



**The risk management process on transport infrastructure works**

**By**

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**A THESIS REPORT  
Presented to the Project Management Program in the  
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MASTER OF SCIENCE OF PROJECT MANAGEMENT**

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To my lovely Mom.

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Dionisis V. Arkadinis

June 2010

## Curriculum Vitae

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I acquired my bachelor degree from the department of Civil Works and Infrastructure Technology that exists at the Faculty of Technological Applications of the Technological Educational Institute of Athens.

My working experience started three years ago when I worked in the Ergoependytiki S.A for two years as a site manager in the repair and the extension of buildings. I have been working in the School of Pedagogical and Technological Education as assistant teacher on the laboratory of the traffic systems and studies since 2009.

In addition, I am also employed by the Ministry of Labour and Social Insurance as an advisor to the Minister for issues that are related with the company Olympic Village 2004 S.A which is subsidiary of the Workers Housing Organization.

## Abstract

For many countries, in the last decades the construction field and specifically the transport infrastructure projects are the lever for their high growth. The same thing applies in Greece since today.

Through this paper I will present theories and studies of the risk management process in the construction industry and how the risk estimation of a project can be affected.

In the end it will be an evaluation of the risk management procedure that is followed by the Greek construction firms through a quantitative research, it will present the weaknesses and the oversights of the risk management process and how the mistakes could be minimized in the specific process of the project management.

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## Introduction

### *Nature of the study*

The competition in the constructional sector and more specifically on transport infrastructure works field is very big and it has been increased dramatically after the end of the Athens 2004 Olympic Games because there has been a reduction of public work in Greece. The project management process has become necessary in all construction corporations after the big competition, with the aim of a better implementation in projects. The risk management process is basic and necessary on transport infrastructure works and influence a project at cost, quality and the schedule.

This study will try to discover the weaknesses and oversights that exist in a risk management process, how the risks are integrated in the estimation of a project and how much the economically impact in the project from a failed risk management procedure will be evaluated.

### *Needs Assessment*

The stakeholders in a project on transport infrastructure works, except the project manager and the project team, are the Greek government and the construction corporation that has taken the responsibility of the effectuation of the project. In addition, the corporation might be one of the customers in the case that the project is being co-financed. Through the improvement of the risk management procedure and the minimization of the mistakes that come from risk management that influences the estimate of a project, the construction corporations and the Greek government will be in place to economize on the project. This thesis will present analytical:

- Definitions about risk and risk management process
- Presentation of the risk management phases
- Adoptions that have been made from the construction industry about its application of the risk management process.
- Tools and techniques that is used in the risk management process.
- Alternative options for the estimation of a project.
- The connection between the risk management process and the estimation of a project.

#### *Purpose of study*

The expectations of this study are that the outcome will be a useful tool for constructions in order to help them improve the risk management procedure and to minimize the mistakes in a project that comes from the risk management and may influence the estimate of a project.

#### *Relation to the Program of Study*

My thesis is related with the following courses of the program and will help me to better comprehend my issue: Project Risks and Decisions and Project Financial Management.

PM 508, Project Risks and Decisions is one of the nine knowledge areas that are included in the Project Management. It provides a systematic approach of how a project manager can handle a risk in the entire life of a project and describes a complete risk management procedure that can be followed from a project manager for a project.

PM 507, Project Financial Management helped to realize some very sensitive financial elements that were noted in a project. It explains which the criteria are for the investors when they select a project and how they can identify opportunities for an organization in the global

market. Also, it is very important for a project team to understand the financial concepts of the project that will help them have a successful project on cost. Some of these financial basics are the estimation of the project, an effective resource planning, cash flow, pricing methods and the value of money.

### Problem Statement

There are negative financial consequences on the transport infrastructure works- field due to weaknesses and oversights of the risk management process followed by Greek construction corporations.

### *Rationale*

The construction industry for the last two decades was one of the main sectors that influenced the Greek gross domestic product. The Technical Chamber of Greece has enumerated more than two thousands firms that have the right to construct a transport infrastructure project and most of them used the project management.

Nevertheless, the number of the construction firms that undertake an infrastructure work either as a contractor, or either as a part of a public-private partnerships do not surpass the one hundred.

The transport infrastructure works have a lot of specifications that influence the scope of a project and for this reason it is difficult for a construction firm to assume the construction of a bridge, a highway road or a port.

The construction firms dedicate a lot of the time to make a study for the construction of these project, which includes details of the resources that will be used.

Nowadays, one of the threats that the construction firms face are the derailment in the budget of a project and one reason that can economically affect a project is the risks that are exposed.

For this reason the corporations give a lot of attention in a successful risk management procedure that will help them avoid financial consequences, a minimization of the profit losses and have a success driver in their projects.

### *Objectives*

The objective of this thesis is to evaluate the process of risk management that is followed from the construction firms in the transport infrastructure works' field. The identification of the oversights and gaps on the procedure will drive in proposals that will minimize the mistakes that give birth to negative financial consequences on a project.

### Review of Literature

The scope in the literature review of my master thesis is to cover the theory of the two areas, related to the problem statement. These areas are the risk management theory and the project financial management theory. The first area which is the risk management theory apart from the definitions, I will conclude the steps of the risk management process and how it is used in the transport infrastructure work field.

In the second area of the project financial management theory I will find finance definitions and adoptions of a method for the estimating of a project and how the risks are included in an estimate of a project

#### *Risk Management*

All the transport infrastructure works are unique, complex and multidimensional projects. The construction of a highway road or the construction of a bridge has long term duration, a big budget and many specifications and requirements in their studies. In the construction industry, the project management is necessary because all the construction firms or corporations are anxious for their projects to be on time, on schedule and on scope.

Carol Jacobson and Sang Ok Choi (2008) in a study that has been made found that one of the majors factors for the success of the public-private partnerships and public works projects is the risk awareness. For this reason a success vision process will be the tool for a correct risk analysis and reorganization of the risk factors for these projects.

The nature of these projects has a big extension' on risks that affect many things such as the project management integration, the quality, the time, the cost, the contract procurement, the human resources, the communication plan and the scope of the project. Through the project risk management process, a construction firm tries to reduce these risks from the projects and to be in place to be complete their projects.

This is the main reason that many studies have taken place over the last decades, for the risk management process in the construction field and the effectiveness that has in a construction project.

Initially, the first question that must be answered and be clarified is what the meaning of the risk in a project is, because it has different perception for any of us. The Britain's Royal Society (1991) gives a definition as that a risk is an unexpected event that could be appeared in the duration of a project.

In the construction projects, a common phenomenon is to confuse whether a hazard is the same thing with a risk. The definition that the British Standards (as cited in Bunni, 2003) give for the hazard is "A situation that could occur during the lifetime of a product, system or plant that has the potential for human injury, damage to property, damage to the environment, or economic loss". (Bunni, 2003, p.26)

However, risk is not always related to negative meanings, but it could have positive outcomes as well. Damodaran (2008) combines the two different concepts of positive and negative outcomes and with the help of a Chinese symbol give a meaning that a risk is a combination of a threat and a chance in a project and always a project manager must have a positive view for a risk.



There are three main types of risk, associated with the foresee ability of the factors that create them and is the first distinction of the project risks. These are:

- I. known risks,
- II. known unknowns risks and
- III. unknown unknowns risks

The known risks are the risks which have a small consequence in a construction project (swings in material costs) and could be managed with any project management process. The second type of risks is these that the occurrences are foreseeable and the last one is the type which the factors that create them or the effect that could have in a project cannot be predicted.

The need of the risk management is essential when in the duration of the project the phrase “what happen if...” appears and a construction manager is getting suffered, often from this phrase. The Project Risk Management Guidelines define the Risk Management as the operation that “refers to the culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects” (Cooper, Grey, Raymond, & Walker, 2005, p.3) and has as a scope to manage the risks that have been identified from the project management team.

