Open University Cyprus Hellenic *Open University*

Master's join degree/post graduate Programme
Enterprise Risk Management (ERM)

MASTER THESIS

Assessing the Impact of Risk Factors in Public Projects

Nikolaos Melas

Supervisor
Pandelis Ipsilantis

May 2020

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Faculty of Economics and Management

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Summary

The aim of this “Master’s dissertation” is to assess the impact of risk factors in a highway project. A short reference to the definition of project, project types, as well as to the history of public projects in Greece, will be done. The principles, the international standards, and the organizations of project management will be mentioned as the risk assessment is part of project management (PM). The Greek approach to PM through the years will be discussed.

An extended literature research, the experts’ opinions, and writers experience used to classify and identify the risk factors that affect a highway project. The classification was done relevant to the stages of the project (design, construction, operational stage), and based on crucial factors that affect the viability of it (time, cost, environment, quality, and safety).

The assessment based on a questionnaire survey. A five-point Likert scale used for the answers. The questionnaire consisted of two parts. The first one refers to the demographic facts of the respondents (education, working experience, etc.), while the second part included the proposed risk factors based on the probabilities, they will occur during the life cycle of the project. A First Approach (FA) through graphs and tables was performed. The second step was the evaluation and analysis of the survey with the use of Relative Importance Index (RII). The last step of the analysis was the investigation about the perception of risks regarding the working experience, with the use of Analysis of Variance.

Finally, conclusions were stated according to the RII analysis and the performed ANOVA tests, regarding the risk factors that may occur during the life-time circle of a highway project, and a comparison between the FA analysis and the results of the RII analysis is performed.

Περίληψη

Σκοπός της παρούσας διπλωματικής εργασίας είναι η αξιολόγηση των επιπτώσεων των παραγόντων κινδύνου κατά την κατασκευή ενός αυτοκινητοδρόμου. Γίνεται αναφορά στον ορισμό και τους τύπους των έργων καθώς και μια σύντομη ιστορική αναδρομή στην ιστορία των δημοσίων έργων στην Ελλάδα. Καθώς η αξιολόγηση και διαχείριση κινδύνων αποτελεί τμήμα της ολοκληρωμένης διαχείρισης ενός έργου, γίνεται αναφορά στις αρχές, τα διεθνή πρότυπα και τους οργανισμούς που ασχολούνται με την διαχείριση έργων (project management). Επιπλέον συζητείται η ελληνική προσέγγιση στη διαχείριση έργου διαχρονικά.

Ο προτεινόμενος καθορισμός και η κατηγοριοποίηση των παραγόντων κινδύνου που επηρεάζουν την κατασκευή ενός αυτοκινητοδρόμου βασίστηκε στη διεθνή βιβλιογραφία, σε συζητήσεις με έμπειρα στελέχη του κατασκευαστικού τομέα και την εμπειρία του γράφοντος σε ανάλογα έργα. Η κατηγοριοποίηση έγινε ανάλογα με το στάδιο κατασκευής του έργου (σχεδιασμός, κατασκευή, λειτουργία), καθώς και βάσει κρίσιμων παραγόντων οι οποίοι καθορίζουν την βιωσιμότητα του έργου (χρόνος, κόστος, ποιότητα, περιβάλλον, ασφάλεια).

Η έρευνα βασίστηκε σε ερωτηματολόγια. Για τις απαντήσεις επιλέχθηκε η πενταβάθμια κλίμακα Likert. Το ερωτηματολόγιο αποτελείτο από δύο μέρη. Στο πρώτο υπήρχαν γενικές ερωτήσεις προς τους συμμετέχοντες που αφορούσαν σχετικά με την έρευνα στοιχεία (μόρφωση, εργασιακή εμπειρία, κ.λπ.). Στο δεύτερο μέρος ζητείτο η αξιολόγηση των παραγόντων κινδύνου με βάση την πιθανότητα εμφάνισής τους. Η πρώτη προσέγγιση (FA) των δεδομένων έγινε μέσω πινάκων και γραφημάτων, ενώ η περεταίρω ανάλυσή τους έγινε με βάση το δείκτη σχετικής σημασίας-σπουδαιότητας (RII). Στο τελευταίο στάδιο θα διερευνηθεί η αντίληψη των κινδύνων σχετικά με τα χρόνια εργασιακής εμπειρίας.

Τέλος αναφέρονται τα συμπεράσματα της ανάλυσης με βάση τον δείκτη RII και της ανάλυσης διακύμανσης (ANOVA) σχετικά με τους κινδύνους σε ένα μεγάλο έργο οδοποιίας. Συγκρίθηκαν τα εξαγόμενα της πρώτης προσέγγισης (FA) των αποτελεσμάτων και της ανάλυσης με βάση το δείκτη σπουδαιότητας (RII), ενώ επιχειρήθηκε και η σύγκριση των αποτελεσμάτων μεταξύ της ανάλυσης RII και των τεστ ANOVA.

Acknowledgments

This dissertation is dedicated,

- to the loving memory of my mother. Her pure and unselfish love raised me as a decent man,
- to my father, whose kindness, honesty and integrity always admire, for been there for me,
- to my wife for being the bright lighthouse that always helps me find the way back to the safety of the harbor,
- and finally, to my precious children (Eleni and Kostas) for their love, support, encouragement, and inspiring me to be a better person,
- to my aunt Eleni for encouraging and helping me to be a good student again in my late forties.

Table of Contents

Appendices

Chapter 1
Introduction

This “Master’s dissertation” theme is the assessment of the impact of risk factors in public works. The subject is very widely spread and includes a lot of project types. So, this dissertation will be focused on assessing the risk factors in the construction of a highway project in Greece.

Risks are involved in every aspect of human activities, and of course, are involved in every construction stage of a highway project. The meaning of risk may be assumed as something positive or negative, even though the common meaning of risk is involved with the negative consequences of human activity. Risk is defined as the possibility of loss, injury, or destruction, and also, as the probability of occurrence of a defined hazard and its consequences.

In every project exists the probability of various risks to occur. The management of these risks – risk management-, is part of the whole project management procedure.

In this “Master’s dissertation,” the definition of project will be defined, the project types will be described, and the history of public projects in Greece will be briefly associated. There will be references to the project management (PM) procedures, the international standards of PM, and the Greek approach to the project management procedures through the years.

Focusing on public highway projects in Greece, there will be an identification of risk factors that may affect this type of projects. The tools that will help this procedure are literature review, experts’ opinions, and personal experience from working all these years in the highway construction sector (designer, site engineer, deputy project manager).

The next step will be the development of a questionnaire that will be used as the primary tool of risk factors assessment.

The evaluation of risk factors will be done based on international practice, using the tools of descriptive statistics and the relative importance index analysis. At the same time, a comparison between evaluating the results as they occur from the "first approach" of questionnaire responses with the help of descriptive statistics, and the relative importance index analysis.

The flow diagram of this "Master's dissertation" could be as follows:

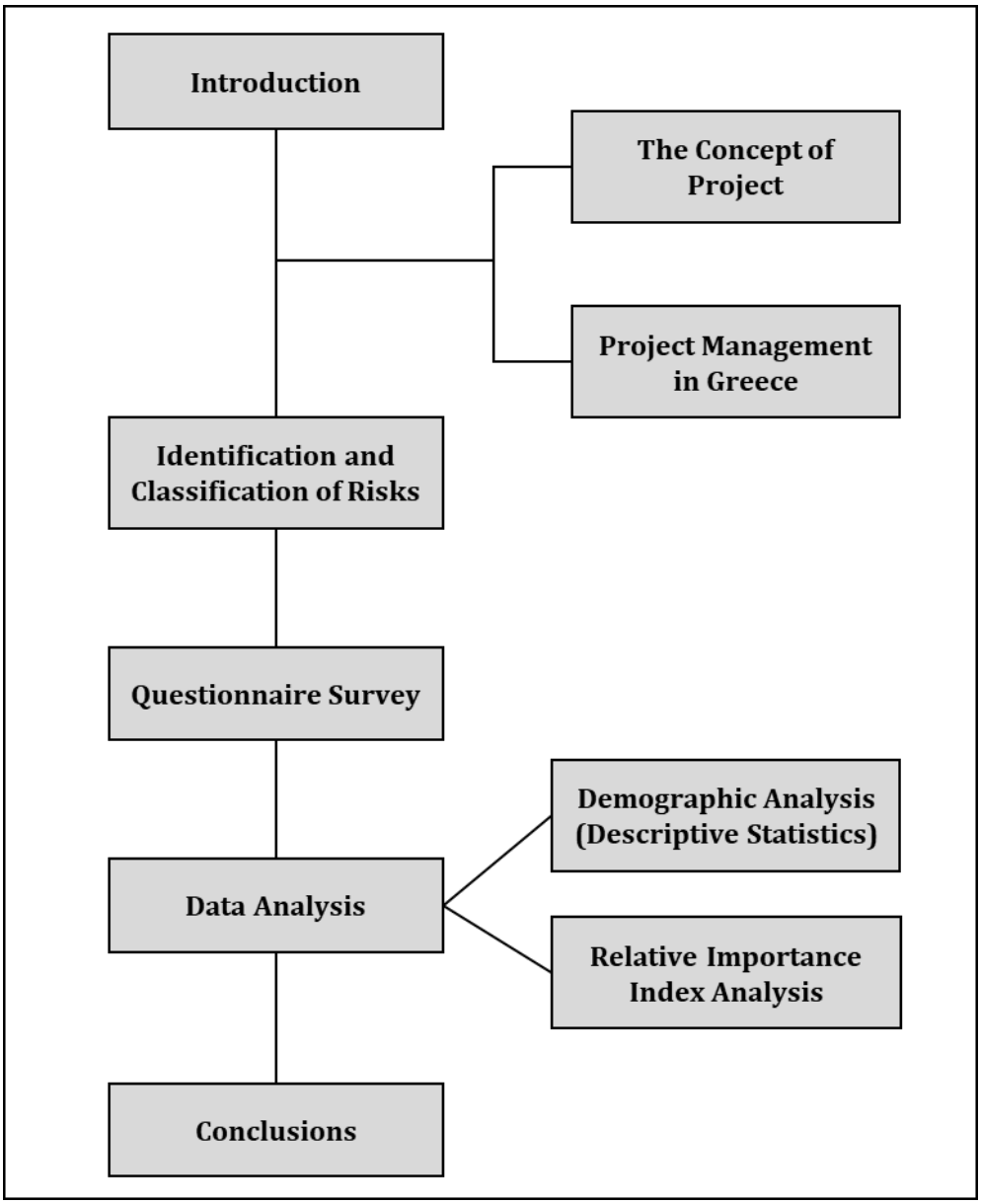


Figure 1. Master's Dissertation Workflow (Authors Design)

Chapter 2

The Concept of Project

In this second chapter of the “Master’s dissertation,” an extensive review will be done to the definition of the “project,” the project types, and a brief report of the history of public projects in Greece.

2.1. Definition of project

The word project comes from the Latin word projectum and the Latin verb proicere. The ‘pro’ part of the word probably adopted by Romans from the Greek word ‘πρό,’ which means before something and ‘iacere,’ which means to do. The term "project" thus originally meant "before an action." (Wikipedia)

Although the modern use of the term ‘project’ according to the Project Management Body of Knowledge (PMBOK) 6th edition (2017), refers to a ‘temporary endeavor with a beginning and an end and it must be used to create a unique product, service or result.’

V. Papathanasiou (2005) approaches the term ‘project’ as a multitude of processes performed by various well trained and specialized workforce in order to achieve the technical, visible, or not, but in any way existing result.

Wysocki, Beck, and Crane (2000) define project as a sequence of activities that are directly related to each other, are unique and complex “in nature.” These activities have a specific purpose and must be accomplished at a specified time frame with a given budget and fulfilling specific requirements.

Another aspect of project definition was given by Ipsilantis and Syracoulis (2005). According to them, a project can be considered as a sequence of interdependent activities with specific characteristics, such as:

- Specified time frame of execution
- Well defined and sufficiently described targets
- Production of a specific result
- Routine activities which are unrepeatable
- Consuming money, time, human capital, and irreplaceable material resources.

