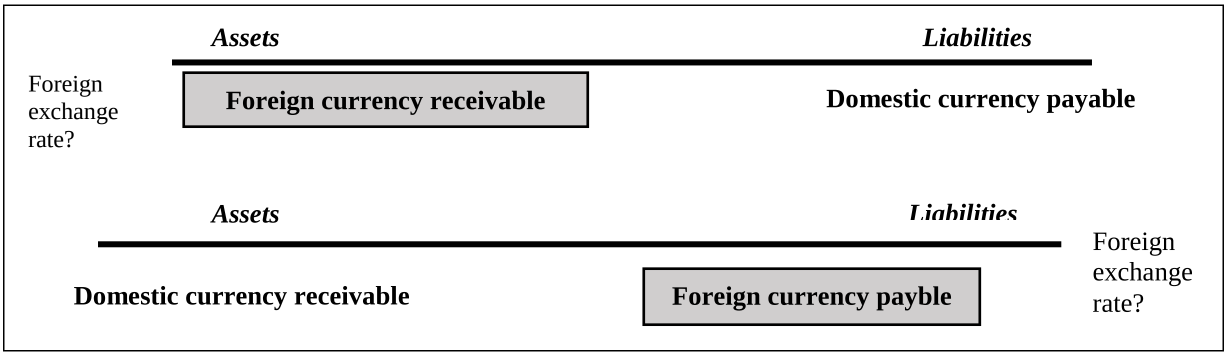


Figure 4. Foreign exchange rate exposures (adapted from [1])

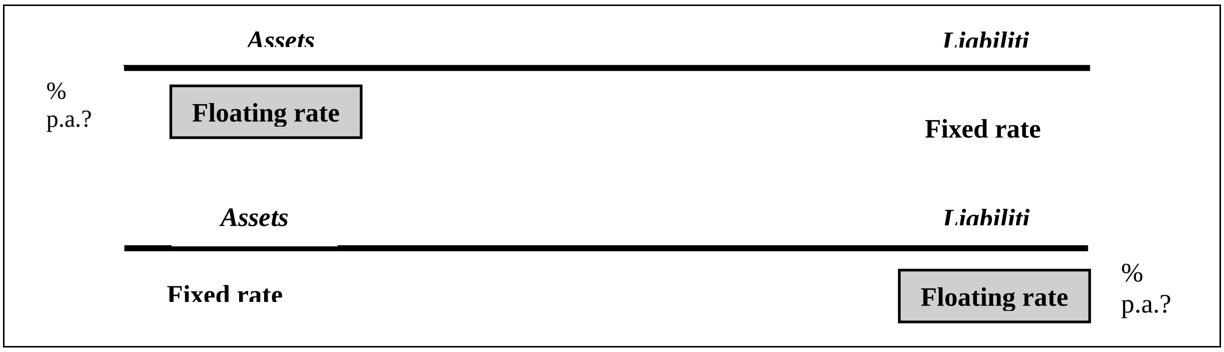


Figure 5. Interest rate risk exposures (Adapted from [1])

When interest rates changes, the net present value of future cash flows will adapt accordingly – that is, when rates go up, the value of future cash flows goes down, and vice versa. Since the future cash flows of assets and liabilities with variable rate structure are adapted more or less in accordance with changes in the interest rate level, floating-rate instruments are less price sensitive than fixed-rate instruments where future interest payment remain constant. Hence, the effect of changing interest rates in a given currency can be assessed in terms of their effects on the net present value of assets and liabilities. The concept of duration provides an indication of the relative price sensitivity of a given string of future cash flows, for example, of a security or commercial venture [1].
Looking upon corporate business activities as future earnings streams or cash in-flows and liabilities as source of funding to be repaid makes it possible to assess the interest rate sensitivity of the corporate equity position under changing economic scenarios [1].