P.J. Edwards and P.A. Bowen (1998) give a more clarified definition for the risk management and state that “Risk management is a systematic approach to dealing with risk. A risk management system should: establish an appropriate context; set goals and objectives; identify and analyze risks; influence risk decision-making; and monitor and review risk responses”.

The risk management process is not a forecast of the future of a project; it is a procedure that shows how much a construction manager is aware of the requirements of his project. These requirements are totally connected with the cost, the scope and the schedule of the project, and all these elements could be affected from various risk events.

The first attempts to integrate a formal project risk management process into the construction field, have been made from Flanagan & Norman (1993) who define the risk management as “a discipline for living with the possibility that future events may cause adverse effects” (Flanagan, & Norman, 1993, p.46). In this frame they suggest that the project risk management process can be divided into the follow stages: risk identification, risk classification, risk analysis, risk attitude and risk response.

An alternative model has been presented from Chapman & Ward (2003), which promote another risk management process for organizations that have no experience in risk management. As shown in figure 1, in this model the project risk management process is divided into nine stages and described it as a finish to start procedure.

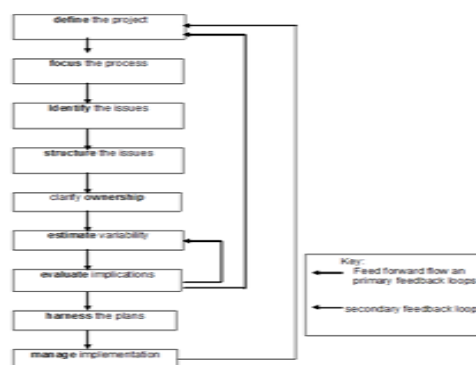


Figure 1: SHAMPU (Share, Harness and Manage Project Uncertainty) flow chart portyal (Chapman and Ward, 2003)

Also the process and the guide that I will follow and use as the base for my survey is from the Project Management Body of knowledge (PMBOK 2004) which includes the following six phases:

- ❖ Risk Management Planning
- ❖ Risk Identification
- ❖ Qualitative Risk Analysis
- ❖ Quantitative Risk Analysis
- ❖ Risk Response Planning and
- ❖ Risk Monitoring and Control.

#### *Risk management plan*

The risk management plan is the document that explains how the risk management intensity in the project life cycle is. It also describes the tools and the information's sources that will be used from the firm for the risk management execution.

Other elements that someone could find in the risk management plan is the roles and the responsibilities that the members of the team in the PRM process have, as well the budget that is required for the risk management and how it will influence the schedule of the project from the risk management activities.

The most critical input in a risk management planning is the culture and the policy each organization has, as it determines the progress of the procedure and the strategy that the construction manager will follow. These two things show how the corporation will deal with the risk events in a project and the amount of risk tolerance which will be acceptable from the

firm. The project manager has a key role about the risk tolerance of the project, because he is correlated with the unique temperament that each of them has.

However, in the composition of the risk management plan one of the most remarkable points is the categorization of risks that any company or organization will use for the risk identification phase. The classification of risks can be accomplished with many ways.

The Risk Management: Concepts and Guidance book that was published from the Defense Systems Management College is classified into five areas: Technical, Programmatic, Supportability, Cost and Schedule. In Project and Program Risk Management (PMI, 1993) another approach of categorization is also presented according to the affect that a risk can have in the four pillars of the project: Scope risks, Quality risks, Schedule Risks and Cost risks. The disadvantage of this approach is that a risk could affect more than one category resulting in the project team inaccurate counting of risks.

In the construction field, J. H. M. Tah & V. Carr (2000) explains the need of a “common language” for the risk description and taxonomy that must be followed by any construction corporation if they want to have a success risk management plan. In their approach, the risk classification is named as the Hierarchical Risk Breakdown Structure (HRBS) and has the following structure as show in the figure 2.



Figure 2: Hierarchical Risk Breakdown Structure (J. H. M. Tah & V. Carr, 2000)

Grimsey & Lewis (2002) observed that in a risk evaluation that they made for infrastructure projects, the construction firm in the period of a construction life project deals with nine types of risk. These risks are: technical, construction, operating, revenue, financial, force majeure, regulatory/political, environmental and project default (a combination from the previously risks).

Finally, the last element that is included in a risk management plan is the way that the probability and impact matrix table will be made and how the scale of the probability (numeric scale) and the scale of the impact (high, low, moderate, etc.) of each risk from the project team will be.

*Risk identification*

The risk identification phase exists in all the risk management process models that are suggested from the scientists and in the most of these proposals, it is considered as the most critical step of the entire risk management procedure. A definition of the risk identification could give as “the process of examining the program areas and each critical technical process to identify and document the associated risk” (Kerzner, 2003, p.719).

Stewart & Fortune (1995) presented an interesting model which the project management team can apply the system thinking theory as a technique for the risk identification and that could be a part of the project management planning and specifically, it could be integrated in the project scoping process.

C.H.Loch, A.D.Meyer & M.T.Pitch (2006) specify the risk identification as the step, that the project management team can recognize the factors that could affect the project plan and convert it to be not applicable. The identification phase is an essential iterative process that ends when the project is completed, for the reason that some risks could appear during the life of a project.

The inputs that are needed to begin a construction firm, the identification of risks in a construction of an infrastructure work (ports, highway roads, bridges, etc.), are many technical information, data from previous similar projects and the project management plan.

According to the Project Management Body of knowledge (PMBOK 2004) the techniques and the tools that could be used from the project management team to identify the risk events and the risk factors in a project are:

- a. Documentation Reviews
- b. Information Gathering Techniques
  - Brainstorming
  - Delphi technique
  - Interviewing
  - Root cause identification
  - Strengths, weaknesses, opportunities, and threats (SWOT) analysis
- c. Checklist Analysis
- d. Assumptions Analysis
- e. Diagramming Techniques
  - Cause-and-effect diagrams
  - System or process flow charts
  - Influence diagrams

Nigel J. Smith, Tony Merna and Paul Jobling (2006) suggest that the brainstorming technique as the most suitable technique for the risk identification in the construction field. In this proposal, the authors give a warning in obsessions that could either be individuals or groups that can affect the judgment of the team members.

As an output of the identify phase, a risk list must be describe the risk events or these tasks that must be analyzed from the construction manager who then has to make a strategy for these.

#### *Qualitative risk analysis*

The risk analysis is grouped in to two main categories, the qualitative and the quantitative risk analysis. The scope of the qualitative analysis process is to assess the impact and the

probability of the risks that have been identified and to prioritize the risks as the construction firm set for each project.

Carl L. Pritchard (2001) described the qualitative process as the first attempt of a project management team to make a risk list in relation to the probabilities and the impacts. This opinion analyzes that the rating of a risk is connected with a different risk value that came from different risk analysts' personalities. Another observation from this proposal is that the organizations must have the same terminology and the same descriptions for the "likelihood" of risks for all projects, because the risk impact could be different from project to project.

Tom Kendrick (2003) presents as a practical tool for the qualitative analysis a risk assessment table that provides two types of tables (Appendix A & B). In the first approach after the risk description, each risk is evaluated for the probability and the impact that they have. The scale that is used for both the evaluation of the impact and the probability is a simple manner (High/Moderate/Low) and has as a result for the overall risk combining the information's from the previous columns (impact - probability).

In an alternative proposal the risk assessment matrix, which is usually a square, the risks are put in a two-dimensional matrix where the rows and columns are depicting the categories of probability and impact. In the right top corner of the square is the highest risk area and in the left down corner is the lowest risk area. In the risk matrix it is common to use colors for the partition of the risks areas. This action helps the organizations members to better understand which risks are more dangerous for the project that are working.



*Quantitative risk analysis*

The quantitative risk analysis process intends to explore numerically the probability of each risk and the effect on a project, to measure the total risk exposure of the project and most importantly to determine the cost and the schedule reserves that a project will need.