2.2. Project Types

There are many proposals for classifying the projects according to their type. An obvious and easy separation is related to the owner of the project if it is a public or a private one. Differentiation can also be done by the subject of the project, as follows:

- Construction projects. The project produces an artifact. This artifact may be a complex system using human and mechanical components. Examples of such projects are the construction of a highway, of an industrial building, of a dam, a ship, an IT system, a call center, etc.
- Research projects that produce knowledge. This knowledge may be represented as models, patterns, or patents, or may be embedded in a working process or artifact. Some research projects examples are developing a model for the Greek economy, developing a new treatment for a disease, developing new approaches to project management, etc.
- Reengineering projects that produce targeted change to various systems or processes. Taking UK Sterling to Euro, implementing corporate governance in a traditional company, designing, and installing a new production line, are some particular cases of reengineering.
- Procurement projects that produce a business relationship contractually based on selected suppliers for defined products or services based on fixed specifications and/or defined specification processes. Examples of such projects are outsourcing a specific construction or research project, or a complete business function (such as IT), or even imposing new rules and measures on regulated industry.

- Business Implementation projects that produce an operationally effective process. Installing e-commerce in a firm or developing a new business process to rearrange and exploit existing assets.

Although this classification includes almost all projects, there are some of high symbolic significance for a nation or humanity that cannot be classified as mentioned above. Such projects are sending a man on the moon, or the construction and maintenance of the International Space Station (ISS), the celebration of two hundred 200 years of Greek Independence, creating an artificial part of human body, or mass inoculation programs.

Finally, in all projects, there are three straightforward questions.

- Where does the project start?
- When must the project end?
- When can the results be evaluated?

The answers to these three questions, as shown in the following table, strengthen the above-implemented classification of the project types and impose that each project type needs a different process and management style.

	Start	Stop	Evaluation
Construction	With a certain goal or set of requirements. With a predefined solution.	When the artifact is done. When the requirements are satisfied.	At the end of the construction period. Over the lifetime of the artifact.
Research	With a hypothesis. With a problem.	When the time or budget runs out. When we detect diminishing returns.	When the knowledge is confirmed or disconfirmed by other researches. When knowledge is used by other researchers.
Reengineering	With a problem. With an opportunity.	When the process is a step ahead of the problem. When another process higher in the flow chart changes the requirements.	At any time.
Procurement	With a set of requirements. With a defined solution.	With the issuance of the final version of the contract With the signing of the contracts with the supplier.	Over the duration of the contract. At the end of the contract.
Business Implementation	With an opportunity.	When the process is operational.	After a certain period that the operation is running normally.

	With a business idea.	When the business benefits are starting to become visible.	When the benefits become visible. Anytime during the process.

Table 1. The answers to the questions where a project starts, when it ends and when it can be evaluated.

2.3. Public Projects in Greece

The creation of the modern Greek State in 1828, after the revolution against the Ottoman empire in 1821, found the newly born country almost ruined. One of the first things the governor I. Kapodistrias and later King Othon were to repair the existing infrastructures and construct new one. Until the end of the 19th century, the public projects that were built in Greece were mainly infrastructure projects and, more specifically, bridges, roads between the main cities of the country, harbors, aqueducts, public buildings (schools, university, courthouses, etc.). The purpose of these projects is to help people improve their standard of life. Alongside the construction of these infrastructure projects, there were attempts to organize the state according to the European standards. Although these attempts were ineffective, they were kept going until nowadays with dubious results. In the late 19th and the early 20th century, public projects in Greece were still focused on infrastructures. At this period developed the railway network, which remained the same until the late 20th century, constructed the Korinthos canal, Kopaida lake drainage, and other similar projects. Alongside these infrastructures, other projects aimed at the improvement of the public services (education, tax, and legislative reforms).

Until the outburst of the Second World War, Greece, although it was mainly a poor country and its economy, was mostly dependent on the primary sector (agriculture), had made some vast improvement in the infrastructure section. However, it was still struggling to keep up with modern European countries. The end of WWII and the end of the civil war in 1949 found the Greek State destroyed in every sector. Alongside with the help of the Marshall Plan of the USA, a tremendous plan of public projects was implemented. The “main course” was again the infrastructure section, as 95% of the pre-war infrastructure was destroyed.

The main objective of the post-civil war governments was to "rebuild" the country and help the Greeks to improve their standard of life. A mass plan of public projects focused on infrastructure was implemented. The decades of 1950 and 1960 Greek economy achieved rates of economic growth better than the big European countries. The main sectors of public projects that were constructed that period were:

- Construction of Highways and provincial road network,
- Construction of school buildings all over the country,
- Water and sanitation projects focused in the biggest cities,
- Electricity reached even in the smallest village of the country
- Urban projects (construction of boulevards, roundabouts, landscaping projects in Athens and Thessaloniki),
- Projects related to tourism (Xenia Hotels, restoration, and renovation of archaeological sites, new museums)
- Construction of new ports almost in every island,
- Construction of airports in major Greek cities and islands

The construction of infrastructure continued during the '70s on a reduced scale. The next decade (80's) as Greece has entered the European Economic Community (the later European Union) the European funding that the Greek State received, funded infrastructure projects in the neglected provinces of Greece.

Until mid 90's the process of the infrastructure public projects in Greece, in brief, was as follows:

- Some State authority (Ministry, prefecture, municipality) decided about the projects that will be constructed. Almost all times without a feasibility study and with no central planning.
- The technical department of the authority conducted a preliminary design, estimate the cost of the design stage of the project, wrote down the specifications and requirements of the design study, and conducted a public tender for the designer of the project.
- The designer submitted the final design study of the project, alongside with the budget and time schedule estimation, and the technical requirements of the project.
- The owner of the project (the state authority responsible for the project) conducted a public tender, so the contractor of the project was to be decided. The

candidates were making an economic offer (with no limits in discount) on the budget, and in accordance with the compliance to the technical requirements, the result was finalized, and the project has a contractor. Possible objections upon the result are not taking under consideration.

With little differentiation, this was the way that public projects and, more specifically, infrastructure projects were assigned in Greece until mid-'90s. During all these years, the only common thing in the infrastructure construction in Greece was that the Greek State was the sole financier.

At this certain period, the project of "Attiki Odos" was assigned to the Construction Joint Venture of "Attiki Odos." This highway project constitutes the ring road of the greater metropolitan area of Athens and the backbone of the road network of the whole Attica prefecture. It was designed to be and still is a modern urban toll motorway. It was the first project in Greece that was constructed as a Public-Private Partnership (PPP) on a concession basis.

A public-private partnership (PPP) concessions a contractual and project financing mechanism that helps public authorities lessen the impact of their limited financial resources (Jeerangsuwan 2014). In return, for its contribution to the financing of the project, the concessionaire receives the right to operate and, of course, maintain it for a specified period. This creates strong potential and new opportunities for the construction of more infrastructure facilities than those that could be afforded through public funds only.

"Attiki Odos" was a pioneer project that essentially paved the way and laid the foundations for the execution of future successful concession contracts in Greece. In nowadays, the Public-Private Partnership is the "rule" to the construction of infrastructure facilities not only in Greece but all over the world.

Chapter 3

Project Management, the Greek case

In this chapter will be attempted to be defined the meaning of Project Management and its characteristics. Following by a short review of the relevant international standards and the most well-known organizations of project management. In the last paragraph, there will be an attempt to describe the Greek aspect of project management in the construction sector over the years.

3.1. Project Management Definition & Characteristics

As described in detail project is a unique, transient endeavor undertaken to achieve planned objectives, which could be defined in terms of outputs, outcomes, or benefits. The best way to carry out successfully a project and especially a construction one is through the "right" project management.

The association of project management (APM) in the United Kingdom defines project management as the application of processes, methods, skills, knowledge, and experience to achieve specific project objectives according to the project acceptance criteria within agreed parameters. In contradiction with simple management, which is an ongoing process, project management has final deliverables within a finite timescale and a specific budget.

But how project management is being implemented? According to the PMI's (Project Management Institute) A Guide to the Project Management Body of Knowledge

(PMBOK® Guide), can be identified in every project management five typical stages (common process groups):

- Initiating phase, where at the beginning, is clearly defined the object, the requirements, and the plan of the project.
- Planning stage, where the detailed plan of the project is set. It includes the deliverables, the risk analysis, possible deviations from the initial planning, part of the procurements, and the time-schedule.
- Executing stage, where the project is being constructed, and its progress is being tracked
- Monitoring and Controlling stage, where reviews relevant the construction with references to probable deviations from the target is conducted (goals, budget, time schedule).
- Closing stage, where the project is completed and accepted from the project owner with the final reports and analysis.

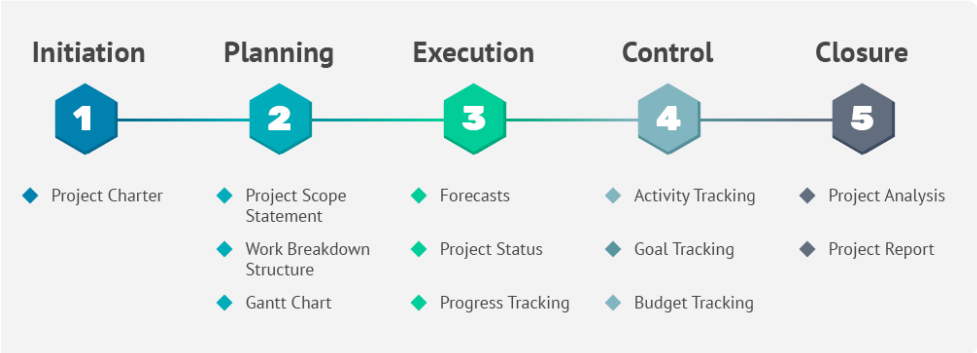


Figure 2. The five stages of Project Management according to PMBOK
(Source: Cohen, 2014)

Because of the complexity of the recent projects, a professional needs a wide range of skills, often technical skills, and certainly people management skills and good business awareness. These skills are shown in the following figure:

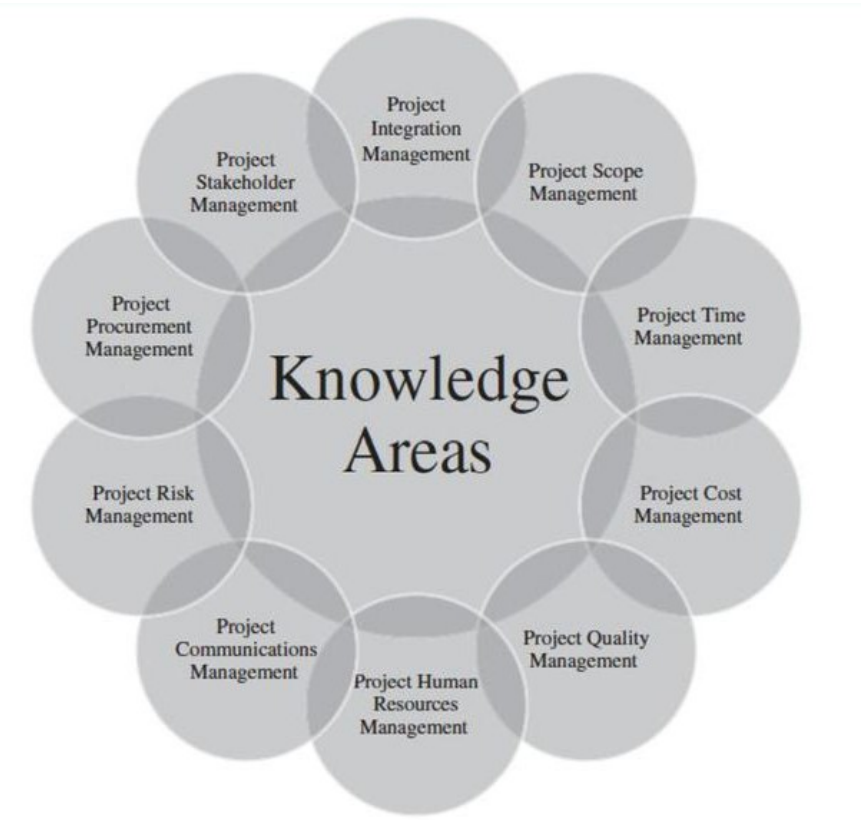


Figure 3. PMBOK 10 areas of knowledge
(Source: Wiley & Sons, 2015)

The knowledge areas can be implemented during anyone of the above five stages of project management. We can think of the five stages as the horizontal axis of a chart, while the knowledge areas are the vertical axis. The knowledge areas are at the core of an effective project management. These critical areas briefly analyzed as follows:

- Project integration management (the way of making various processes work together). At this area developed the project charter, designed the project management plan, the "roadmap" of the project. The safe way for a successful end. Once created, this "roadmap" is approved by stakeholders, and then it's monitored as the project progresses.
- Project Scope management. This area includes all the procedures guarantee that all the necessary and vital for the project works, and only them will be involved for the successful completion of it. These are planning the scope management, collecting requirements, defining the scope, and creating WBS (work breakdown structure), validating and controlling the scope.
- Project time management. It includes processes such as planning the schedule, defining the activities and their sequence, estimating resources, and their duration,

developing and controlling the schedule. The main challenge of project time management is to complete the project on time.