c. Interact effects of market-related risks
The price relationships between different commercial markets are determined through a complex set of interacting supply and demand conditions across numerous intertwined industry value networks. Similarly, the relative prices between different countries are influenced by national economic policy variables as they affect economic conditions and commercial opportunities. The myriad of commercial transactions that take place among agents throughout the global economy shape the intricate relationships between different market prices as well as price relationships in one national economy affecting conditions in other economies through various cross-border transactions. Hence, the foreign exchange rates that determine the conversion between two currencies are related to the relative demand conditions, inflationary pressures and interest rate developments in the respective currency areas. Similarly, the price developments across different productive inputs, such as capital, labor, raw materials, energy, etc. and prices for different types of output, including semi-products, final goods and various services, interact in ways that link transnational price developments together. Therefore, when corporations consider the aggregate economic effects of these complex market developments, the underlying price relationships must be taken into account. However, the implied price risks should only be aggregated if they are completely independent of each other because the market-based price risk is reduced by diversification when the price changes are interrelated [1].
Different elements of the economic conditions are intertwined. For example, when demand is increasing, inflation goes up and interest rates increase to retain real returns. As nominal interest rates change between currency areas with different economic conditions, the foreign exchange rates that determine the exchange value between the two currencies will adapt accordingly [23]. Since these changes are interrelated, all of these effects should be taken into account when assessing the corporate economic exposures.
However, the analyses of transaction exposures treat both the quantity sold and the sales price as being independent of changes in foreign rates [1]. While this may be the case over shorter periods, the likelihood of adjustment increases over time and thus becomes more important in the assessment of longer-term operational exposures that deal with extrapolations of future cash flows foreign currencies.
One consequence of this may be that it only makes sense of hedge future foreign exchange positions over times where there is a little transnational adaptation between economic conditions and financial market prices. It also means that when economic exposure are evaluated within a multinational corporate structure over longer time horizons, it is necessary to consider the interacting effect of all market-related risks at the same time [23; 1].

C. Political events
In order for a company to identify, measure, and manage its political risks, it needs to define and classify these risks. In Figure 6 presents a typology of the political risks facing organizations as being firm-specific, country-specific, or global-specific [22].

- Firm-specific risks (micro risks) are those political risks that affect the organization at the project or corporate level. Governance risk is the main political firm-specific risk.
- Country-specific risks (macro risks) are those political risks that also affect the organization at the project or corporate level but originate at the country level. The two main political risk categories at the country level are transfer risk

and cultural and institutional risks. Transfer risk concerns mainly the problem of blocked funds, but also peripherally sovereign credit risk. Cultural and institutional risks spring from ownership structure, human resource norms, religious heritage, nepotism and corruption, intellectual property rights, and protectionism.

- Global-specific risks are those political risks that affect the international organization at the project or corporate level but originate at the global level. Examples are terrorism, the anti-globalization movement, environmental concerns, poverty, and cyber-attacks.