Eric Banks and Richard Dunn (2003) identified that the main reason the quantitative analysis is essential for a firm is because the funds and the safety can be clarified. These needs push the organizations to measure the exploration of the risk in a project. In this study, it is suggested that mathematical measures include a crowd of mathematical knowledge of statistics, analytics, scenarios, value at risk and maximum loss. The alternate way of measure is through the experience and the intuition of each firm.

According the Project Management Body of knowledge (PMBOK 2004) the tools and the techniques that can be used from a project manager are:

- Data Gathering and Representation Techniques
  - Interviewing
  - Probability distributions
  - Expert judgment
- Quantitative Risk Analysis and Modeling Techniques
  - Sensitivity analysis
  - Expected monetary value analysis
  - Decision tree analysis
  - Modeling and simulation

In a research survey made from Akintoye & Macleod (1997), had as a study subject the construction industry of the United Kingdom and how the risk management process and the contractors react and how the project management practices. In the question of which risk management technique is preferred, all the organizations are based on intuition/judgment/experience and the second technique is used for sensitivity analysis.

Another technique that is also commonly used in the construction industry is the Decision Trees. Tom Kendrick (2003) had the opinion that this technique is “generally used to evaluate several options prior to selecting one of them to execute. The concept is applied to risk analysis in a project by using the weights and estimates to ascertain potential impact for specific alternatives.” (Kendrick, 2003, p.177)

Nowadays, the Monte Carlo simulation is the tool that is used frequently in projects such as the transport infrastructure works’ and the main reason is that the Monte Carlo simulation could respond much better when a project has many parameters.

The handbook of risk and reliability analysis for civil engineers discerns from the main advantages of the Monte Carlo simulation “that it permits detail description of the system, its inputs, outputs and parameters. All the critical parameters of the system can be included in its description. The other advantages include savings in time and expenses” (Singh, Jain, & Tyagi, 2007, p.439). In the other theory area of the financial management will be present the Monte Carlo simulation as a tool that could be used from an organization to estimate a project.

Finally, the results of a quantitative risk analysis can become a useful tool for the project manager and the other members of the team into making decisions. For this reason Vose (2008) pointed out that a risk analysis can be poor if the analyst hasn't got lots of experience

and a number of key areas (assumptions, lack of data/information's, etc) exist in a risk analysis then the quantitative risk analysis could fail if it does not meet the requirements of the risk management process.

#### *Risk response planning*

The risk response planning could be described as the reaction process, in which the project manager decides the way of handling each risk, with specific methods, separately or in a combination.

Kerzner (2003) provided and analyzed four risk handling options that could a project manager can choose in order to handle a risk:

- Assumptions, is the way that the project manager have fully aware of the risk.
- Avoidance, the project manager is not accepting the risk and drive the team in changes in the project plan.
- Control (Mitigation), project manager monitoring the risk and develop a contingency plan.
- Transfer, the project manager wants to share the risk with other stakeholder.

The transport infrastructure projects in most cases have the form of public-private partnerships or the form of a public project and this is the main reason that the construction firms would like to be unambiguous in which part (contractor -supplier-government) has the responsibility of each risk. The nature of these big projects such as the erection of a bridge has many details in the requirements' and is dominated from high standards. For this reason the transfer option is a common strategy in the risks of a construction project.

In this direction El-Sayegh (2008) realized through a survey that a risk in many cases is better to share and managed from two parties to allocated risks in the party that could be handling better. In the same survey El-Sayegh found many risks that could not be allocated and this is a reason that characterizes the construction contracts as a complex thing.

Reed, Shedd, Morehead & Pagnattaro (2008) defined as the purpose of a contract, “the creation of an agreement which courts will order to pay consequences for the failure of performance.” (Reed, Shedd, Morehead, & Pagnattaro, 2008, p.194). The legal consequences that are attributed by the court are being linked with the national law of each country, unless the auction of the project is an international one where the contract falls under the international law.

Bunni (2003) supported that in a construction contract the scope the budget and the schedule must be included. It must also contain a description concerning the risks that the project faced off, the way these will be handled and it must be clarified whose the responsibility is (contractors, supplier and government). From many researches, it is found that in many cases the choices of the strategy are influenced from the degree of participation that the people that take the decision in the specific task have.

In these directions, it is easy to understand that the strategy that is picked for a risk from the construction manager and his team which is also associated with the psychology those they have. Kerzner (2003) defined three classifications of tolerance for risk which are the Risk Averter, the Risk Neutral and the Risk Seeker or Lover. The decisions about the strategy that a construction manager might take about a risk that face off in a project are being determined by which classify belongs to the project manager.

*Risk monitoring and control*

As already observed before, the risk management is a repeat process and is terminated when the project is completed. For this reason the risk management procedure must always be renewed and not be obsolete. The reassessment of the risk management could be done through the monitoring and the control of the procedure.

According to Verzuh (2008) the continuous risk management brings no surprise to the project manager and his team. The key for a successful and continuous risk management are the monitoring, the meetings and the repetition of the identification phase. If the team comes up with a new risk, it must be introduced in the procedure and all the phases of the procedure must be regained.

Pickett (2005) made a step further and believed that after the monitoring and the reassessment of risk management, the results of the reports must provide a communication of risks to stakeholders. The communication of the results will make the organization richer in experience and it can enrich the trust between the client and the organization.

Meredith and Mantel (2006) point out that the monitoring is the link that connects the control with the plan and is based on the criteria and the standards' that is entered from the project team. When it comes to the control of the risk management process, it must be determined from the meetings of the team and the frequency of the reports. The reports are separated into three types, which are the routine, the exception and the special analysis.

Finally the most basic thing for a successful risk monitoring and control is that the members of the team and the project manager must have a total perception of what a risk means. Chapman and Ward (2003) explain that the phase of the monitoring and control is "not a mechanical reactive task; it is a flexible and creative proactive task, concerned with

understanding what is happening in real time in relation to what was planned, anticipating future departures from plans, and initiating all necessary revisions to earlier plans.”

### *Financial management*

In the Governor’s Annual Report of 2009 that is published every year the National Bank of Greece noticed that the capital for the public work and the public-private partnerships projects would reach the 700.000.000€ and that this amount was reduced by 11,3% compared to the previous year. This element shows that the construction industry does not pass the greatest days in Greece and the construction firms that are specialized in the transport infrastructure projects have realized that the projects are few.

Nowadays the choice of projects for a company has many criteria and one of these is the financial elements that are studied. The same applies for the construction firms that take projects of public-private partnerships projects and in this case, the economic part of a transport infrastructure project is very critical and sensitive because all the forms aim to have the least possible financial loss and the maximum benefit from a project.

Goodpasture (2002) points out that there is a number of factors, as that the money have less value in future and must estimate the time value of money, that the investors must be convinced for their investment or that the future hides risks for the project. These factors guide the firms into a financial investment analysis and account for the above financial elements: the net present value, the economic value add, the expected monetary value, the return on sales, return on assets and the return on investment.

All the construction corporations that are contractors in the public works or in public-private partnerships projects before the execution of the project they prepare estimation. Rad (2002) presented five basic methods that an organization could follow for the estimation of a project and these are:

- Analogous
  - (1) Ratio
  - (2) Three-Quarters Rule
  - (3) Square Root Rule
  - (4) Two-Thirds Rule
- Parametric
  - (1) Modular
  - (2) Parametric Model
- Range
- Expert Judgment
- Normalization

In the same study Rad suggests, that the project manager must estimate the financial impact of a risk on the estimation of the project and propose a method which determines a statistical monetary value for all risks and the sum of the statistical impact of all risks to be incorporated with the project estimate. This method includes some tools which are necessary for the risk estimating which are the probability and the cost impact for each risk.

Picken and Mak (2001) present an alternative method for the estimation of a project and the technique of the estimating risk analysis. This method was used from the Government of Hong Kong and showed an improvement in the estimating performance for the public projects.