- Project cost management is responsible for the cost management planning, cost estimation, and cost control, as well as for the determination of the budget. Its mission is to complete the project under the planned budget.
- Project quality management includes the planning of the quality management process, the quality assurance process, and the quality process belongs. Quality management processes ensure to meet the projects' quality objectives.
- Project human resources management. This knowledge area has four processes. Planning the resource management process, acquiring the project team, developing and managing this team. All project activities intended to be performed by project team members. Resource management processes mainly aim to people management of project resources, so the project will finish on time, according to the budget limitations, and with the requested quality.
- Project communications management consists of planning communications, managing, and control them. Communication is a vital piece of the project's machine, and it takes place internally and externally. The proper dissemination of information is a significant boost towards the completion of the project.
- Project Risk Management consists of the risk management plan, the identification of risks, analysis of qualitative and quantitative risk factors, and finally, from risk response. These processes mainly aim to reduce the risk impact on the project.
- Project procurement management. It includes the process of planning the procurement management, conducting, executing, controlling, and closing the procurements. Procurement management is crucial for the proper implementation of the project as it "obtain" the necessary resources and services.
- Project stakeholder management consists of identifying stakeholders, planning stakeholder management, managing, and controlling stakeholder management. Stakeholder management processes help to manage the expectations of project stakeholders during the project.

The five stages of project management and the project management areas of knowledge are strongly interconnected to each other, as one or more processes of the knowledge area are subsets to one or more processes belonging to the five project management stages. This chain between them is shown to the following table:

Knowledge Areas	Five Stages of Project Management				
	Initiating Stage	Planning Stage	Executing Stage	Monitoring & Controlling Stage	Closing Stage
Integration Management	Project Charter	Project management plan	Direct -manage project work	Monitor &control project work	Close project
Scope Management		Plan scope management, collect requirements, define scope, Create WBS		Validate scope Control scope	
Time Management		Plan schedule management Define activities Sequence activities estimate activity resources, activity duration develop schedule		Control schedule	
Cost Management		Plan cost management Estimate costs Determine Budget		Control costs	
Quality Management		Plan quality management	Perform quality assurance	Quality control	
Human Resources Management		Plan human resources management	Acquire – develop - manage project team		
Communications Management		Plan communications management	Manage communications	Control communications	
Risk Management		Plan risk management Identify risks analyze risks plan risk responses		Control risks	
Procurement Management		Plan procurement management	Conduct procurements	Control procurements	Close procurements
Stakeholder Management	Identify stakeholders	Plan stakeholder management	Manage stakeholder management	Control stakeholder management	

Table 2. The interconnection between the five stages of PM and the ten areas of knowledge (Source: PMBOK Guide 6th edition)

As a conclusion, we can, without doubts, say that when the project managers are well aware of all the stages of project management as well as with the project management knowledge areas, they can conduct a project more efficiently.

3.2. International Standards and organizations of Project Management

It would not be far from the truth to say that project management follows humanity from its appearance on earth. From the early years when humans tried to hunt as a team, there was a rudimentary and unconscious approach to project management. The way the primitive people assigned the duties so they could increase the hunting results and eat more food, refers to the deep core of project management principles.

Although project management has almost the same age as human beings, it was only the mid-sixties that the scientific community considered project management as a distinct scientific entity. As a result of this, international organizations, whose only subject was the study and promotion of project management, were set up. Some of the most prestigious organizations are:

- The International Project Management Association (IPMA). It is the world's first project management association, founded in 1965. IPMA is a federation consisting of about 70 member associations. The organization encourages its members to interact and develop relationships with other professionals, corporations, public authorities, and universities. Training and consultation are also part of their duties. Mission of the IPMA is the development of project management competences all around the world.
- Last year the Project Management Institute (PMI) completed half a century serving the society of project managers and nowadays counts over half a million members worldwide. With presence in almost all parts of the world, PMI aims to advance careers, improve organizational success, and improve the project management profession. The tools they use are global standards, certifications, communities, resources, academic research, publications, professional development courses, and networking opportunities. The organization aims to prepare the individual project manager for the project economy.
- Another respectable project management organization is The Association for Project Management (APM). Although it is not a global one, but a national one, active in the United Kingdom. Its mission is: "Inspiring communities to deliver meaningful change for societal benefit by advancing the art, science, theory, and practice of project management." This scope can be served and supported through five key objectives, known as five dimensions of professionalism:

- Breadth, Breadth of knowledge,
- Depth of competence,
- The Demonstration of achievement through professional qualifications,
- Commitment through continuing professional development,
- Accountability through adherence to a code of professional conduct.

Regardless of the international organizations whose aim is to promote the science of project management, it is necessary to exist a "common language," a global tool that will help the communication between the project managers and help the successful completion of the projects. This tool can be found at international standards. But what are the international standards? Standards are published documents that establish specifications and procedures designed to ensure the reliability of the materials, products, methods, and/or services people use every day. Standards address a range of issues, including but not limited to various protocols that help ensure product functionality and compatibility, facilitate interoperability and support consumer safety and public health.

The major and most used international standards for project management are:

- The Project Management Body of Knowledge (PMBOK), written by the PMI, reflects the many years of experience of the institute. The PMBOK is not just a simple text for the project managers, but as its title says is the body of knowledge of project management, developed and consolidated over the years. It includes the "best practices" and the experience of pms' all over the world. The first edition was back in 1983, and the latest is the 6th edition issued in September 2017. The contents of PMBOK were briefly analyzed in a previous paragraph and referring to the ten areas of knowledge. While the PMBOK Guide offers a general guide to manage the vast majority of projects, there are currently three official extensions:
  - Construction extension
  - Software extension
  - Government extension
- The International Project Management Association (IPMA) has defined a worldwide standard for competences in the areas of Project-, Program- and Portfolio Management. Counter to the PMI PMBOK, the IPMA does not have a main standard

following by some extensions, but it has issued the following standards depending on the sector:

- The IPMA Individual Competence Baseline (ICB4)
- The IPMA Project Excellence Baseline (PEB)
- The IPMA Organizational Competence Baseline (OCB)
- The IPMA Competence Baseline for Coaches, Consultants and Trainers in the field of projects, programs, and portfolios (ICBCCT4)

- The PRINCE2 (projects in a controlled environment) standard was created in 1989 by the Central Computer and Telecommunication Agency as the British standard for IT project management. Very quickly, it was adopted by various projects, so in 1996, was issued a new version of the standard for general use. Since then, it is mainly used as a project management standard by the British Government, and it is well reputable in the private sector.
- V-Modell is a model for planning and realizing projects. It improves project transparency, management, and increases the probability of project success by specifying stable approaches and responsible roles. The first edition of this standard was V-Modell 97, and the latest issuance is V-Modell XT. It defines the project results to be achieved and describes the processes for developing these results. It also specifies the responsibilities of each participant and answers in detail to the critical question of the standard "who" has to do "what" and "when" in the project.

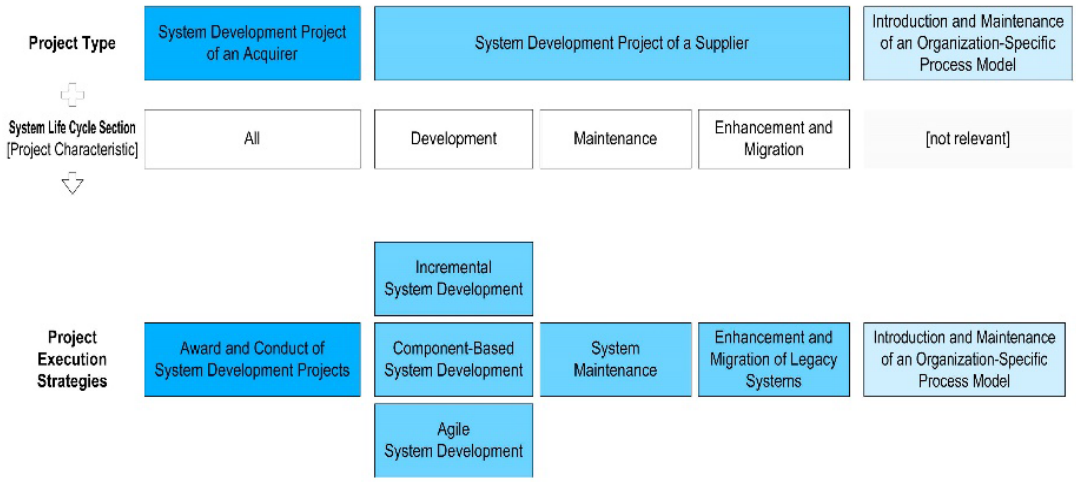


Figure 4. Allocation of Project Execution Strategies to Project Types according to V-Modell (Source: V-Modell XT, Part 1: Fundamentals of the V-Modell)

- Organizational Project Management Maturity Model (OPM3), was developed from PMI to support an initial implementation and subsequent improvements of organizational project management (OPM). OPM is the alignment between the organization's projects and its strategic goals. This standard defines a specific methodology for OPMs implementation and improvement. It comprises a five-step iterative cycle that emphasizes assessment and continuous improvement. In the broadest sense, *OPM3®* is a maturity model, quite different from other maturity models (Capabilities Maturity Model, etc.) in the way it defines a continuum of maturity to discrete levels.
- The SIMPLE (Strategy Implementation Maturing Protocol for Learning Enterprises) is the standard that made OPM3 look outdated and led PMI not to issue an update. SIMPLE is a procedure for assessing and developing the maturity of strategy implementation in organizations that focus on projects. It makes the implementing strategy so simple by enabling the respective organization members to develop capabilities and implement practices that naturally complement each other. This causes the whole to become greater than the sum of its parts without the need for constant coordination by those at the top. SIMPLE's advantage relative to OPM3 is that it enables users to infer their OPM3 maturity level and achieve the highest level of maturity in a fraction of the time typically required by OPM3.
- ISO 21500:2012, Guidance on Project Management, is an international standard developed by the International Organization for Standardization (ISO), released in 2012. It was designed to provide generic guidance, explain the principles, and implement the value of "good practice" in project management. ISO also developed this standard to align with other, related standards such as ISO 10005:2005 Quality management systems − Guidelines for quality plans, ISO 10006:2003 Quality management systems − Guidelines for quality management in projects, ISO 10007:2003 Quality management systems − Guidelines for configuration management, ISO 31000:2018 Risk management – Principles and guidelines.
- British Standard BS 6079-1:2010 Project Management. Principles and guidelines for the management of projects. This standard aims to help people and organizations to continually improve their organization's capability in project management, as well as to contribute to the learning within projects. The principles provided in this standard are as relevant either to small organizations and for small projects or to major organizations with multimillion euros projects. It provides support and guidance for:

    - Managers in organizations that operate projects
    - Project sponsors
    - Project managers
    - Team managers and members
    - Project support staff

- Technicians
- Educators and trainers

BS 6079-1 aims to help and guide the above workforce on sectors like sponsorship, management, planning, undertaking of projects, application of project management techniques.

- P2M – a Japanese guidebook of Project and Program Management for Enterprise Innovation. It has been developed by the Engineering Advancement Association's (ENAA) Committee for Innovative Project Management Development Committee. This standard aims to create a guide that allows the integration of project business strategy elements and utilization of valuable knowledge created through projects and programs.

The keyword throughout P2M is value creation to enterprises, either commercial or public.

3.3. The Greek aspect of Project Management through the years in the construction sector

According to (Kwak, 2003), project management has been used for thousands of years since the Greek and Egyptian times. This aspect seems to be logical regarding the colossal projects of ancient times (Parthenon, pyramids, fortresses, Eupaline trench, aqueducts, and water supply projects). This kind of projects could not be completed without some facts of management. Their complexity, which is still admired, the lack of mechanical resources, and specialized staff, etc. born the need to the chief architect to imply methods of project management during the construction period.