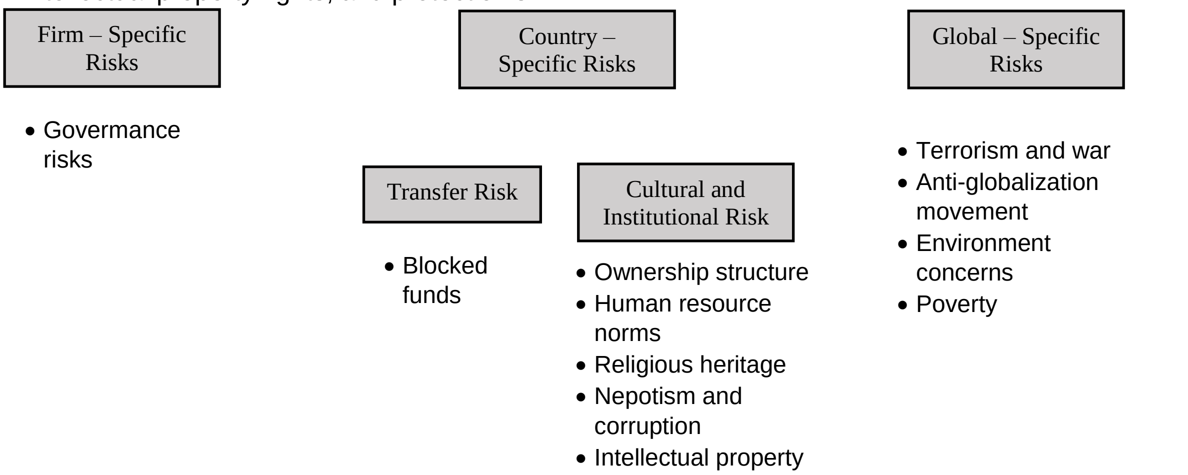


Figure 6. Classification of political risks

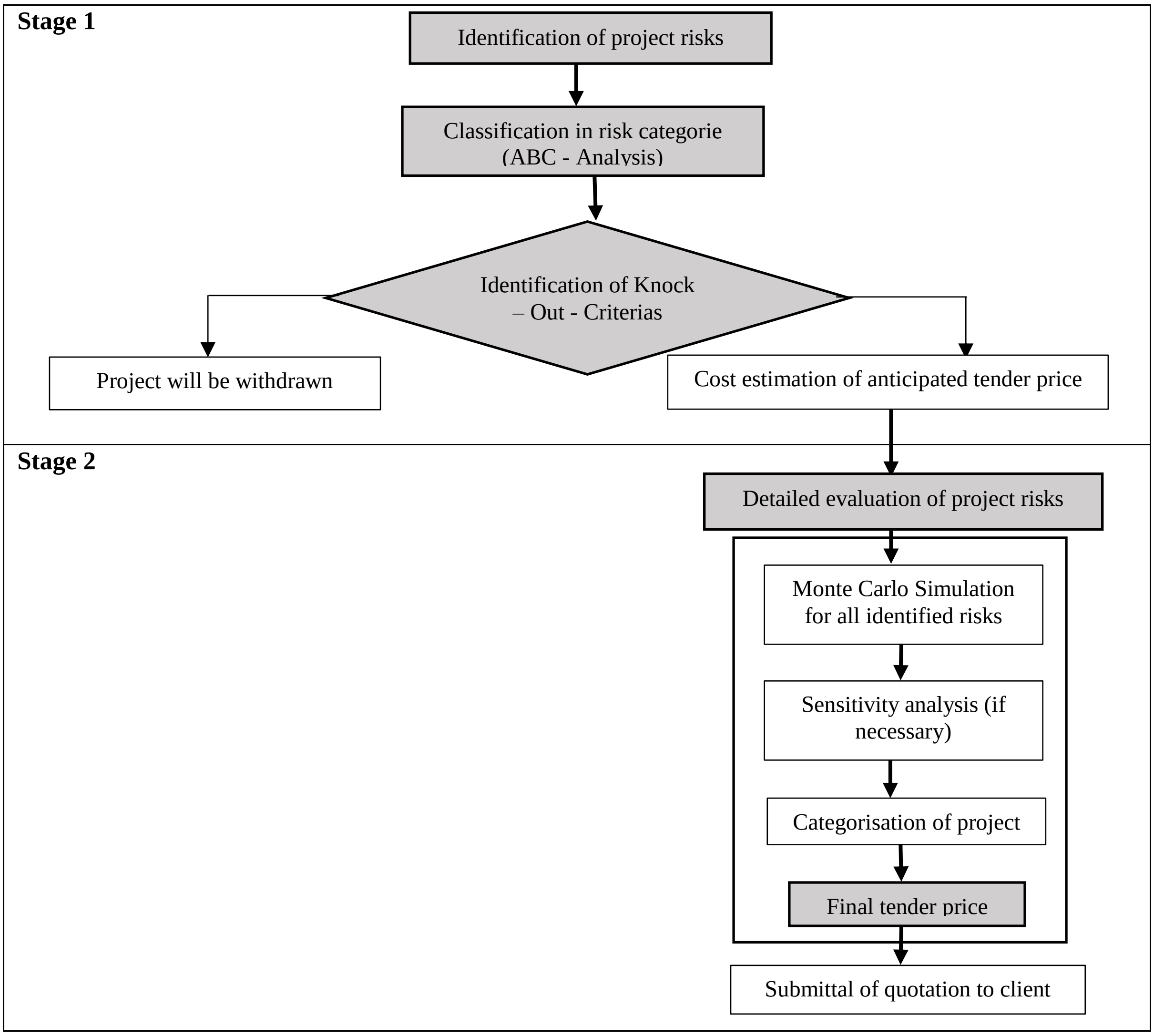


Figure 7. Practical Workflow within Cost Estimation Procedure

This method of classification differs sharply from the traditional method that classifies risks according to the disciplines of economics, finance, political science, sociology, and law. It is preferred this classification system because it is easier to relate the identified political risks to existing and recommended strategies to manage these risks [22].