In this technique the project team is calculating the average and the maximum risk allowance and through this method could a construction firm have two estimations for a project which are:

- Average Risk Estimate = Base Estimate + Total Average Risk Allowance
- Maximum Likely Estimate = Base Estimate + Average Risk Allowance + Maximum Likely Addition

An alternative approach is presented from Chou, Yang & Chong (2008) who proposed the cost estimating of highway projects through the Monte Carlo simulation and believed that the estimation of a construction project can be “determined by combining fixed and variable costs , a probabilistic estimate is only developed for variable cost components. The variable components are later combined with fixed components in order to be simulated to derive the final project total costs” (Chou, Yang, & Chong, 2008, p.571). This approach of the range estimation is a method which the project is separated in work packages and estimates each one statistically.

Another financial element that must be estimated and includes a lot of risk for an organization is the project cash flow forecast. This factor could be a reason for a project to go bankrupt and especially a project such as a transport infrastructure work which have a big budget and a long duration that is executing.



In a study that has been made from Hwee & Tiong (2002), the development of a computer model was presented that aids in an estimate of the cash flow and analyzed five risk reasons- project duration, over/under measurement (developer), over/under measurement (sub-con), variation of work and material cost variances. Through this study, it is realized that these reasons could affect the cash flow forecasting in the duration of the life cycle of a project and notice the importance for the estimation of the cash flow in these huge projects.

After the estimation of the cash flow, it is very important for a construction firm to control the cash flow of a project. Kerzner (2003) provided the Earned Value Method as a solution for the cost/schedule control system and through this way, monitored and controlled the cash flow schedule of the project. The Earned Value Method is a practical tool for the project manager to compare the master schedule of a project with the budget (during the project), but also to compare these elements with the estimation that have been made in the project plan phase.

To conclude this theoretical area, no specific method or a technique of the estimation exists which will not have a deviation from the final cost of the project, but all the organizations want and have as a goal to minimize it (Verzuh, 2003). All the techniques have advantages and disadvantages but an experienced project manager knows which approach is the best for his occasion.

### Methodology and Procedures Used

In previous chapters we distinguished that the purpose of this study is to improve the risk management procedure and to minimize mistakes that may influence the risk management and as a result influence the estimate of a project.

In this thesis the tactic that is used is the evaluation methodology, for the reason that in my research I will evaluate the risk management process that is followed by construction corporations and in the next step I will present the gaps found in the risk management procedure and the consequences in the estimation of a transport infrastructure work. The results of the study could be used as a guide for the construction firms to better understand which are the weaknesses and oversights of the risk management process.

The research in the literature has as a purpose to analyze the risk management procedure, to present tools and techniques that are used in the six phases of the process and how it is applied in the construction industry. In the other theoretical area of the financial management, the research focuses in the financial criteria for the choice of a project, which are the methods of the estimation for a project and the way it affects the estimation of the risks in a project.

The main scope of the literature was not to present only the six phases of the risk management, which can be done simply by reading the Project Management Body of knowledge (PMBOK 2004), but to discover the viewpoint that a construction industry has for the risk management procedure, the degree and the risk management process and how a project can be affected from the foreseeable when it comes to the estimation of a project

After the literature research, the second part of this study was to identify which firms or corporations are related to the construction of transport infrastructure works. The list of these firms was taken from the Technical Chamber of Greece with information's about the projects that have been participated in the last years. In addition, I took some interviews from construction managers and I also moved on to the completion of the questionnaires from the firms that couldn't spare some time to come in a face to face contact.

The interviews were an extremely interesting process which in most cases the discussion was not limited in the questions that was included in the questionnaire. The construction managers except from the data that was needed for the thesis, they presented a lot of details that are hidden in a transport infrastructure project and provided their opinion on the construction industry and the changes that have been pointed from the integration of the project management in constructions.

The other way of data collection was through the questionnaires (Appendix C) that was sent and received via emails. These questionnaires consist of 17 questions and are separated into three units. If a construction manager or any engineer wanted to answer the questions and take part in this study, the construction firm that the construction manager worked for had to use the act of the project management for their projects.

The first unit includes the questions 1-8 that have as a purpose to collect some general information's about the construction firm, the relationship of the firm with the project management, the risks and how each firm understands the risk management procedure.

The second unit consists of the questions 9-16, which are more specific and have as a scope to collect data about the risks management procedure, how it is used from the firms

(tools and techniques) and the way that is followed for the estimation of a project and evaluating some financial elements.

The last unit develops to retrieve some individuals information's about the gender, the age and the job position.

After the blend of the data that has been retrieved from the literature review, the questionnaires and the interviews, the next stage is to taxonomy and analyze them using statistics. The characteristic in the quantitative research is that the gathering of the information is collected in numbers and analyzed in the same form.

In the end the theoretical part must be compared to the practical part and a conclusion must be presented based on the results that have been milled.

The outcome of the research is expected to be a map for the construction firms to fix the negative practices of the risk management process which may result in negative financial consequences.

## Results

This chapter presents the outcome of the research that is the quintessence of this study and it will be the tool for the next chapter, from which we will draw conclusions and will grow the changes that must be done in the risk management process that is followed from the construction firms.

The results have been separated into two main categories, which are the literature findings and the questionnaire/interview results. The conclusions of this thesis will be supported from the several outcomes of these two sections.

### *Literature findings*

In a first view of the research that has been made in the literature it is easy to understand the risk management procedure as an one of the nine knowledge areas that include the project management, it is a very sensitive procedure that could affect the scope, the cost, the quality and the schedule of a project. For this reason the construction corporations have introduced the risk management process into the procedures that must be followed for the construction of a transport infrastructure project.

In an attempt to understand what the risk management is, the first thing that this study researched is to identify the meaning of the word risk in a project. Today, risk is a coin that has two sides, the negative and the positive. It is a common phenomenon in the construction field to be wrong perception between the hazard and the risk in a project, nevertheless at the present time has been overcome this confusion.

The next phase of the literature research focuses in the classification of the risks and the different approaches of the risk management process that a project manager must follow in proportion of the type of the risks that is phasing off.

In continuing, the literature research points out that the risk management process is not a forecast procedure but a systematic approach to manage a risk that states in which degree the project manager and the project team have a complete understanding of the project that works in.

The Project Management Institute proposes a complete risk management procedure and explains the way it could be used in a project. This procedure consists of six separate phases, which are of the same importance for a project if an organization wants to have a successful risk management procedure. These phases are described as a finish to start processes that are repeated until the project to be finished.

The same process is being applied in general in the construction industry, but the transport infrastructure works have a unique identity and for these reason a specific version of the risk management procedure is followed. One of the most important literature findings are the tools and the techniques that are used in each risk management phase from the project management team.

To be more detailed, it is necessary for a construction firm to use common language for the risk description in the projects they assume and this thing helps an organization to have an accurate classification of the risks.

Another key finding is that the brainstorming is the most proper technique that is used for the risk identification in the transport infrastructure projects and the special role this has in the decision making the Monte Carlo simulation.

Yet, founded the relevance of the contract in these projects, because it is important to clarify who has the responsibility of each identified risk and whose are the risks that are been shared in a project.

Closing, with the risk management procedure an important find is the role of the monitoring phase through that the risk management became a nonstop procedure.

In the other theory area of the financial management the research focuses into two parts, the first of that are the methods that are being applied from an organization to estimate a project and the other is the integration of a risk in the estimation of a project which are the financial elements of a project that could be affect from a risk. The interesting finding in this literature area is that the perfect method to estimate a construction project is the parametric estimating.

Finally, it is very important for a project to be estimation of each risk separately and the construction firm must calculate a risk reserve for each project.