Not until the beginning of the second decade of the 20th century, project management was applied, especially in the construction sector, based on the experience of the chief engineer. But it was around 1910 that Henry Gantt invented the Gantt chart (a chart in which a series of horizontal lines shows the amount of work done or production completed in certain periods of time in relation to the amount planned for those periods). This chart was the cornerstone of project management, as it helped all the previous centuries experience, based on empirical facts, to turn to a science, which the later years proved to be critical in every kind of project.

The Greek construction sector in the previous years (until the beginning of the 21st century) was "divided" into two main groups. The first one consisted of the big

construction firms of the country and the second from the medium to small firms, which were mainly locally established.

It was the construction sector's contribution that “boosted” the Greek economy to grow at a tremendous rate during the 1960s and 1970s. Thanks to the vision and dedication of some engineers, the Greek construction firms expanded their activity worldwide. Companies like EDOK-ETER, SKAPANEAS, ARCHIRODON, constructed big infrastructure projects in the Middle East, Africa, and Asia. In a very competitive environment, the management adopted project management procedures. These firms have well established the following necessary departments, which were in accordance with the five stages of project management (initiation, planning, execution, control, closure):

- Financial Department.
- Human Resources Department.
- Procurement Department.
- Project Department.
- Engineering Department.
- Marketing Department.
- Designing department
- Logistics department (in its purest form)
- Mechanical equipment department
- Law department
- Auctions department

These departments were established at the headquarters, but branches are in every construction site the company had, or there were region headquarters regarding the quantity and the complexity of the projects in a region. These project management procedures and their successful implementation were based on an amazing workflow chart and instant communication. Taking into consideration that communication systems at this period were not including internet, mails, cell phones, etc., and many of the sites were in places far away from “civilized” world, can be easily understood in what extend and how successful were the management procedures these companies have established.

On the other hand, the small local construction firms used to work in the old traditional way, were very few people, mean to do all the work. The project management (pm) was

not a known meaning to them, but to a certain extent, they were following some empirical project management procedures, based mainly on their experience. Some of these companies, the leaders in this sector, have established some of the departments as mentioned above, like financial, engineering, and mechanical equipment departments, and a sort of communication procedures.

In the last 20 years, although that most of the pioneers of the Greek construction sector don't exist anymore, many steps towards the adoption of project management procedures have been done more professionally, either for the leading companies or for the smaller, local firms. This direction helped the new generation engineers that are more educated and aware of project management principles as a crucial tool for the successful completion of a construction project in a qualitative, profitable way within the time schedule.

Summarizing the Greek aspect of project management, some visionary engineers foresaw the future and the need of project management in the construction sector. But like many things in Greece, the majority was very slow in accepting and adopting the necessity of this new science, and in many cases, it did in a unique, incomplete, and amateur way.

Chapter 4

Risk Factors in a Public Highway Project

The context of the fourth chapter will include the definition of risk and how it occurs in everyday life. There will be classified and then identified the risk factors that may appear during the life cycle of a construction project. This procedure will be based on relevant literature, on discussions with experienced executives of the construction sector, and the writers' knowledge from many years of involvement from various positions (designer, site engineer, deputy project manager) in the construction of highway projects.

4.1. Risk in everyday life

An exact definition for risk is hard to be found, and the way it is measured is controversial as well. Literature research ended with the conclusion that the word "risk" is used with many different meanings. The Oxford English Dictionary defines risk as "chance or possibility of danger, loss, injury, etc.". The UK's *Orange Book* attempts an approach of "measuring" risk. It states that risk "has to be assessed in respect of the combination of the likelihood of something happening, and the impact which arises if it does actually happen." Risk also refers to the concept that an action or choice can result in a losing situation. The loss could be emotional, monetary, or otherwise. When the word "risk" is used, it means that the concept of choice is involved.

In almost every decision in someone's life, risk is involved. From the simplest one, which way to drive to work, to the harder one like what to study? In the first choice, there is

always the risk of traffic on the roads, while in the second one may turn false and not successful. Every minute of a human's life is full of questions that demand answers, including the corresponding risk.

4.2. Identification of Risk Factors in public highway projects

One of the various definitions of risk, as already discussed, is an event of uncertainty that may cause a negative impact (mainly). This uncertainty is measured in terms of its probability of occurrence. In the context of an infrastructure project, there are also different definitions issued or used by various agencies and institutions. Most of the definitions are focused on the probability or likelihood of the event.

Risks have significant effects on any one of the aspects of a project, namely cost, time, or scope of the project. It is not a secret that large infrastructure projects have a reputation for being risky and costly. This reputation is well-founded, Flyvbjerg et al. (2003) estimate that 90% of infrastructure projects result in cost overruns, with costs, on average, 28% higher than anticipated. Understanding risks in the early stages of a project is the first critical step towards reducing its impacts and complete the project in an improved and more efficient manner. But before understanding the risks in highway construction, these risks must be identified and classified.

In this "Master's dissertation," the proposed classification will be based on two different parameters. The first will be regarding the critical stages of the construction of the project, and the second will be relative to crucial factors that will "allow" the project to be successful.

The critical stages of construction include all the phases from the adoption of the project until the end. Regarding the construction process, three main stages can be identified:

- The design stage, which includes the adoption of the idea of the new project, the preliminary design, the initial time schedule, the budget estimation, executing and approve the final plans and studies, obtaining all the necessary licences, setting the specifications and proceed to the auction of the project.

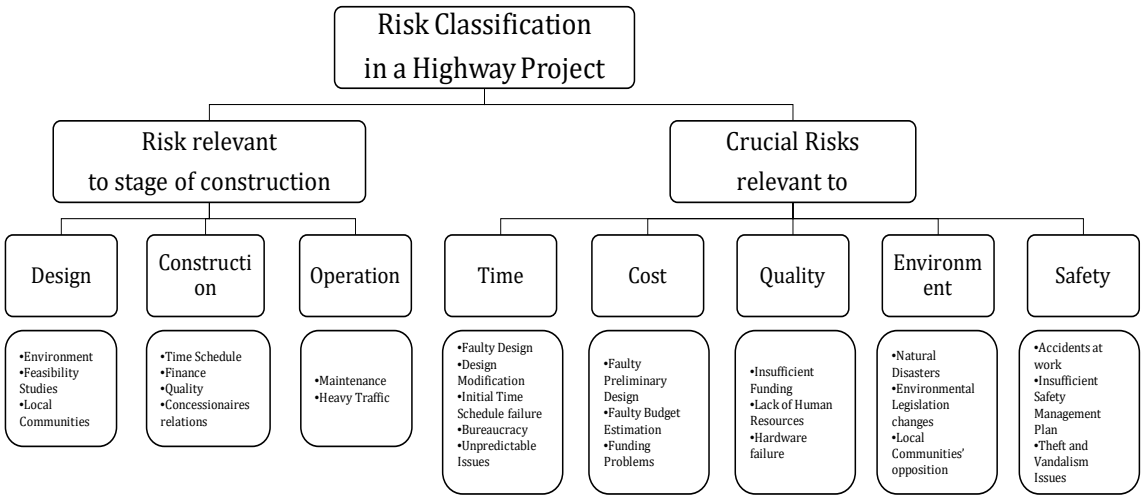


Figure 5. Risk Classification in a Highway Project (Authors design)

- The construction stage, which includes all the construction works in all levels (earthmoving, structures, hydraulic and electromechanical works, etc.), possible modifications of the design through the application studies, and all the necessary tasks for the successful completion of the project.
- The operational stage of the project, which includes traffic and emergency management, the maintenance works, and to secure the financial success of the project.

The second classification attempt will be regarding the crucial factors that will convert the project to a successful investment from all aspects. These critical factors are relative to:

- Time, the on-time completion of a project is always requested,
- Cost, it is vital for every project to be completed with no significant budget overrun,
- Quality, good construction quality will help a project through its lifetime circle,
- Environment, preserving and respecting the local environment is a necessity for every project
- Safety, the construction works will be executed with the highest degree of respect to the employees.

Most of these risk factors are related to each other. A change to one of them affects many others and finally increase the total risk exposure of the project. This bondage between the risk factors is shown in figure 5.

Following will be identified and analyzed the main risks originated from this, eight categories, classification. Relevant literature, discussions with experienced executives of the construction sector, and the writers' personal experience will be used.

4.2.1. The design stage risk factors

The design stage risks of a project are relevant to:

- Environment, with issues that are not compromising with the requirements of the environmental legislation, or not considering the protection of the environment. In some cases, ministries, prefectures authorities for political reasons, promote projects without taking into consideration before their decision, the experts' opinion. In some cases, the need of an Environmental Impact Assessment is downgraded or deliberately mislead. So, risks originated

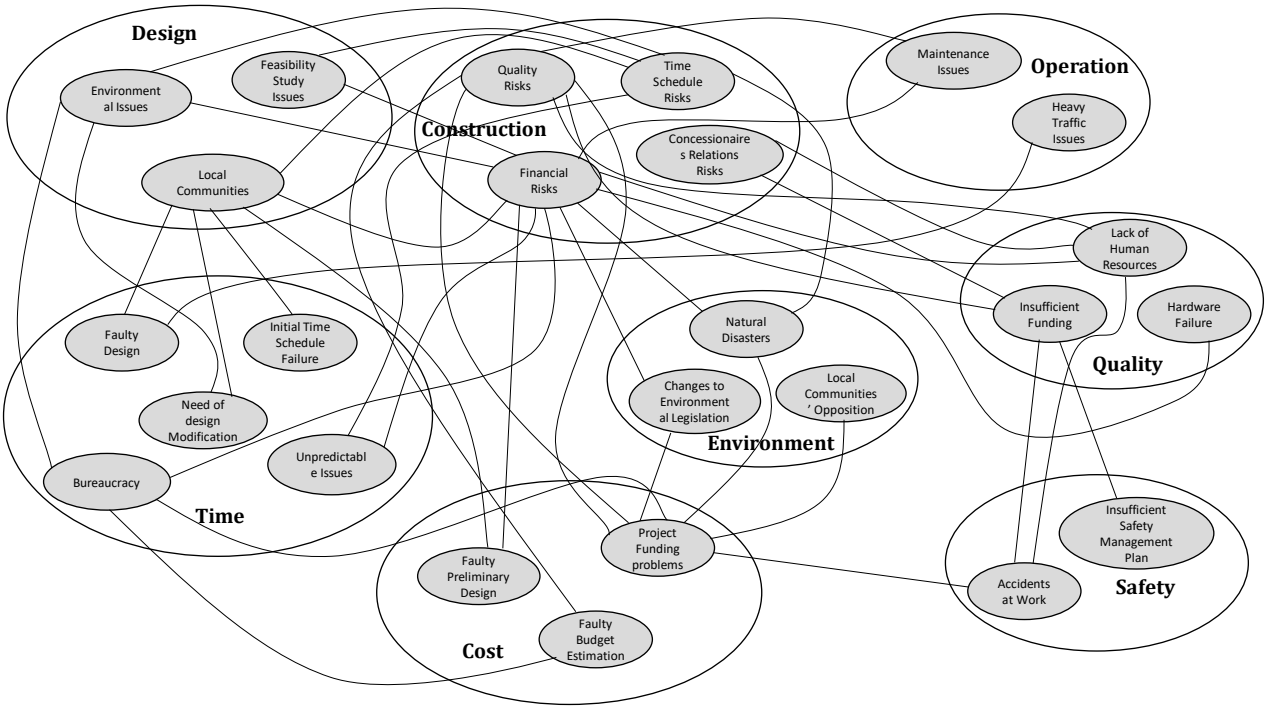


Figure 6: Bondage Chain between Risk Factors (authors design)

from environmental issues, and acts of the authorities regarding the environment are a severe threat for a construction project.

- Feasibility studies, especially in developing countries (Greece is not one of them, but in many cases, the authorities act like it is), where the absence of a central design is more than obvious, projects are announced and prepared to construct, without the proper feasibility studies. Feasibility studies must be undertaken in the very early stage of a highway project. They are necessary in large scale

projects where there is doubt or controversy about the proposed development. Its purpose is to examine if the project is viable, identify feasible options, and assist in the development of other project documentation such as the business case, project execution plan, and strategic brief. Every failure or weakness in the feasibility study implies tremendous risks regarding the future of the entire project.