How can multinational firms anticipate government regulations that, from the firm's perspective, are discriminatory or wealth depriving? Normally a twofold approach is utilized. At the macro level, firms attempt to assess a host country's political stability and attitude toward foreign investors. At the micro level, firms analyze whether their firm-specific activities are likely to conflict with host-country goals as evidenced by existing regulations. The most difficult task, however, is to anticipate changes in host-country goal priorities, new regulations to implement reordered priorities, and the likely impact of such changes on the firm's operations [22].

D. Environment concerns

Organizations have been accused of exporting their environmental problems to other countries. The accusation is that organizations frustrated by pollution controls in their home country have relocated these activities to countries with weaker pollution controls. Another accusation is that organizations contribute to the problem of global warming. However, that accusation applies to all firms in all countries. It is based on the manufacturing methods employed by specific industries and on consumers' desire, for certain products such as large automobiles and sport vehicles that are not fuel efficient [22].

Once again, solving environmental problems is dependent on governments passing legislation and implementing pollution control standards. In 2001, the Kyoto Treaty, which attempted to reduce global warming, was ratified by most nations, with the notable exception of the United States. However, the United States has promised to combat global warming using its own strategies. The United States objected to provisions in the worldwide treaty that allowed emerging nations to follow less restrictive standards, while the economic burden would fall on the most industrialized countries, particularly the United States [1].

III. IMPLEMENTATION OF RISK ASSESSMENT IN ESTIMATION PROCEDURE: CASE STUDY

III.1. Two-stage system and comprehension of Monte Carol Simulation – Methodological Aspects

The specific risks for a project are classified in categories and are respectively evaluated. Risks and their number diversify from project to project. However, a risk with knockout criteria is an important measure for assessment of each project. Therefore, a two-stage system for the aggregation of project risks is implemented. In the first stage, all risks are analyzed. Afterwards the critical risks for the project will be evaluated in detail. The Monte Carlo Simulation (MCS) is emphasized in this evaluation process, because the results of the MCS are significant when compared to other risk analysis methods [4; 27; 35]. In this context and in regards to the risk management circle the stages are defined as follows (Figure 7): Stage 1 = Phase 1 + 2 (identify and analyze the project risks) and Stage 2 = Phase 3 (evaluate the risks with MCS) and preparation for Phase 4 (monitoring). The risk monitoring (Phase 4 of risk management circle) will be done within construction process. The results of the preliminary work within the tender process will be used therefore. The practical workflow within the cost estimation procedure in shown in Figure 3. The following example shows a model that explains the procedure and the two-stage system as described in above capture. There are several complex software tools for simulating cost estimation. The results of the cost estimation have to be evaluated with a dynamic simulation tool. The simplest version is Microsoft Excel. The steps according stage 1 to find and classify the risks have to be done in advance. In regards of a simplification and to comprehend the procedure, the example evaluates the subcontractor risk only. In normal cases, all risks within the different cost elements would be evaluated in detail and would be therefore part of the model.

A. Application on Risk Evaluation

a. Stage 1 = Cost Estimation of Anticipated Tender Price

Table 1 shows the result of the cost estimation of the anticipated tender price because of Stage 1 ("Scenario 0" = Base Estimate). This estimation is based on the daily market prices and no dynamic effects are included.