#### *Questionnaire/interview data analysis*

The next part of the research was the collection of the data that arose from the questionnaires and the interviews from the construction firms' employees. All the interviews were based in the questions were included in the questionnaires, but further than that a notable characteristic that resulted from the discussions, was that the people that took part in the interviews tend to talk on more issues from the ones that were included in the questionnaire.

For this reason the data analysis that is being presented in this study has been supported only from the data that concluded from the questionnaires and will not present information's about the companies, the participants or other details.

As already mentioned in previous chapters the questionnaire has been broken into a three units and the reason was that the first two units of the questionnaire would have as a scope to lead from a general to a more specific information about the project management and the risk management procedure. The last unit results into general information's about the firms that belong in the construction industry.

In the first unit after the first question that defines if the respondent is qualified to participate in the research, the next four questions focus in the project management process that is being followed by the corporation.

More particularly, the second and the third question have as a scope to identify how many years the project management is used from the Greek construction corporations in their projects and to recognize the level and the experience that they have acquired in the project management. Most of the Greek construction corporations have been integrating the project management process more than eight years in their projects and only a 22% of them believe that the project management level in their firm are in a satisfactory degree.

In the evaluation of the affection that the project's execution has been received from the introduction of the project management (Appendix D) only the 26% of the responders believe that the impact of the project management is negligible and have been noted with very little changes.

Analogous with the previous evaluation is the degree that points out the majority of the construction industry about the changes that have been made in the organization's procedures by the introduction of the project management. Only the 34% of the participants believe that the procedures in the construction corporations have received a large influence and through the interviews it is clear that construction firms expected a better organization and a



completely different way of supervision in their transport infrastructure projects after the integration of the project management.

After the general opinions that the participants have for the project management process in their construction firms, the three last questions of the first unit have as a purpose to introduce in the research the ingredient of the risk and the risk management procedure.

The next question asks from the responders to give a belief on how they understand a risk in a project. As it can be observed at the figure 3 (Appendix E) most of them believe that a risk is synonym to a hazard and while the 16% believes that a risk is a combination of a threat and an opportunity.

In the next chart (Appendix F) points of view of the participants are presented of the risk management process that is followed from the construction firms in their projects. Only a 17% have a positive opinion about the risk management procedure, while the 62% of the construction memberships believe that is a deprived process in their organizations.

In the last question of the first unit the participants are asked to point out the importance for their corporations of the risk management process in the estimation of a project and the biggest part of them answered that the estimation of a project does is not connected with the risk management process.

In the second unit the questionnaire includes more detailed questions on the risk management procedure and through these results the risk management procedure will be presented more clearly.

The first question of the second unit has as a purpose to identify the level that each phase of the risk management process has. As you can see in the chart-bar (Appendix G) all the phases of the process have been evaluated negatively. The most negative evaluation has been

in the risk identification and in the risk monitoring/control phases that only the 15% and 16% have a positive sign respectively.

In the next question the risks that the participants met in an infrastructure project have been measured. From the number of the rates the risks that have been evaluated as most dangerous are the construction risks (78%) and the financial risks (65%) in contrast to the operating risks and the political risks, which are believed to be more manageable and of less frequency in Greece.

An interesting finding is that the results from a previous question presented in another chart (Appendix H) that show which techniques are used from the organizations to identify the risks of a project. The most common technique that is used from the corporations is the documentation review, while only the 21% use variants of the information gathering techniques. Impressive is the large percentage (12%) that no recommended techniques are used by anyone and this thing orders us in safe conclusions.

In the next question (Appendix I) most respondents chose the experience as the technique that is used for a quantitative risk analysis and helped them for the decision-making.

Furthermore, the majority of the participants admit that the risks that have been identified do not estimate each one alone and are not included as a parameter in the estimation of a project. For the estimation of a project the technique that is used from most firms is the expert judgment and only the 22% use the parametric model which is the second most prevalent method.

In the columns of the last chart (Appendix J) results are presented of the evaluation that has been made in some economic elements related to the affect it could have from projects risks. The financial elements that could accept the biggest influence from the project risks are

the cash flow of a project and the risk reserve, while the material estimation and the loans accept the lowest impact from the risks.

In the last question of this unit the participants are asked to express their opinion about which is the phase that a project is affected most in the financial section. In this question the options are being divided, because the participants evaluate with the same degree the three phases of a construction project (start, middle, closing).

The last unit has as a scope to explore some characteristics of the construction industry and the firms which belong in the specific industry. The group of the last three questions makes a preview in the gender, the age and the position that the participants have.

In the results of the first question, it shows that the construction industry consists from men, and only a 27% of the employees are women. One important finding from the next question shows that the human resources of the corporations are large in age. The 65% of the employees belong in the age between forty and sixty and only the 25% belongs to the age of the decade of thirty.

The last question helped the research to collect opinions from all the work departments of a construction corporation, but as it was expected that the most interesting in this research comes from the project management office.

The results that have been presented in this chapter will be the basic theme that will be discussed in the next chapter and will serve as the tool for a further analysis about the existing condition of the risk management procedure.

### Discussion, Conclusions, Recommendations

This chapter of the study has been separated into two parts, which are the conclusions that will be arisen through the comparison of the literature findings and the questionnaire findings that arise from the Greek construction field and the second part which is the recommendations that will be proposed in order to minimize the negative financial consequences on the transport infrastructure works- field due to weaknesses and oversights of the risk management process followed by Greek construction corporations.

In a first sight it is easy for anyone who read this study to understand that the findings from the literature research about the risk management process and how it is applied in the construction field with the research that have been made in the Greek construction corporations about the risk management process that is followed by them in their projects have not any link between them.

Analyzing the answers of the first unit of the questionnaire, we can conclude that the Greek construction organizations have a poor experience in the project management and have not tasted the big benefits which can be brought from the project management procedure.

One of the main reasons that this happens is because the project management process has not got a long life in the Greek organizations, but apart from that another reason is the lack of the project management and risk management culture. This thing is proving through the findings which the participants observed that the procedures of the organizations have not accepted a big change in the organization procedures and the participants recognize a risk only as a hazard for their project opposing to the literature findings which a risk has and an opportunity site.

Another contradiction between the literature and the questionnaire results is that the Greek construction firms do not connect the estimation of a project with the risk management procedure and do not make an estimation of the risks which will be as a part of the general estimation of a project.

The results of the second unit of the questionnaire could point out the very low level of the risk management procedure that the Greek construction firms have and the bad choices about the techniques and the tools that are used in any phase of the risk management process.

Based on the literature the Greek construction corporations must use information Gathering Techniques (Brainstorming, S.W.O.T analysis, Delphi technique) for the identification of the risks and not only the experience that they have from similar projects.

Furthermore, the Greek construction firms do not take the advantage from tools and techniques such as the Monte Carlo simulation and the Sensitivity analysis which can help them in the decision making procedure and generally in the quantitative risk analysis. They should also give a lot of attention in the contract of a project which is a very sensitive point if they want to have a better performance in the risk response planning.

Regarding to the financial consequences, the Greek construction corporations estimate the projects based in the experience and they do not follow the parametric estimation method as the literature suggest. The firms understand the importance for a better forecast in projects cash flow but they do not connect it with the risk management process.

The contrasts between the literature of the risk management and how it applies the risk management in the transportation projects are huge. As a conclusion of this research, the project management level as well as the risk management level in the Greek construction

corporations is in a very low point, but in parallel they have many chances to improve both these two areas.

The Greek construction corporations have not been trained on the culture of the project management and obviously they are not skilled in the risk management. The Greek organizations are using the experience as the tool that will help them in the execution of the transport infrastructure works and not the project management that will help them for a better result in the scope, the budget, the schedule and the quality of a project.

The risk management procedure in the Greek firms is in an infant situation and does not apply as needed to have a better perform in the handle of the risks. The corporations do not follow any of the risk management procedure as the literature suggests and they do not use tools and techniques that could help them in the risk management process.