- Reactions of local communities. Local communities and their aspect about the project procedures may prove vital. They need to be in sync and in agreement with the project. Otherwise, any opposition may cancel the whole project or cause tremendous delays and budget increments. Prior to the execution of a highway project, local communities must be thoroughly informed and persuaded about the need of it or significant risks will be implemented.

4.2.2. The construction stage risk factors

The construction stage in a highway project is the core of every project as it includes all the processes that will transform the initial idea to a successful and working project. Regarding the construction stage, a lot and significant threats can be implemented throughout this period.

- Possible delays in the time schedule may imply serious risks and doubts about the project completion. These delays are closely correlated with the total cost of the project (Salunkhe A., and Visshwakarma A., 2016). Fixed expenses will be increased while compensation for the work performed will be the same. Even worse, the contractor, depending on the contract, may be forced to pay compensation to the owner of the project for the delayed completion. This will set in doubt the success of the investment.
- Financing a project is a very complicated and risky procedure. Karim et al. (2012) identified as significant financial risk factors in a construction project (which may be applied and in a highway project), any cash flow difficulties, the lack of financial resources, and delay of payment for claim. Ehsan et al. (2010) claimed that in economic risk factors may be added the fluctuation in foreign exchange, inflation, and changes in tax legislation.
- Quality issues during the construction period may be crucial for the lifetime circle of the project. Xenidis & Angelidis (2005), characterized these threats as Technical risks, which is anything associated with the process of the project's

development and operation. So, this dissertation proposed classification is part of Xenidis & Angelidis one. Therefore, the category of quality construction issues comprises all the aspects that may endanger the project's success (e.g., material and equipment failure, deviations from designs and quality specifications, limited expertise of labor and personnel, etc.). So any failure to meet the project's quality specifications, except the time and cost impact, will affect the operational stage, to the extent that later maintenance needs will dramatically increase.

- Concessionaires relations are critical for the project. Any disagreements may cause delays in the decision procedures relevant to essential issues (e.g., financing, constructing, and managing issues). This will lead to poor communication and lack of commitment amongst the project team (Chileshe & Yirenkyi-Fianko, 2011).

4.2.3. The operational stage risk factors

After the completion of the highway, the operational stage begins. In this stage, the related risks are coming from maintenance issues and heavy traffic issues. The maintenance issues are closely associated with the use of the highway and are divided into light and heavy maintenance. The light maintenance works are small short-term repairs, while the large-scale works are scheduled to be performed in specific periods (e.g., replacement of the asphalt pavement). The maintenance works are inversely proportional to the construction quality of the project.

The design of the highway and its characteristics (number and width of traffic lanes, number of interchanges, etc.) are based on traffic model studies. In case these studies fail, based on wrong assumptions, they consist significant threat for the investment. Heavy traffic issues will appear and may lead potential customers to use alternatives.

4.2.4. Risk factors relevant to time

Time is a crucial factor in every construction project. The on-time completion and delivery to the owner of the project is one of the primary targets. Time imposed risks may be caused to:

- faulty design of the motorway, either preliminary or worse the final design,

- need for modifications of the design, due to various studies failure, changes to legislation, environmental issues, local communities' oppositions, archaeological findings, etc.,
- initial time schedule failure,
- bureaucracy, Greek state's authorities are famous, will affect the licensing of the project either the initial during the design stage or throughout the construction phase,
- unpredictable issues (weather conditions, strikes, political-economical crises, etc.)

These risk factors will directly affect the time schedule of the project, which is in direct and proportional relation with the project cost.

4.2.5. Risk factors relevant to cost

Large infrastructure projects (highways including) are well known for being risky and costly. This reputation is well-founded, Flyvbjerg et al. (2003) estimate that 90% of infrastructure projects result in cost overruns, with costs, on average 28% higher than anticipated. The implemented cost-related threats may originate from:

- Failure in the initial design and the consequent need of revising it,
- Misjudge on the budget estimation at the first stages of the project,
- Economic issues that affect the funding of the project. Increment in necessary resources prices (fuel, steel, concrete, etc.), tax legislation, inflation fluctuations, reduced toll fees income, need of bank loans due to delay on payments, etc.

All these "cost" implemented risks take into consideration the financial viability of the project.

4.2.6. Risk factors relevant to quality

Besides the financial viability, a highway construction project must meet the specified quality standards. These standards may be in doubt due to significant threats:

- Lack of human resources. The construction sites are understaffed, or the personnel is not adequately experienced for the complexity of such a project,
- Hardware failure, the mechanical equipment does not meet the needs of the work,
- Defective materials, due to unreliable suppliers,

- Insufficient project funding, which forces the management to lower the quality standards.

Quality should be non-negotiable at all costs and may save the investment from later maintenance expenses.

4.2.7. Risk factors relevant to Environmental Issues

Tchankova (2002), argues that the environment's influence on the people and vice versa are essential aspects of this source of environmental risk. These threats may originate from:

- Natural disasters, floods, earthquakes extended fires are significant issues that potentially can endanger the viability of the project. Although a natural disaster is not a frequent phenomenon, it is considered as high risk because it cannot be foreseen,
- Changes to environmental legislation, as the environment is more vulnerable to human actions, authorities taking towards making the environmental laws stricter. These changes are severe threats to the construction sector as they imply more requirements that must be met by the project. This may lead to cost and time overruns.
- Local communities' opposition, sometimes is hard to see the greater picture and not some elements of it. Local communities may oppose to a specific project, as they believe their interests are in danger. This conflict is a significant threat to the project as may be the cause of delay in construction, cost overruns due to possible compensatory benefits.

In any case, environmental protection in any aspect can impose severe threats in the construction process.

4.2.8. Risk factors relevant to Safety Issues

Last but not least, threats regarding safety and security issues are crucial and placed under the composite "safety" risk factors.

- Accidents and injuries at work are something that must be avoided in the construction sites. All regulations must be followed, and all means of personal protection will be available for the personnel. In Greece, for 2017, the percentage

of accidents at work in the civil engineering sector was 2.65% (131/4954 accidents).

- Safety management plan, all construction sites must implement a safety management plan. All the employees must be well trained and educated according to this plan.
- Theft on site and vandalism put in danger mainly the equipment of the site.

Chapter 5

Research Methodology and Data Analysis

The fifth chapter will develop the research methodology and will implement the data analysis of the questionnaires' answers.

5.1. Research Methodology (Developing the Questionnaire)

In order to answer research questions, Naoum (2007) and Dawson (2002) identify two types of research (qualitative and quantitative). Deciding which kind of research should be followed, Naoum (2007) argues that it depends on the purpose of the study and the required available information. The quantitative method considered "objective" in nature as it analyses the collected data with statistical procedures, while the qualitative method considered "subjective" in nature as it emphasizes in meanings, experiences, description, etc. (Dawson 2005).

So, for the assessment of the risk factors in a public highway project, the questionnaire method was selected. The questionnaire had been developed based on the factors carried from a literature review, as well as after discussion with experts. The experts consist of project managers, chief designers, and operation managers with many years of experience. The questionnaires were then distributed to the participants to get the agreement level for each criterion. In this research, the questionnaire method was used to gather information. The completion of this questionnaire achieved in several steps, including the adoption of the research objectives from the participants, determining the sampling group, designing the survey, collecting, and interpreting the results.

The proposed questionnaire was divided in two sections. The first section consists of five questions and refers mainly to demographic factors, and the second part includes the main criteria.

The first part, five questions, includes general demographic information about the participants that consist the sample of the research.

- The e-mail address of the participant, to verify the existence of the participant,
- The educational level (graduate of High school, Technical school, Technical College, University, or postgraduate, doctorate diploma holder)
- The years of experience in the construction sector
- The current position of the participant in the construction sector (project manager, site manager, designer, site engineer, site surveyor, quantity engineer, technical office engineer, supervisor of public works, etc.)
- And the average budget (in euros) that the participant has been involved in so far in his/her career,
- And the crucial question if the participant faces any risks during the life cycle of a highway project (design, construction, operation).

The second part consists of ten questions. Eight of them refer to the proposed risk factors, as they resulted from the literature review and experts' discussion, that may affect a highway project and are categorized relevant to the three (3) main stages of a project, the design, construction, and operational stage, and related to five (5) crucial factors for the successful completion of the project. These factors are time, cost, quality, environment, and safety factors.

The last two questions allow the participants to propose and evaluate according to their aspect any other risk factors that are not included in the research.

This part is structured based on the probabilities these risk factors will occur during the life cycle of the project. For the evaluation of the risk factors, a five-point Likert scale was adopted. The possible answers are referring to the occurrence of risk factors are very low, low, medium, high, very high. Although earlier studies in risk management (Garland 1991) have adopted a four-point scale, excluding the mid-point in the answers, the trend in recent studies is to use a five-point scale, including the mid-point (Odeyinka

et al. 2008, Ahadzie et al. 2008). The Likert scale was adopted because of the research subject. Risks in many cases are difficult to be "converted" in straight numbers if their nature is not numerical, and in this case, a five-point Likert type scale is the method of ascribing quantitative value to qualitative data, to make it amenable to statistical analysis. A numerical value is assigned to each potential choice ("1" for Very Low, "2" for Low, "3" for Medium, "4" for High, and "5" for Very High) and a mean figure for all the responses is computed at the end of the evaluation or survey.

The questions that needed to be answered refer to the proposed risk factors relevant to the three main stages of the project. Regarding the design stage, the proposed risk factors come due to:

- Environmental issues
- Feasibility study issues
- Issues based on reactions of local communities

For the construction stage of the project, the selected risks are relevant to:

- The Time schedule and the compliance with it,
- The financial risks related to cash flow, delays in payments, etc.,
- Quality risks associated with Quality issues (construction methods, material, resources, etc.)
- And threats originated from the relation between the concessionaires

The last stage of the project, the operational stage, the proposed risks are relevant to:

- Maintenance
- Heavy traffic

For the five crucial factors, the implemented threats originate

- For Time from faulty design, the need of design modification, initial time schedule failure, bureaucracy, unpredictable issues,
- For Cost from faulty preliminary design following the need of modification, misjudge on budget estimation, funding problems,
- For Quality from insufficient funding, lack of human resources, hardware failure, defective material,
- For Environment from natural disasters, changes in environmental legislation, local communities' opposition,
- And finally, for Safety from accidents at work, insufficient management plan.

The questionnaire distributed in sixty-one (61) respondents who are experts in the highway construction industry. In the sample were included employees of the major construction companies in Greece, some of the most emblematic Joint Ventures in the section (Attiki Odos and Olympia Odos), operators (Attiki Odos, Olympia Odos, Ionia Odos), designers (highway, Hydraulics, Surveyors), supervisors of public works (Prefecture of Attica, Salfo SA), as well as minor constructors. There were also included professionals with different degrees of experience, from less than five years up to more than 25 years, and with various levels of education. Great attention was given, so the sample would be as representative as it could be. The questionnaire was administered using google forms, and fifty (50) of them responded. The survey started in December 2019 with the development of the questionnaire. Around mid-February, it had been sent to all the participants, and by March the 15^{th,} all the responses have been submitted. The whole questionnaire may be found in Appendix A.

5.2. Data Analysis

Data analysis is divided in two sections. In the first one, the demographic facts of the sample have been evaluated using the appropriate graphs. The second section includes the statistical analysis of the survey.

5.2.1. Questionnaire's Reliability

Before any further processing of the questionnaire's answers, a reliability test was necessary to be conducted to check the reliability of the collected data. Assessing a data survey's reliability is vital to ensure that the survey obtained meaningful data, and the use of Cronbach's Alpha (CA) is a useful measurement towards this goal. The closer the CA coefficient is to 1, the more confident we are that the survey's questions are correlated and therefore produce consistent responses. The CA is calculated from the following equation:

$$CA = \frac{k}{k-1}\left(\frac{S^2 - \sum Si^2}{S^2}\right)$$

Where,

k= is the total participants in the survey,

Si^2 = is the standard deviation of the answers in each question

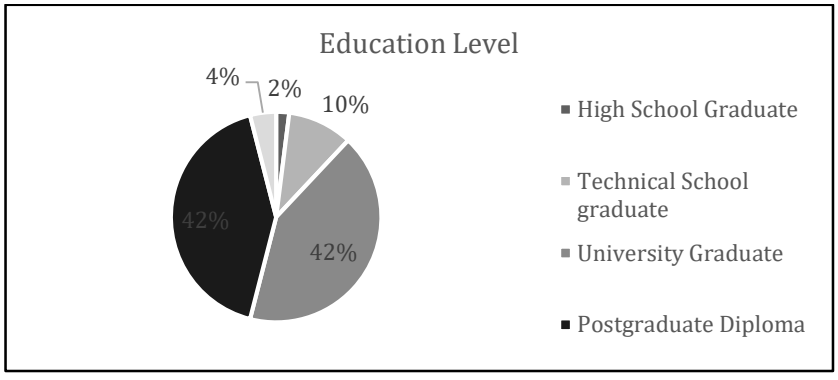
S^2 = is the standard deviation of the sum

The Cronbach's Alpha coefficient is 0.910, with 25 variables. Since the CA calculated more than 0.7, there is high internal consistency for the received data (Hair et al. 1998). The calculations of the Cronbach's Alpha coefficient can be found in Appendix B.1.