Table 1. Cost Analysis for Scenario 0 = Base Estimate [Euro]

Direct (Site Costs)	Scenario 0 Baes Estimate
K.1 EMPLOYEE WAGES	2000000
K.2 MATERIAL	500000
K.3 INDIRECT MATERIAL	50000
(Trainings, ETC.)	13250000
K.4 SUBCONTRACTORS	
SC1	2200000
SC2	1800000
SC3	6000000
SC4	5000000
SC5	2000000
SC6	1500000
SC7	2000000
K.5 EQUIPMENT	100000
K.6 FREIGHT	50000
K.7 CUSTOM	300000
Sub-Total Directs:	23700000
Indirect (Site Costs)	
Management, Yards, etc.	1500000
Direct + Indirect	25200000
Company Overhead + Risk & Profit	
Z.1 F.E. (8%) = eff. 8.70 % V.A.	2142600
Total:	**27342600**

Impact CO + Risk & Profit:	**8.00%**

b. Stage 2 = Risk Evaluation with MCS

After the cost estimation (Scenario zero), every risk will be discussed in detail by the project team. For regular and practical cases, the triangular distribution with the threshold values Minimum, Mean and Maximum is useful. Other continuous distributions, for instance rectangular distribution, beta distribution, normal distribution or uniform distribution, could be used in this context too.

Following the definition of the threshold values (Scenario 1) the MCS starts with the input values according Table 2. Table 3 shows the summary information in regards of the MCS procedure. A number of 10.000 iterations are useful and practicable.

Table 2. Threshold values as basis for MCS (Scenario 1)

	Scenario 1 - **Risk Evaluation of Subcontractor Cost**			
Direct (Site Costs)				
K.1 EMPLOYEE WAGES				2000000
K.2 MATERIAL				500000
K.3 INDIRECT MATERIAL				50000
K.4 SUBCONTRACTORS	Minimum	Mean(Base Est,)	Maximum	20761667
SC 1	2000000	2200000	2500000	2233333
SC 2	1780000	1800000	1825000	1801667
SC 3	5950000	6000000	6500000	6150000
SC 4	4800000	5000000	5300000	5033333
SC 5	1950000	2000000	2100000	2016667
SC 6	1400000	1500000	1650000	1516667
SC 7	1980000	2000000	2050000	2010000
Total	19860000	20500000	21925000	
K.5 EQUIPMENT				100000
K.6 FREIGHT				50000
K.7 CUSTOM				300000
Sub-Total Directs:				23961667
Indirect (Site Costs)				
Management, Yards, etc.				1500000
Direct + Indirect				25461000
Company Overhead + Risk & Profit				2321733
Z.1 (Factory of Influence)				
Total:				**26783400**
Mean CO + Risk & Profit:				**8.66%**

Table 3. General simulation information

Number of Simulations	1
Number of Iterations	10000
Number of Inputs	7
Number of Outputs	1
Sampling Type	Monte Carlo

B. Interpretation of the Results achieved after the MCS

The results of the simulation process are displayed in Figure 8. The total error (E) is calculated according to the relation $E = 3b/\sqrt{N}$, where b is the standard deviation of the random variable, and N is the number of iterations. We can estimate an upper bound of b by calculating the standard deviation between the maximum, the minimum and average values of the random variable:

b = STDEVP (I2:I3, AVERAGE (I2:I3)) = 843032.7198 (1)

Note that it was used the function STDEVP, which calculates the standard deviation of the entire population, in this case only two values. Expected project cost will be the average of the “Total” column:

Expected cost = AVERAGE (I4:I10004) = 20892423.28 Euro (2)

Given that the variable is normally distributed, the median should be very close to the mean:

MEDIAN (I4:I10004) = 20896419.52 Euro (3)

Other useful information is the Kurtois and the Skewness of the distribution. The Kurtois is relative measure of the shape compared with the shape of a normal distribution. The normal distribution has a Kurtois of zero.

KURT (I4:I10004) = -1.209018727 (4)

This indicates that the distribution is somewhat flatter than a normal distribution.

Skewness is a measure of asymmetry. The normal distribution has a Skewness of 0.

SKEW (I4:I10004) = -0.006966892 (5)

Calculations done (formula 5) indicates that the tail of the distribution extends towards the right.

The results can also be represented as probability distribution. Figure 9 shows the density for the example.