Evidence that militates in this direction is a research that made Nikolaou (2007) and has been presented in a congress that named as «Success Drivers in Construction Project Management». This congress has been organized from the Technical Greek Chamber, the American Society of Civil Engineers and the Project Management Institute CREECE Chapter and has as a scope to present factors which are critical for the success of a construction project. In the table 1 presented below, a part of Nikolaou (2007) research which is the estimation, the final cost and the over budget that has been finally in nineteen Olympic projects.

Project	Initial Budget	Final Cost	Over Budget
Olympic Basketball Stadium	2.800.000 €	8.000.000 €	186%
Panathenaic Stadium	300.000 €	11.500.000 €	3733%
Olympic Aquatic Centre	3.500.000 €	22.500.000 €	543%
Olympic Volos Stadium	25.100.000 €	51.400.000 €	105%
Stadium of Pireus	3.000.000 €	29.700.000 €	890%
Centre Olympic of Canoe - Slalom	8.500.000 €	37.100.000 €	336%
Olympic Tennis Center	12.300.000 €	47.500.000 €	286%
Olympic Weightlifting Gym	12.000.000 €	49.000.000 €	308%
Olympic Stadium, Patras	1.100.000 €	45.200.000 €	4009%
Olympic Fitness Galatsi	13.700.000 €	60.500.000 €	342%
Olympic Shooting Centre	12.000.000 €	60.600.000 €	405%
Olympic Rowing Center	25.400.000 €	76.300.000 €	200%
National Stadium of Crete	38.100.000 €	63.700.000 €	67%
Olympic Stadium of Thessaloniki	1.100.000 €	67.900.000 €	6073%
House Season Sports	32.300.000 €	80.800.000 €	150%
Olympic Equestrian Centre	22.600.000 €	110.400.000 €	388%
Olympic Sailing Center	16.500.000 €	118.500.000 €	618%
Olympic Baseball Centre	18.700.000 €	200.400.000 €	972%
Olympic Stadium	3.100.000 €	399.000.000 €	12771%
<b>TOTAL</b>	<b>252.100.000 €</b>	<b>1.540.000.000 €</b>	<b>511%</b>

Table 1: The over budget that have been made in nineteen construction projects (Nikolaou, 2007)

In the analysis that has been made in this research, it can be noticed that one of the factors that affects the final cost of the construction of these Olympic stadiums is the deprived risk management procedure that the Greek construction firms have. The study that has been made by Nikolaou (2007) confirms that the entire construction industry and not only the firms that implement transport infrastructure projects face a big problem in the project management and in the risk management procedures.

As is the current situation in the Greek construction industry, the construction firms could do a lot of things to improve the project management and risk management skills. In my opinion every construction firm must create a project management office that will help the firm to modernize and to be a learning organization. The project management office will help the firm in the organizing of the firm, in the training of the employees and in the creation of a database which will grow after each project.

In this direction, the Greek construction firms must give a lot of attention in the human resources regarding the education and the vocational training in the project management and the knowledge's areas that the project management includes.

One of the first actions the Greek construction firms should take, is the participation of the employees in seminars that will help them understand what is a project and the great importance of the project management in the organizations these days. Through the seminars the members of the organizations will have a first contact with the project management and how it could affect the organizations procedures.

After this step, the construction firms must be staffed with employees that have project management certifications. This thing will help the firms to acquire correct project management procedures and to establish a project management language that all the members will be in place to understand it.

Later, the Greek construction corporations must train the members how they should use the tools and the techniques of the project management in the transport infrastructure projects. This aim can be achieved through tutorials that will be made from the firms with the assistance of people that have the experience in these things.

On the subject of the risk management the most important thing that must be changed in the firms is that the team members of each project must realized that they will always face risks in their projects and must get familiar with the concept of the risks. But the most important in the risk management is that the employees must adopt a double view in the risks.

For this reason I suggest to the Greek construction firms to send the employees on seminars which have as a subject the knowledge that could be obtained from a failed project and how it could affect an organization in the future. Through these seminars the employees



could understand that a risk which terminates a project if it is analyzed could give solutions in the next projects.

These recommendations could help a construction firm to change the culture and the philosophy in a learning organization. The integration of the project management and the risk management processes correctly in the organization procedures would help them in a minimization of the financial losses that came from the weakness and the oversights of the risks management procedure. The Greek construction industry has all the preconditions to be one of the basic pillars of the Greek economy and the Greek construction firms to be much more competitive with the others Europeans construction firms.

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## Appendix A

Table 1: Risk Assessment (Tom Kendrick, 2003)

Risks	Probability (H/M/L)	Impact (H/M/L)	Overall Risk
Risk 1	M	L	ML
Risk 2	L	L	L
Risk 3	H	H	H
Risk 4	H	M	HM
Risk 5	M	L	ML

Appendix B

Table 2: Risk Matrix (Tom Kendrick, 2003)

Probability					
Very High					
High			High Risks		
Moderate					
Low		Low Risks			
Very Low					
	Very Low	Low	Moderate	High	Very High
Impact					

## Appendix C

*Questionnaire*

The above research is conducting for my individual thesis in my attempt to get my Master's Degree in the Project Management from the Technological Educational Institute of Piraeus and the City University of Seattle and the subject of my study is << The risk management process in infrastructure works' field>>

Purpose of my study is to explore the financial impact of the weakness of the risk management procedure.

If you wish to take part in this research you can sent the questionnaire in my personal email [arkadinos\\_dionisis@yahoo.gr](mailto:arkadinos_dionisis@yahoo.gr) , also if you wish to receive the results from the research you can contact with me via email.

Your contribution will be important for the success of this research. Your answers' will be confidential and will not be published the name of your firm and will be used only for the quantitative analysis.

Thank you very much,

Dionisis V. Arkadinos

1. Do you use project management process in your organization?

- Yes
- No

*If your answer is «Yes», please continue to the below questions.  
If your answer is «No», thank you very much for your time.*

A' Unity:	
Question 2:	
How long your organization integrates project management process?	

Question 3:					
	<b>Very Low</b>	<b>Low</b>	<b>Mediocre</b>	<b>High</b>	<b>Very High</b>
Grade the project management level of your organization.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question 4:					
	<b>Very Low</b>	<b>Low</b>	<b>Mediocre</b>	<b>High</b>	<b>Very High</b>
Point out the degree at which the execution of the organization's projects was affected by the introduction of project management.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question 5:					
	<b>Very Low</b>	<b>Low</b>	<b>Mediocre</b>	<b>High</b>	<b>Very High</b>
Point out the degree at which the organization's procedures have been changed by the introduction of project management.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Question 6:	
How do you perceive the concept of risk in a transport infrastructure project?	
As a hazard.	<input type="checkbox"/>
As an opportunity	<input type="checkbox"/>
As a threat or an opportunity.	<input type="checkbox"/>

Question 7:					
	<b>Very Low</b>	<b>Low</b>	<b>Mediocre</b>	<b>High</b>	<b>Very High</b>
Evaluate the risk management process in your firm?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question 8:					
	<b>Very Low</b>	<b>Low</b>	<b>Mediocre</b>	<b>High</b>	<b>Very High</b>
Point out how important is for the estimation of a project the risk management process?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B' Unity:						
Question 9:						
Evaluate the risk management phases based on the risk management procedure, which been followed by your organization						
		<b>Very Low</b>	<b>Low</b>	<b>Mediocre</b>	<b>High</b>	<b>Very High</b>
a.	Risk Management Planning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b.	Risk Identification	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c.	Qualitative Risk Analysis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d.	Quantitative Risk Analysis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e.	Risk Response Planning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f.	Risk Monitoring and Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question 10:						
Evaluate the below risks which are frequently met in an infrastructure project.						
		Very Low	Low	Mediocre	High	Very High
a.	Technical	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b.	Construction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c.	Operating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d.	Revenue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e.	Financial	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f.	Force Majeure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g.	Political	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h.	Environmental	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i.	Project Default	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question 11:		
Which technique is being used by the organization at the risk identification phase		
a.	Documentation Reviews	<input type="checkbox"/>
b.	Information Gathering Techniques (Brainstorming, Delphi & Swot).	<input type="checkbox"/>
c.	Checklist Analysis	<input type="checkbox"/>
d.	Assumption Analysis	<input type="checkbox"/>
e.	Diagramming Techniques	<input type="checkbox"/>
f.	None of the above	<input type="checkbox"/>