5.2.2. Demographic Analysis

Based on the fifty filled questionnaires, descriptive statistics are used to describe the main features of the collected data in quantitative terms. This involved the use of frequencies, percentages, and means for presenting the description findings of the survey. These techniques were employed for analyzing data related to the characteristics of the respondents, their education, working experience, their current position in the construction sector, and open-ended questions/proposals. They were also used for the initial analysis of rating score data of the various research variables. Graphical techniques utilized for presenting the results from these analyses include pie charts, bar charts, and tables.

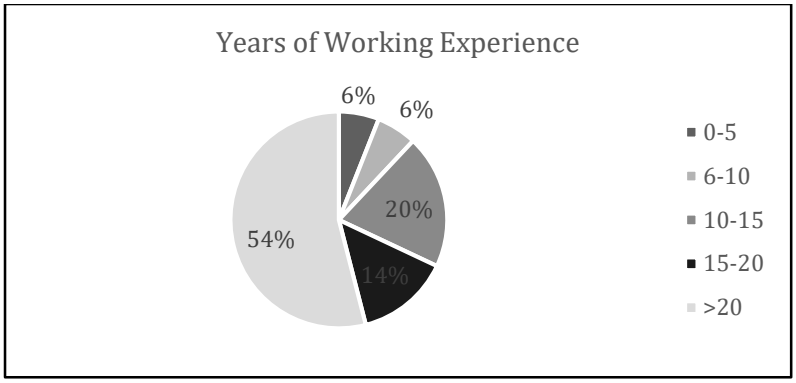
From the received responses, 21 respondents are postgraduate diploma holders, while the same number are University graduates. It means that 84% of the participants have higher education. Also, there is a small percentage (10%) of Technical school graduates. The sample has been completed by 2 Doctorate diploma holders (4%) and 1 High school graduate (2%). The sample from the aspect of education is representative as it includes all types of education, and the vast majority are well educated.



Graph 1. Educational level of the respondents

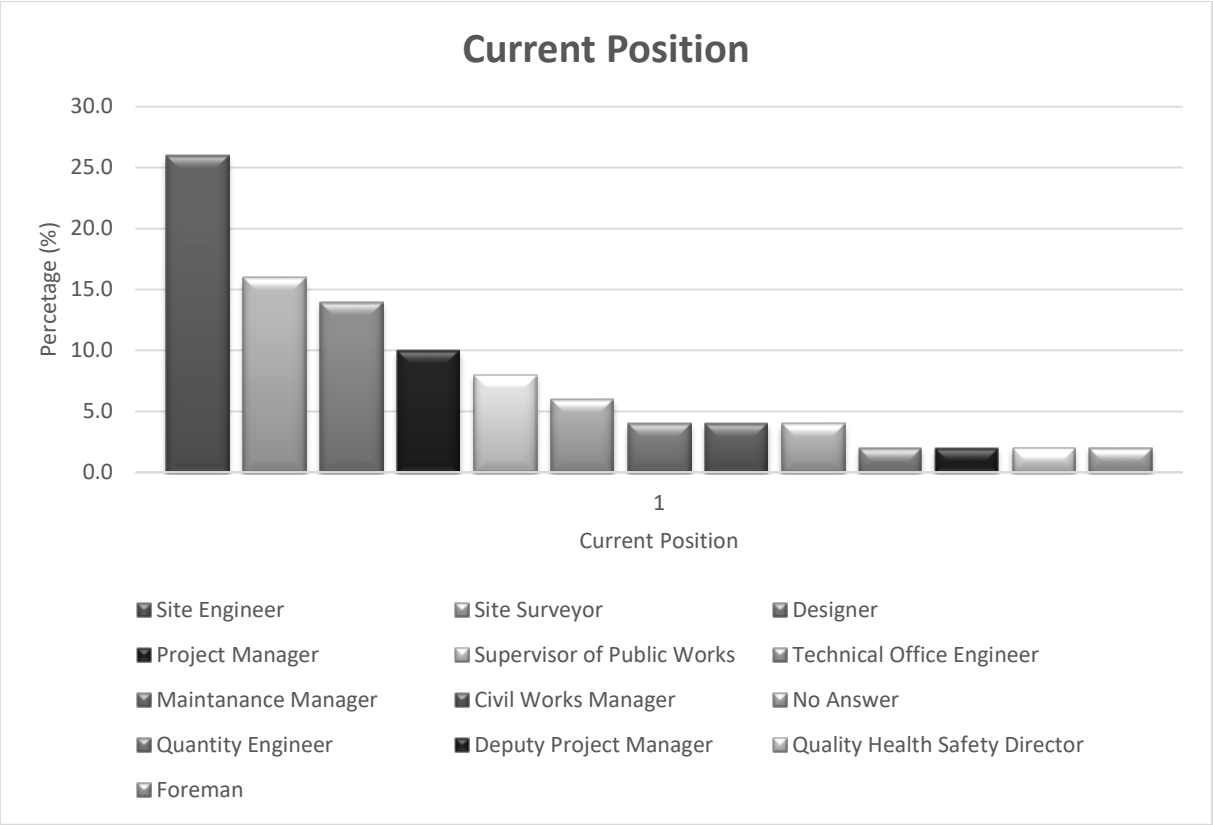
Half of the sample from the aspect of working experience is very experienced, as 54% (27 participants) have more than twenty years of experience in the construction

industry. Another 14% (7) have worked between 15-20 years, and 10 respondents (20%) have working experience between 10-15 years. Also, the sample includes 6 members (12%) with less than 10 years of experience (3 with 6-10 years, and 3 with 0-5 years).



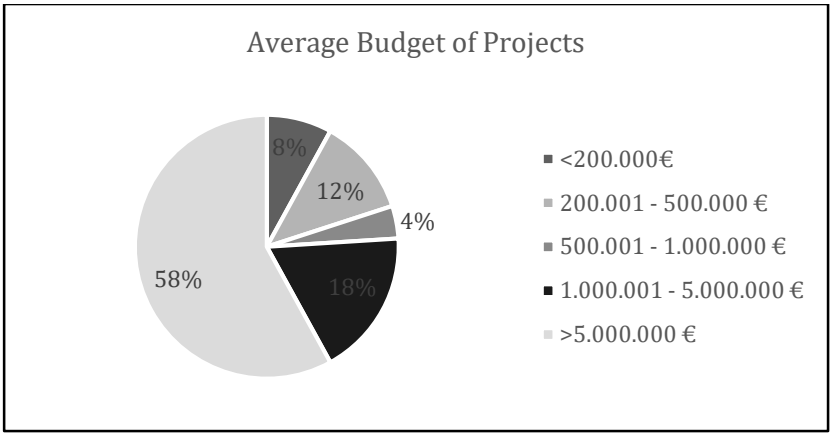
Graph 2. Years of working Experience of the respondents

Regarding the current position in the construction sector 7 respondents (14%) are working as designers, 35 (70%) are involved directly with the construction of the project (5 as project managers, 1 as deputy project manager, 2 as civil works managers, 1 as Quality Health and Safety director, 13 as site engineers, 3 as Technical Office Engineers, 8 as site surveyors, 1 quantity engineer, and finally 1 as a foreman). Two respondents work as maintenance managers in the operational sector of the highways. Four participants (8%) work as supervisors in public works, including highway projects, and two participants (4%) did not mention their current position.



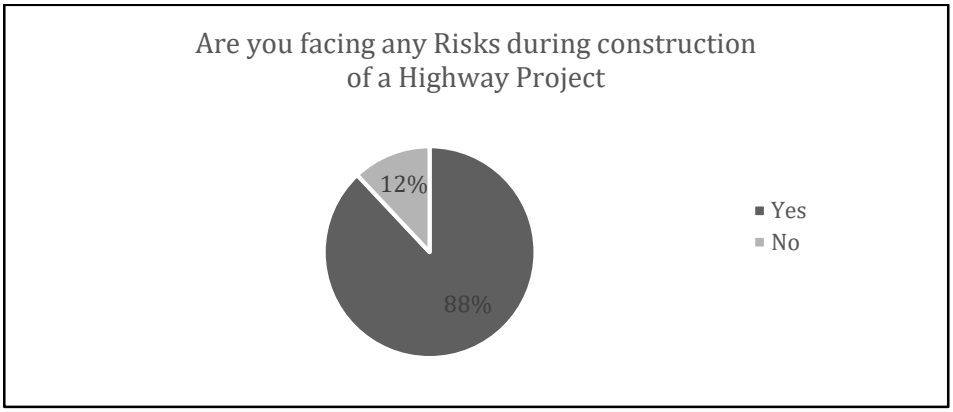
Graph 3. Current position of the respondents

The average budget of the projects that the respondents have been involved in is quite high, as 29 members of the sample (58%) have worked in projects with an average budget above 5.000.000€, while another 18% (9 participants) have an average budget of projects between 1.000.000 – 5.000.000€. Ten (10) respondents, 20%, have worked in projects up to 500.000€, and finally, in medium budget projects, between 500.000€ up to 1.000.000€ have worked 2 of the respondents.



Graph 4. Average budgets of projects respondents have been involved

Finally, at the last question of the first part of the questionnaire, if the respondents face any risks during the construction of a highway project, 44 out of 50 answers are positive (88%), and only 6 are negative. These negative answers are related to respondents that working as designers, or as supervisors in public projects.

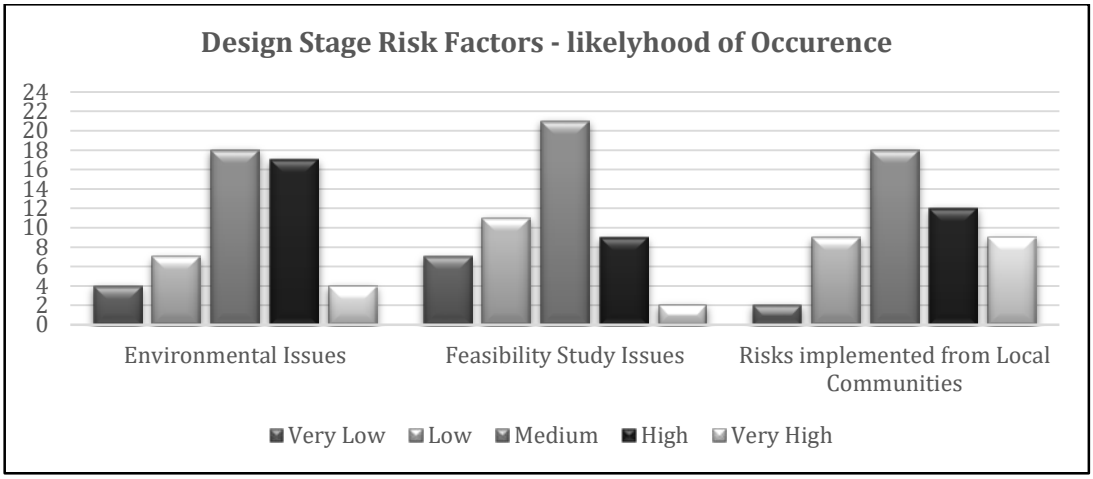


Graph 5. Respondents Risk facing

5.2.3. Questionnaires first approach Analysis

From the responses to the questionnaire and before the statistical analysis of the survey data, a first approach can be made using the charts created from the imported data.