Activity	**SC1**	**SC2**	**SC3**	**SC4**	**SC5**	**SC6**	**SC7**	**Total**
Minimum	2000000	1780000	5950000	4800000	1950000	1400000	1980000	19860000
Maximum	2500000	1825000	6500000	5300000	2100000	1650000	2050000	21925000

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Figure 8. Costs values for Monte Carlo Simulation

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Figure 9. Density Graph

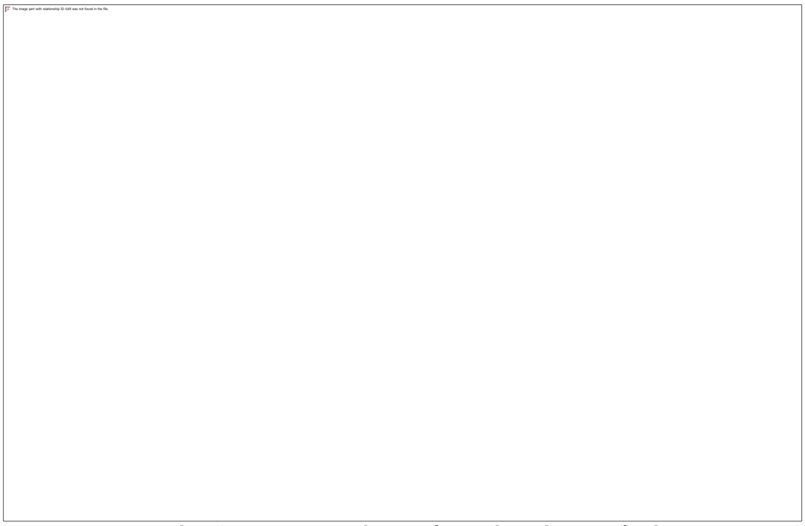

Figure 10. Regression Value (Impact CO + Risk & Profit / Risk Evaluation of Subcontractor Cost)

The maximum figure for company overhead and risk + profit will be 9.84 %, but this figure is the upper limit and will only be achieved if all positive circumstances would occur. Therefore, the implementation of Value at Risk (VaR) is also necessary under this point of view. The result for VaR95% is 8.26%. That means with a probability of 95 %, the figure for company overhead and risk + profit will not exceed 8.26%. In other words, only with a probability of 5%, the figure for company overhead and risk + profit will exceed 8.26%.
After the first simulation, additional MCS are possible and the input values could be analyzed via sensitivity analysis according stage 2. That means, every input value has to be changed, for example in 10% steps, and the MCS will be started successively with different input values. The results of the sensitivity analysis are interpretable and showing the influences of the alteration of every individual input value.
Another evaluation is possible to show which individual risk has a main influence of the result for company overhead and risk + profit. Figure 10 shows the result of these evaluations as regression coefficients. That means, that Subcontractor 3, 1 and 4 have a huge influence of the company overhead and risk + profit. Therefore, these subcontractors have to be monitored very carefully within the succeeding construction phase after potential contract award.

C. Preliminary conclusions on the risk evaluation of new project starting situation

The introduced procedure shows that risks for IT projects are analyzable and evaluable. The procedure gives the management the possibility of a better overview of project risks and explains consequences of a too rash risk acceptance. An IT project and its risks will be more transparent. After a contract award, the identified and evaluated main risks are monitorable and controllable. Therefore, a consequent concentration of the main risk items of a project is possible. This procedure places the management in a better position for understanding and assessment of a project and its risks. Furthermore is it possible to filter high risk projects in a very early stage and monitor these projects separate.

IV. VALUE-AT-RISK FOR PROJECT EVALUATION: CASE STUDY

IV.1. Calculations and results

For illustrative purposes, a first simple project will be considered. Over its projected length of one year, this project will necessitate cost of about 100 monetary units (Euro), and is projected to generate positive cash flows of 140 Euro with probability:

- p_1= 0.4, of 1.400.000 Euro,
- p_2= 0.2, of 1.200.000 Euro,
- p_3= 0.2, of 1.000.000 Euro,
- p_4= 0.1, of 800.000 Euro,
- p_5= 0.0, of 0 Euro.

No embedded options are considered at this stage. The resulting probability distribution for project value after one year therefore is discrete and is easily constructed. Setting a confidence level of 95% allows to easily determining the cut-off point in this distribution, leading to an absolute value-at-risk below zero of 1.000.000 Euro, or a relative value-at-risk to the mean of 1.080.000 Euro. While this seems straightforward and trivial in this simple case, stating these figures already offers additional information regarding risk for the project, and might serve as an important complement to reporting only mean project value, or a measure like discounted cash flows [17].
Next, it will be considered the case of a software growth option, implementing a web-based e-commerce system, embedded into a platform change from “Venice” to “Concert”.