Question 12:		
Which technique is being used by the organization for decision making?		
a.	Sensitivity Analysis	<input type="checkbox"/>
b.	Expected Monetary Value Analysis	<input type="checkbox"/>
c.	Decision Tree Analysis	<input type="checkbox"/>
d.	Monte Carlo Simulation	<input type="checkbox"/>
e.	Experience	<input type="checkbox"/>

Question 13:		
	<b>Yes</b>	<b>No</b>
In the project estimation, is included the risk estimation from the risks that were identifying?	<input type="checkbox"/>	<input type="checkbox"/>

Question 14:		
Which technique is being used for the estimation of a project?		
a.	Analogous	<input type="checkbox"/>
b.	Parametric	<input type="checkbox"/>
c.	Range	<input type="checkbox"/>
d.	Expert Judgment	<input type="checkbox"/>
e.	Normalization	<input type="checkbox"/>

Question 15:						
Evaluate the below financial elements, in which degree can affect them a risk in a project.						
		<b>Very Low</b>	<b>Low</b>	<b>Mediocre</b>	<b>High</b>	<b>Very High</b>
a.	Material Estimation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b.	Loans (type, schedule, rate)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c.	Cash Flow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d.	Market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e.	Risk Reserve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question 16:	
In your opinion in which phase of a project, a risk affects most the project in the financial section?	
Start	<input type="checkbox"/>
Middle	<input type="checkbox"/>
Closing.	<input type="checkbox"/>

C' Unity

Question 17:  
Gender

- Male                       Female

Question 18:  
What is your age?

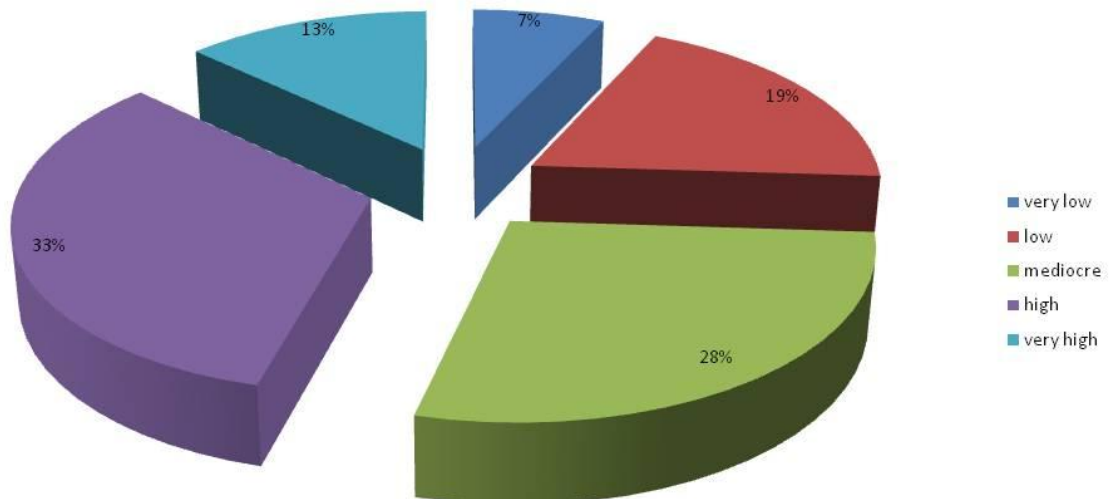
- 25 – 30     31 – 40     41-50     51-60

Question 19:				
	Engineer of Study	Engineer of Site	Con. Manager	PMO
Which is your work position in the firm?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Thank you for your time!*