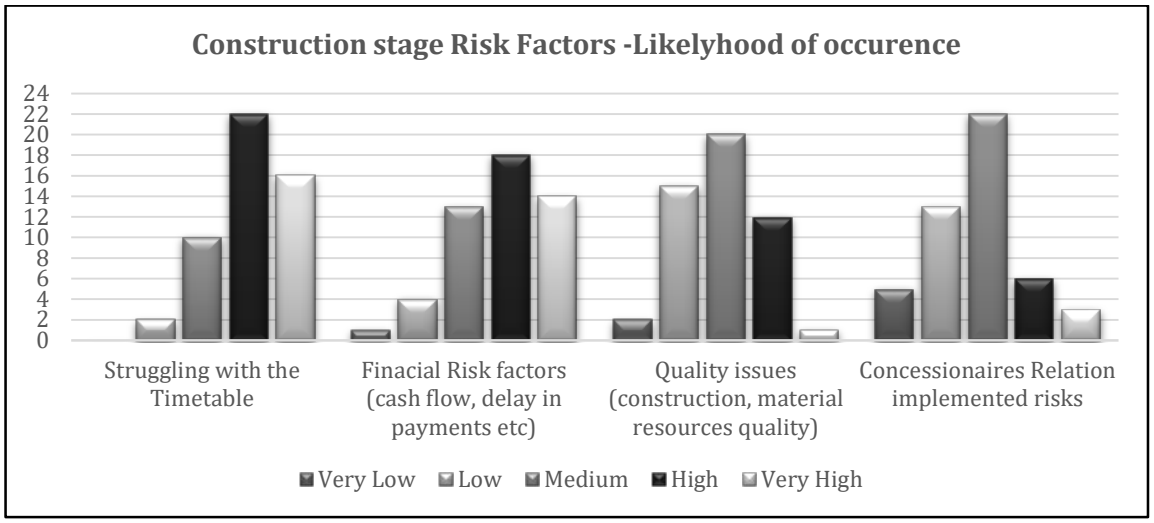
The respondents evaluated the design stage risk factors as medium risks. More specifically, for the environmental issues, 70% of the participants believed these risk factors as medium-high (36% medium and 34% high). The feasibility study issues are recognized from 42% (21 answers) of the sample as medium risks, while 36% (14 very low and 22 low) believe it's a low – very low risk, and the remaining 22% characterizes it as a high – very high one.



Graph 6. The design Stage risk factors evaluation

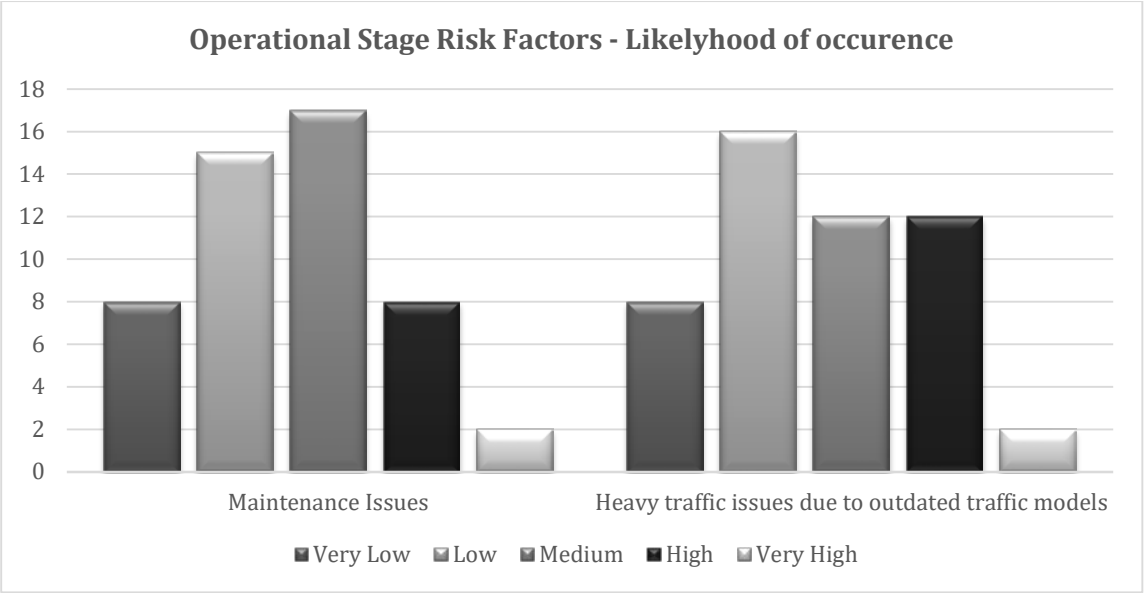
Regarding the construction stage risk factors, the respondents evaluated it as a medium to high risk. In more details, the four identified risks are assessed as follows:

- Delays in the timetable are valued as high to very high risk from 76% of the sample, while 20% estimates it as medium, only 4% as low, and no one believes it is a very low risk.
- Only 10% believe that financial risks during the construction period are a low – very low risk, while 26% classify them in medium-range and 64% evaluate them in the high–very high rank of risks.
- Quality issues are recognized as low to medium risks from 70% of the sample, and only 24% evaluate them as high risk.
- The concessionaire's relations are considered as medium risk (44.9%), 26.5% assess them as low risk, and 10.2% as a very low threat.



Graph 7. The Construction Stage risk factors evaluation

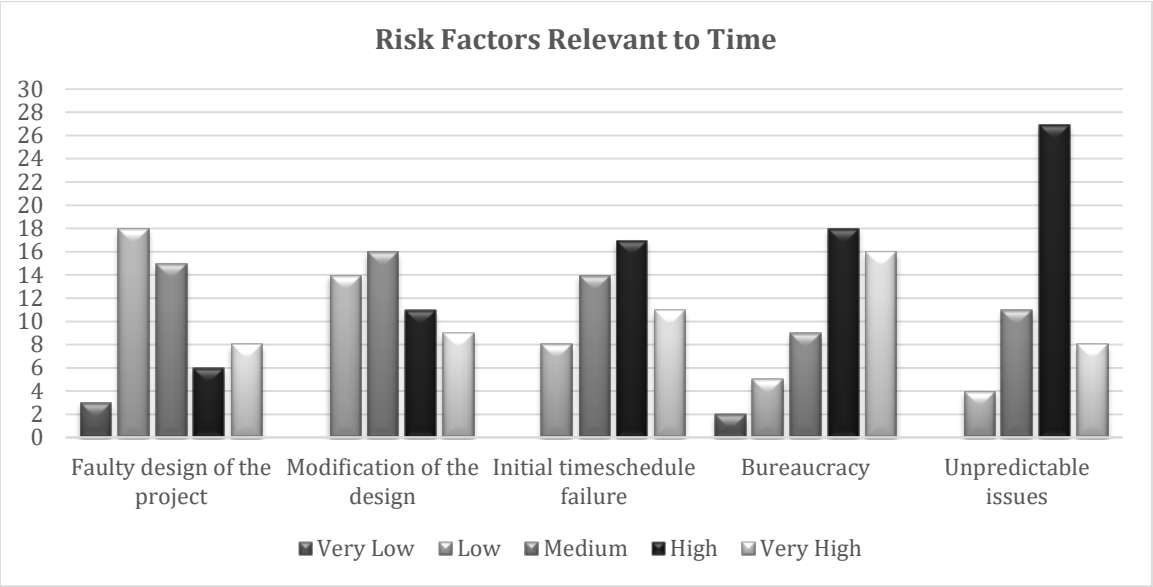
The risks relevant to the operational stage of the project by the first approach of the following chart are considered medium to low risks. The maintenance issues are evaluated by 64% of the sample medium to low risks. The heavy traffic issues due to outdated traffic models tend to be assessed from low to high risks as the answers are shared to low risk from 32%, medium from 24%, and high from another 24% of the respondents.



Graph 8. The Operational Stage risk factors evaluation

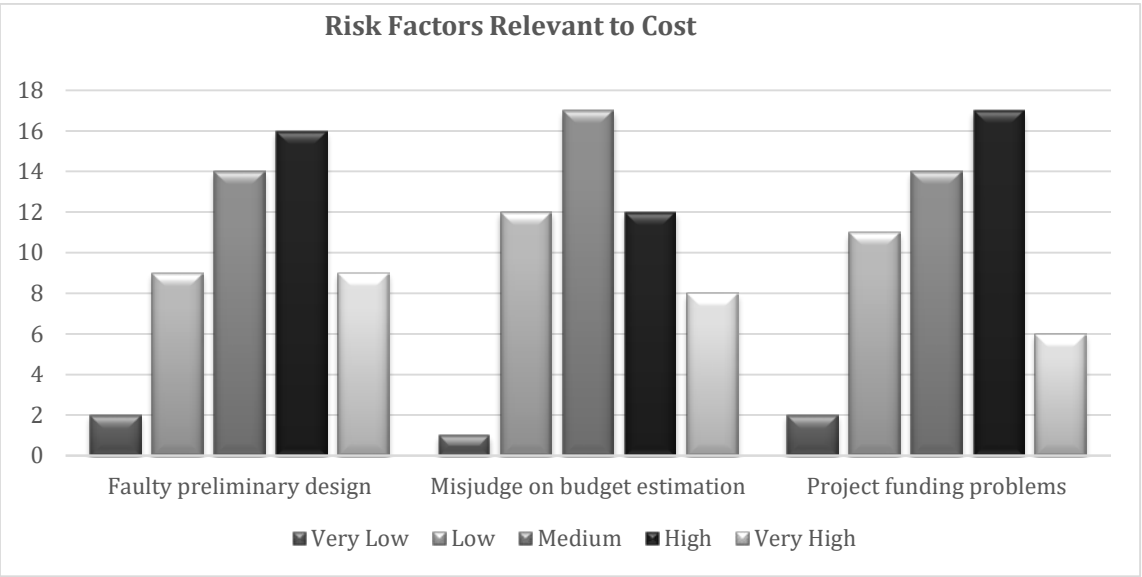
For the risks that may be implied in project construction and are relevant to time, cost, quality, environment, and safety, a first approach evaluation based on the answers of the respondents may be done.

The respondent's answers evaluated the unpredictable incidents (weather conditions, economic crisis, strikes, archaeological findings, etc.) as the higher risk relevant to time. They believe it is a high risk in a percentage of 54%, while another 16% says it is a very high risk, and only 8% perceive the unpredictable issues as a low, very low risk. Bureaucracy is perceived as a high, very high risk by 68% of the participants in the survey. The consistency of the initial time schedule is another fear factor by 56%. 60% of the respondents evaluate the need of modifications in the design of the project as medium to low risk, and another 66% believes that the risk of a faulty design is medium to low.



Graph 9. Risk factors evaluation relevant to time

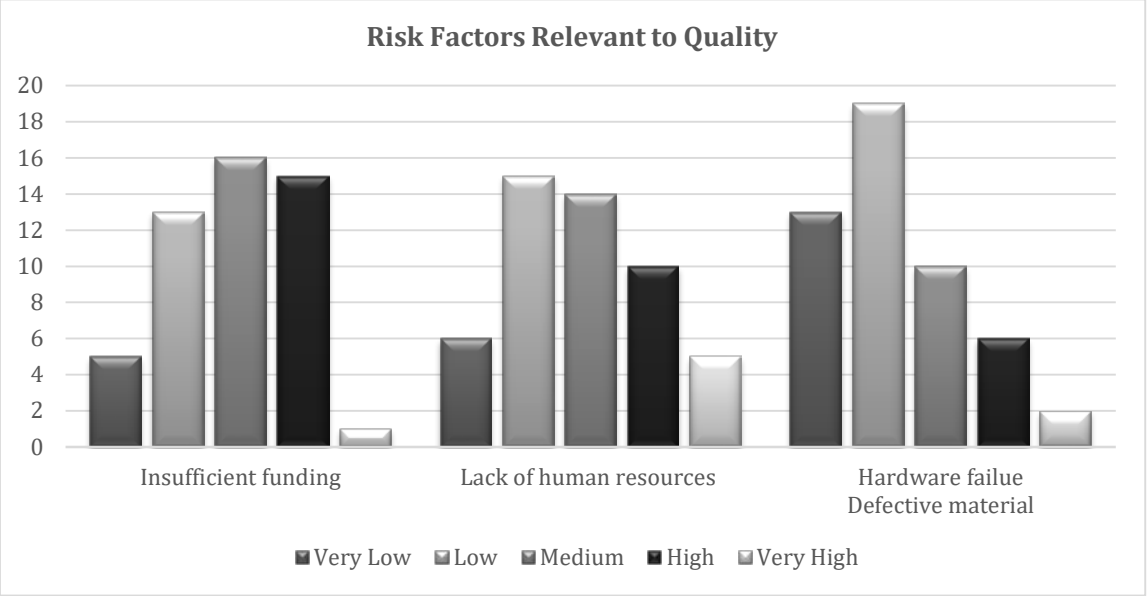
The first approach to the risk factors relevant to cost shows that the sample characterizes the proposed risks (faulty preliminary design, misjudge on budget estimation and project funding problems) high risks -32% for the preliminary design, and 34% for the project's funding problems. An objection there is only on the budget estimation, which is considered as a medium one (34%) while the same number of respondents (24%) believes it is either a low risk or a high one.