Given the spot price: $S_0 = 880.000\ Euro$
Volatility is σ = 0.8

Using Black-Scholes formula [9] we have a 514.000 Euro as result, with $\Delta = 0.7756$.

Using Delta-normal valuation and 95% confidence level (corresponding to $\alpha = 1.645$ in equation:

$$\mathrm{VAR} = |\Delta_{\mathbf{0}}| \times |VAR_S = |\Delta_{\mathbf{0}}| \times (\alpha\sigma S_0) \qquad (6)$$

Results in a value-at risk of 898,207 Euro.

For illustration, we it will be expanded on treatment of the option presented above complemented with the main platform project. Again, data are taken from [33], although a volatility for the main project of $\sigma_{project} = 0.2$ is introduced. Data for the web-based e-commerce system remain unchanged from last section. Furthermore, we presume the presence of two risk factors, with each position exposed to one of them, the option according to delta-normal method with delta 0.7756, and the platform project with its full value at 416,500 Euro. Last, a correlation of 0.3 is assumed between the risk factors.

Using VAR = $\alpha \sqrt{X'\sum X}$ at confidence level 95% corresponding to $\alpha = 1.645$ gives.

$$VAR_{div} = 1.645 \sqrt{[-416{,}500 \;\; 0.7756x880{,}000]} \times$$
$$\times \sqrt{\begin{bmatrix} 0.2^2 & 0.3^2 \\ 0.3^2 & 0.8^2 \end{bmatrix} \begin{bmatrix} -416{,}500 \\ 0.7756x880{,}000 \end{bmatrix}} = 828{,}907 \text{ Euro}$$

The portfolio value-at-risk therefore is 828,907 Euro, due to diversification smaller than the sum of individual value-at-risks (the undiversified value-at-risk) of:

$$VAR_{undiv} = VAR_{project} + VAR_{option} \qquad (7)$$

$$VAR_{undiv} = (1.645 \text{ x } 0.2 \text{ x } |-416{,}500|) + 898{,}207 =$$
$$= 137{,}028 + 898{,}207 = 1{,}035{,}235 \text{ Euro.}$$

Analyzing the portfolio value-at-risk, the change in value-at-risk due to addition of a new position can also be computed, termed incremental value-at-risk, as well as component value-at-risk, giving the reduction of the portfolio value-at-risk resulting from removal of a position. Due to diversification, both measures would in most cases be different from the individual value-at-risk of the position. This allows for in-depth analysis of components in a portfolio, or could even be used as a constraint for portfolio optimization [17].

IV.2. Preliminary conclusions on value-at-risk for project evaluation

This sub-chapter has presented and argued for adopting the value-at-risk approach in the evaluation of single project and also portfolios constructed from these projects and/or related real options. As has been detailed, value-at-risk is a common and accepted measure in the finance sector, and offers several advantages in the area of IT projects. While several approaches for computing value-at-risk exist, not all of these might be applicable for IT projects, as large historical samples will mostly be absent. On the other hand, both Monte Carlo simulation and an analytical approach seem feasible.
Using small, illustrative example, it has been shown that value-at-risk can indeed offer additional information in evaluating single IT projects or real options on such projects, offering an easy to interpret way of quantifying and comparing associated risks, and especially in evaluating IT project and/or option portfolios, as this method explicitly accounts for diversification effects. In addition, the changes in risk due to changes in the portfolio, both from eliminating and adding new elements, can easily be determined, making value-at-risk a useful tool for risk management, complementing and extending the real options approach.
If value-at-risk is indeed adopted, many further enhancements are possible, including the introduction of risk adjusted performance evaluation of business units or project managers, using profit over value-at-risk for assessment. Naturally, many further issues still need to be investigated in the context of value-at-risk for IT projects, especially the definition of primitive risk factors, the mapping of positions to these and others. Nevertheless, adopting value-at-risk might provide important additional information for IT decision makers, and might constitute a necessary step towards IT risk management.