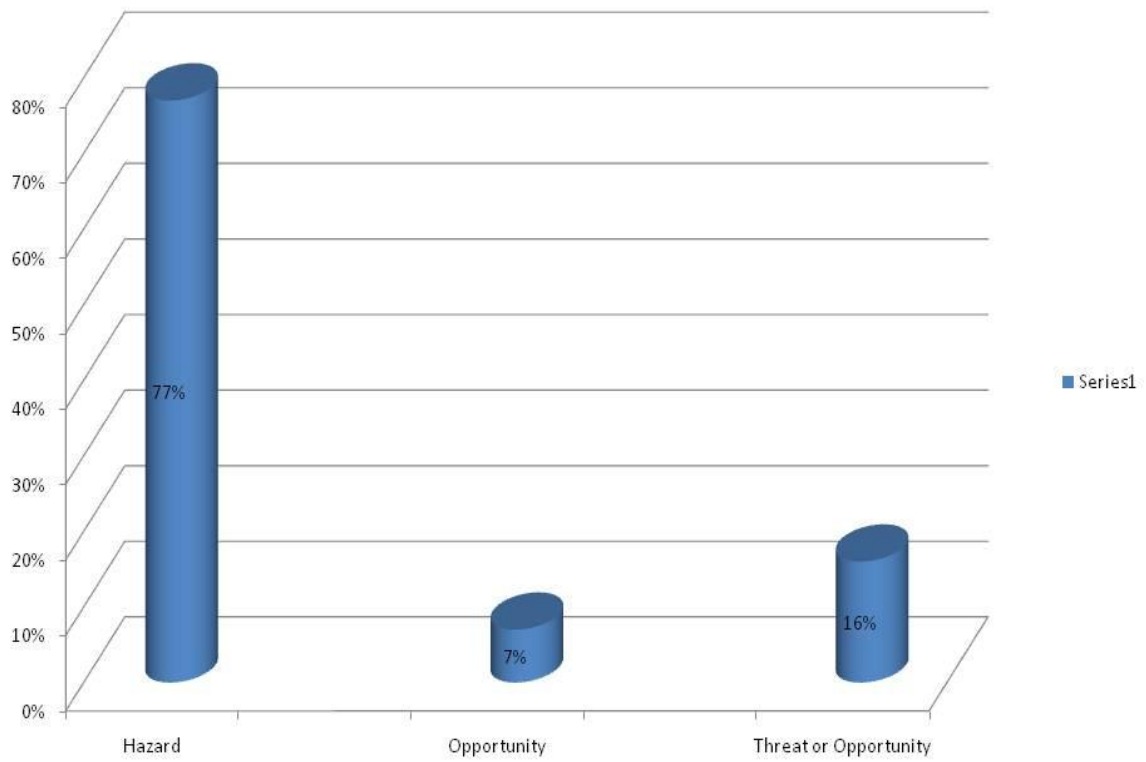
Appendix D

**EFFECTION IN THE PROJECT EXECUTION BY THE PROJECT MANAGEMENT**



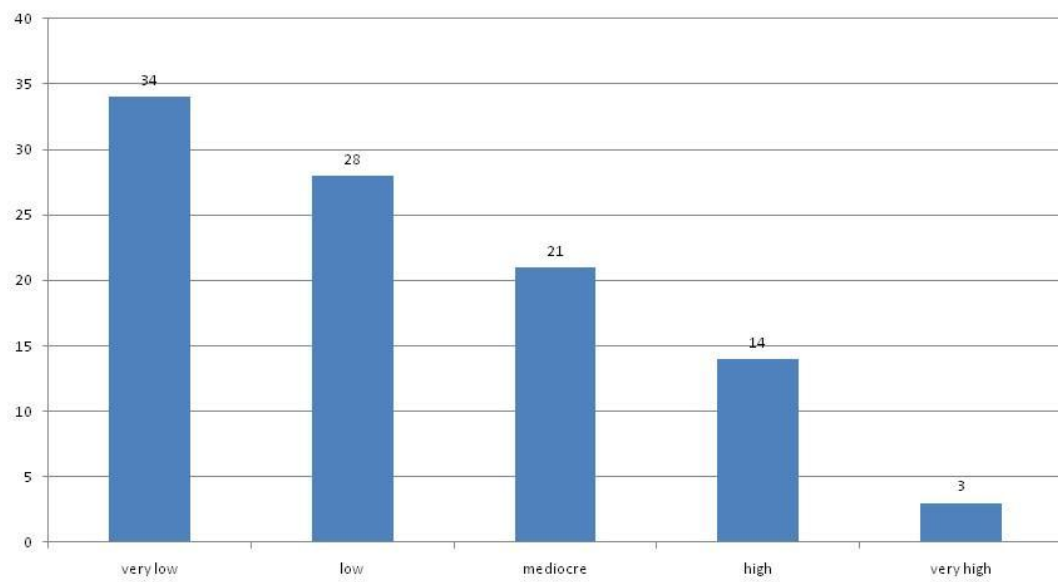
Appendix E

**CONCEPT OF RISK**



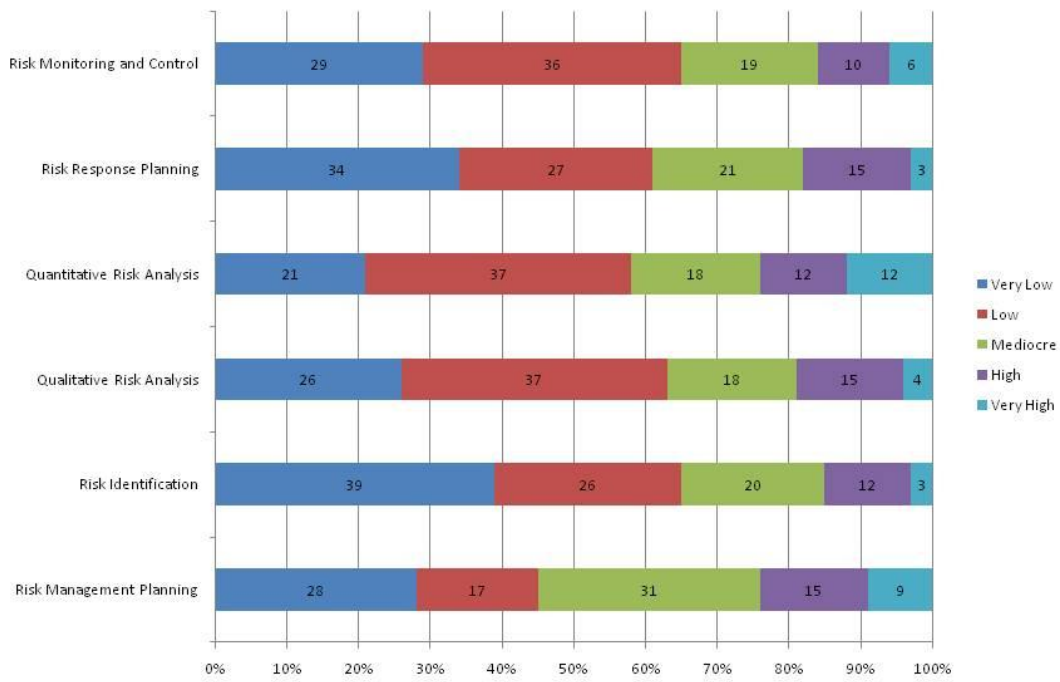
Appendix F

**EVALUATION OF THE RISK MANAGEMENT PROCESS  
IN THE CONSTRUCTION FIRMS**



Appendix G

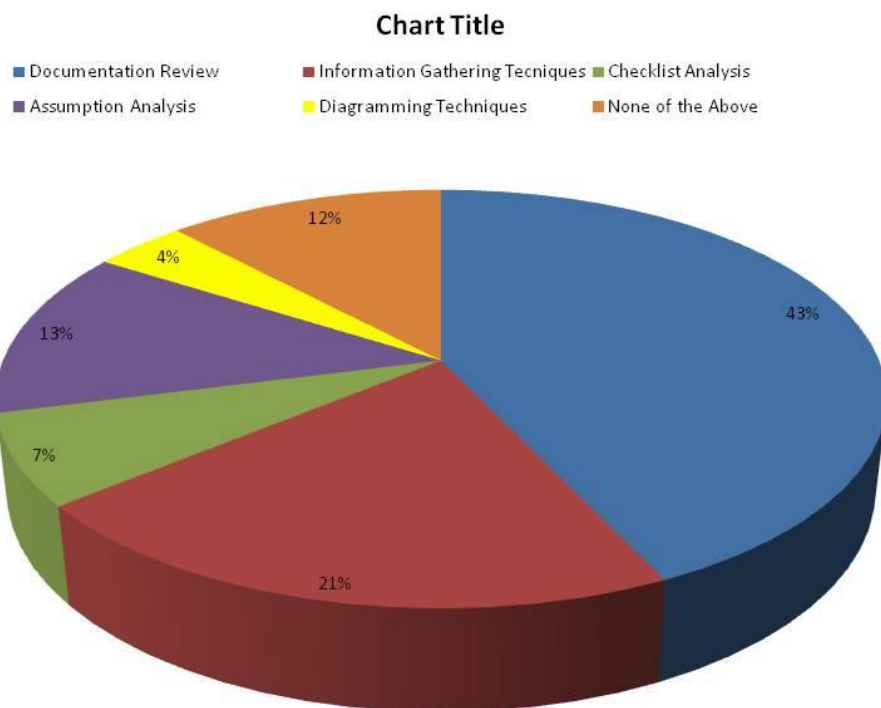
**EVALUATION OF THE RISK MANAGEMENT PHASES**





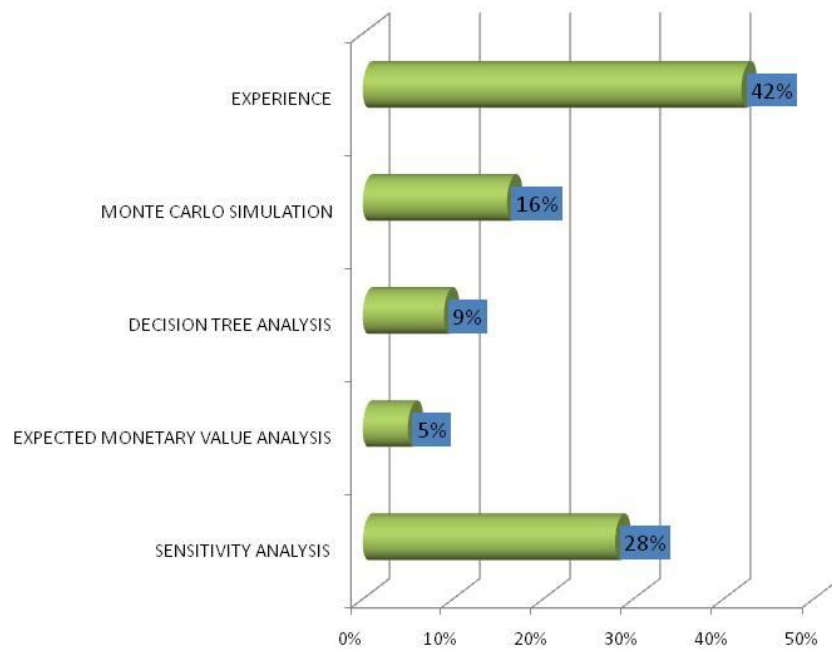
Appendix H

**RISK IDENTIFICATION TECHNIQUES**



Appendix I

**DECISION MAKING TECHNIQUE**



Appendix J

**EVALUATION OF FINANCIAL RISKS**