V. EVALUATION AND CONCLUSION

The study was set out to explore the concept of managing risks on projects, process that includes risk assessment and a mitigation strategy for those risks designed to eliminate or minimize the impact of the risk events – occurrences that have a negative impact on the project. The study has argued for adopting whether the value-at-risk approach in the evaluation of single project and portfolios constructed or implementing the risk assessment in cost estimation in order to verify MCS model, also. The study sought to answer three of these questions:

1. How are risks and risk management perceived in a software project?
2. How possible events and associated risks can affect project objectives?
3. What analysis tools help to reduce risks effectively?

As per content of this paper, risk management can be considered as Project Manger's friend. Done well, it helps to ensure that the 'appetite for risk' is appropriately understood at the start, that all the risks are agreed upon, prioritized, assessed, communicated and understood in alignment with this 'risk appetite'. There is always the potential of 'unknown' impacting a project, but the more it can be assessed reasonable risks from the start of the project and actively manage them throughout, the better placed we will be as a team that realize a positive outcome for the project.

When speaking about risk management we understand that it means we are dealing with a complex activity, which involves, among others, a strong relationship between members of the project team in terms of project information sharing or applying some complex RM models in the project plan. All these arguments, but not exclusively, justify the use of the specialized tools that can assist the risk management activities. The great benefit is provided by speed of work. Once the data are collected and filled into the system, any operations (budget sheets, schedules, plans etc.) can be done in minutes. Moreover, with Intranet/Internet technologies all these can be done from outside the decisional office.

Another major benefit is economy. In most of the cases, the computer is providing important advantages in terms of cost comparing with the manual system. Supposing that the data were filled in correctly, the possibility to make mistakes in processing them are reduced to minimum and updating them can be done with low cost.

There are many software solutions for project risk management, tools for identifying and evaluating risks in IT projects and not only. There are numerous software solutions available to model MCS. @Risk® is an add-in for Microsoft® Office Excel, which mostly handles cost risks and risk drivers. ORACLE® Primavera Risk Analysis is a standalone application that will model risks, costs, and schedule.

The key to successful contingency planning based on MCS lies in whether the project manages risk continuously versus a discrete or even a periodic risk management approach. In the past, document and information management challenged, even taxed, projects in ways that made disciplined, continuous risk management too costly. The investment of time and resources to build the model for a MCS was prohibitive for medium and small projects; only large projects could afford the overhead for such an undertaking.

Today, with electronic information storage and transfer within the project as well as outside the project, capturing the data needed to build and simulate project risks and cost estimates via a MCS is considerably less costly and less difficult than before. With sophisticated software tools that operate on a desktop, rather than a multi-floor, computer, MCS run faster and provide a more comprehensive suite of analysis tools. Now that MCS are easier and faster to prepare, the benefit of this analysis is more readily available for medium-sized and smaller projects.

Managing uncertainty, incorporating contingency based on risk drivers with consideration of cost and risk correlations, demonstrating the cost benefit of risk management and reducing cost capital are easily achievable. Care must be given when running MCS. There are many ways to create difficulties when it comes to this complex process. Although benefits are real and important, only the skillful use of MCS can yield powerful results.

The scale of this debate is therefore extensive even at the level of cost estimation. To generate achievable policy strategies and development targets concerning an accurate analysis of risks, there is need for more case studies to allow further assessment of dimension of the subject. Exploring duration estimates as future research strategies can facilitate the attainment of this goal.

Although widely accepted and used, MCS methods and so the @Risk for Project has some weakness because is a unidirectional model and does not offer some interactive link between data and parameters.

Despite of what is often reported about software industry that pays more lip service to risk management than it actually performs, the study has shown that running toward risk rather than away from it is an indication that the organization has reached it adult state.

The limitation of the presented research is because it focuses on the software industry and is based on theories of risk management described in limited references that were considered. The research was complemented by a study of a software project implementation in a small and medium size enterprise that operate in software development industry, but in cooperation with some of the stakeholders (related to the enterprise and the considered project). Other research limitation is related to time dimension: the considered case study project was investigated during the planning and design phases only, focusing on costs estimation analysis.

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