Graph 10. Risk factors evaluation relevant to cost

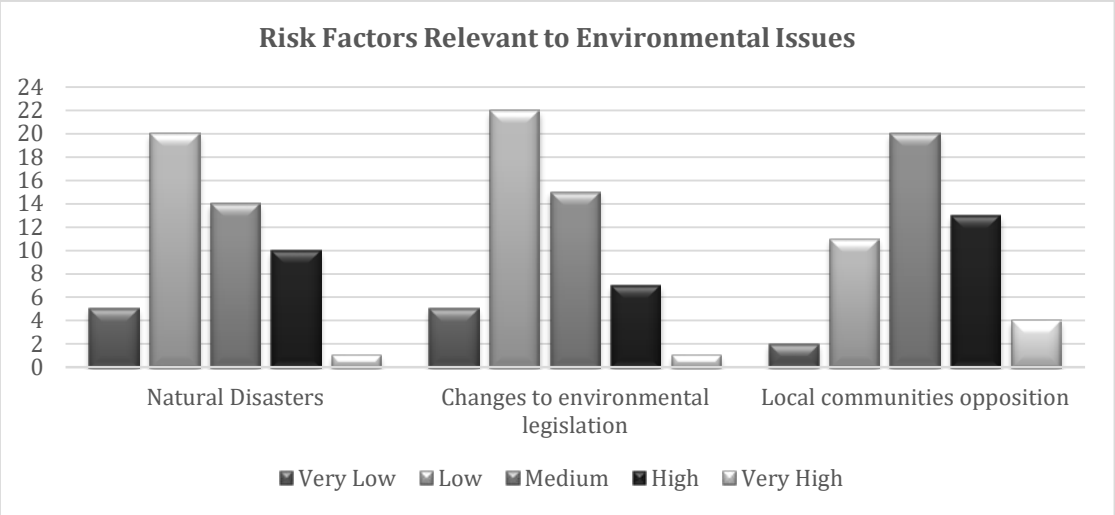
The risks originated from quality issues are perceived mainly as low risks according to the sample's answers. Hardware failure or defective materials are by 64% a low, very

low risk. The lack of human resources does not seem to worry the participants a lot, as 58% considers it as a medium-low risk. Things seem to change regarding the worries of the project funding, and 62% assume this as a medium-high risk.



Graph 11. Risk factors evaluation relevant to quality

Natural disasters and changes to environmental legislation are not seemed to worry the respondents as 40%, and 44% respectively realize them as low risks. Local communities' opposition relevant to environmental issues seems to worry the members of the sample as 40% consider this as a medium risk, while another 26% face it as a high risk.



Graph 12. Risk factors evaluation relevant to the environment

Finally, risks originated from safety issues are by far considered as low, very low risks from the participants. Respectively 51% and 54% realize that accidents at work and insufficient safety management plan – uneducated/inexperienced personnel are not severe threats for the construction of a highway project.

Graph 13. Risk factors evaluation relevant to safety

The vast majority of the respondents, 40 out of 50 answers, did not add any other risk factors besides the proposed. The remaining ten respondents add and evaluate risk factors, as shown in the following table:

Proposed Risks	Risk Evaluation					Without Evaluation
	Very Low	Low	Medium	High	Very High	
Changes in State Governance lead to funding delays, revision / re-interpre tation of contractual terms, etc.				1		
Lack of time and resources requires additional effort which means increased risks						1
Lack of specialized labor workers					1	
Traffic management (in case works are executed under traffic)				1		
Lack of geotechnical studies			2			1
Unforeseen Conditions				1		
Inadequate design					1	
Design Failure			1			

Table 3. Respondents proposed Risk Factors

After analyzing the answers, respondents gave to the survey, an evaluation effort without any further statistical analysis, but relying only on strict numbers and the percentages (%) can be done. The evaluation will be based on a 5-point scale, and the grading will be low, medium-low, medium, medium-high, and high. For each risk factor, its percentage based on the answers given will be calculated and then will be classified according to the 5-point scale. The results of this evaluation are shown in Table 4.

Risk Category	Risk No	Risks	First Approach Classification (percentage %)					Importance Level
			Very Low	Low	Medium	High	Very High	
Design	R1	Environmental Issues	8.0	14.0	36.0	34.0	8.0	H-M
	R2	Feasibility Study Issues	14.0	22.0	42.0	18.0	4.0	M
	R3	Risks implemented from Local Communities	4.0	18.0	36.0	24.0	18.0	M
Construction	R4	Struggling with the Timetable	0.0	4.0	20.0	44.0	32.0	H-M
	R5	Financial Risk Factors	2.0	8.0	26.0	36.0	28.0	H-M
	R6	Quality issues (construction, material, resources quality)	4.0	30.0	40.0	24.0	2.0	M
	R7	Concessionaires Relations implemented risk	10.2	26.5	44.9	12.2	6.1	M
Operation	R8	Maintenance Issues	16.0	30.0	34.0	16.0	4.0	L-M
	R9	Heavy Traffic Issues due to outdated traffic models	16.0	32.0	24.0	24.0	4.0	L-M
Time	R10	Faulty Design of the Project	6.0	36.0	30.0	12.0	16.0	L-M
	R11	Modification of the Design	0.0	28.0	32.0	22.0	18.0	L-M
	R12	Initial Timeschedule failure	0.0	16.0	28.0	34.0	22.0	H-M
	R13	Bureaucracy	4.0	10.0	18.0	36.0	32.0	H
	R14	Unpredictable Issues	0.0	8.0	22.0	54.0	16.0	H
Cost	R15	Faulty preliminary Design - Need of modification	4.0	18.0	28.0	32.0	18.0	H-M
	R16	Misjudge on Budget Estimation	2.0	24.0	34.0	24.0	16.0	M
	R17	Project Funding Problems	4.0	22.0	28.0	34.0	12.0	H-M
Quality	R18	Insufficient Funding	10.0	26.0	32.0	30.0	2.0	H-M
	R19	11.Risk Factors relevant to Quality, Lack of Human Resources	12.0	30.0	28.0	20.0	10.0	L-M
	R20	Hardware Failure/Defective Material	26.0	38.0	20.0	12.0	4.0	L
Environment	R21	Natural Disasters	10.0	40.0	28.0	20.0	2.0	L-M
	R22	Changes to Environmental Legislation	10.0	44.0	30.0	14.0	2.0	L-M
	R23	Local Communities' Opposition	4.0	22.0	40.0	26.0	8.0	M
Safety	R24	Accidents at Work	16.3	34.7	20.4	18.4	10.2	L
	R25	Insufficient Safety Management Plan	16.0	38.0	22.0	18.0	6.0	L

Table 4. Respondents answers first approach classification

5.2.4. Relative Importance Index Analysis

The method that will be used to statistically analyze the findings of the research, because it fits best to the purpose of this study is the Relative Importance Index Analysis (RII). Relative Importance Index or weight is a type of relative importance analysis. The RII aids in finding the contribution a particular variable makes to the
prediction of a criterion variable both by itself and in combination with other predictor variables (Johnson-LeBreton et al. 2004).

The Relative Importance Index is calculated with the following equation:

$$RII = \frac{\sum w}{AN} \ (0 \leq RII \leq 1)$$

Where,

W=weight given to each risk, by response to the questionnaire, and varies from 1 to 5 (where "1" refers to very low and "5" to very high).

A= highest weight, 5 for this purpose since a 5point Likert scale was used,

N= total number of respondents in the survey.

Several risk factors (25) are proposed, calculated, and ranked in compliance with the Relative Importance Index Method (RII). The higher RII is, the more severe the risk factor is. Respectively the lower the RII is, the lower the risk is. The results of the RII analysis are shown in the following table:

Risk Category	Risk No	Risks	RII	Rank
Design	R1	Environmental Issues	0.64	11
	R2	Feasibility Study Issues	0.55	18
	R3	Risks implemented from Local Communities	0.67	7
Construction	R4	Struggling with the Timetable	0.81	1
	R5	Financial Risk Factors (cash flow, delay in payments, etc.)	0.76	3
	R6	Quality issues (construction, material, resources quality)	0.58	14
	R7	Concessionaires Relations implemented risk	0.56	17
Operation	R8	Maintenance Issues	0.52	22
	R9	Heavy Traffic Issues due to outdated traffic models	0.54	20
Time	R10	Faulty Design of the Project	0.59	13
	R11	Modification of the Design	0.66	8
	R12	Initial Time schedule failure	0.72	5
	R13	Bureaucracy	0.76	2

	R14	Unpredictable Issues - weather conditions, strikes, economic crisis, archaeological findings, etc.	0.76	4
Cost	R15	Faulty preliminary Design - Need of modification	0.68	6
	R16	Misjudge on Budget Estimation	0.66	9
	R17	Project Funding Problems - economic crisis, delay on payments, reduced toll fees income, inflation fluctuations	0.66	10
Quality	R18	Insufficient Funding	0.58	15
	R19	Risk Factors relevant to Quality (Lack of Human Resources - understaffed sites, inexperienced personnel	0.57	16
	R20	Hardware Failure/Defective Material	0.46	25
Environment	R21	Natural Disasters	0.53	21
	R22	Changes to Environmental Legislation	0.51	24
	R23	Local Communities' Opposition	0.62	12
Safety	R24	Accidents at Work	0.54	19
	R25	Insufficient Safety Management Plan - uneducated/inexperienced personnel	0.52	23

Table 5. Risk Analysis with Relative Importance Index (RII) method

A further categorization of the above table can be done in accordance to Akadiri's (2011), five important levels that are transformed from Relative Index values: High (H) ($0.8 \leq RI \leq 1$), High–Medium (H–M) ($0.6 \leq RI < 0.8$), Medium (M) ($0.4 \leq RI < 0.6$), Medium–Low (M–L) ($0.2 \leq RI < 0.4$), and Low (L) ($0 \leq RI < 0.2$). The result of this processing is shown in Table 6.

Risk Category	Risk No	Risks	RII	Ranking by Category	Overall Ranking	Importance Level
Design	R1	Environmental Issues	0.64	2	11	H-M
	R2	Feasibility Study Issues	0.55	3	18	M
	R3	Risks implemented from Local Communities	0.67	1	7	H-M
Construction	R4	Struggling with the Timetable	0.81	1	1	H
	R5	Financial Risk Factors (cash flow, delay in payments, etc.)	0.76	2	3	H-M
	R6	Quality issues (construction, material, resources quality)	0.58	3	14	M
	R7	Concessionaires Relations implemented risk	0.56	4	17	M
Operation	R8	Maintenance Issues	0.52	2	22	M
	R9	Heavy Traffic Issues due to outdated traffic models	0.54	1	20	M
Time	R10	Faulty Design of the Project	0.59	2	13	M
	R11	Modification of the Design	0.66	1	8	H-M
	R12	Initial Timeschedule failure	0.72	3	5	H-M
	R13	Bureaucracy	0.76	1	2	H-M
	R14	Unpredictable Issues - weather conditions, strikes, economic crisis, archaeological findings, etc	0.76	2	4	H-M
Cost	R15	Faulty preliminary Design - Need of modification	0.68	1	6	H-M
	R16	Misjudge on Budget Estimation	0.66	2	9	H-M
	R17	Project Funding Problems - economic crisis, delay on payments, reduced toll fees income, inflation fluctuations	0.66	2	10	H-M
Quality	R18	Insufficient Funding	0.58	3	15	M
	R19	Risk Factors relevant to Quality (Lack of Human Resources - understaffed sites, inexperienced personnel	0.57	4	16	M
	R20	Hardware Failure/Defective Material	0.46	3	25	M
Environment	R21	Natural Disasters	0.53	1	21	M
	R22	Changes to Environmental Legislation	0.51	2	24	M
	R23	Local Communities' Opposition	0.62	1	12	H-M
Safety	R24	Accidents at Work	0.54	2	19	M
	R25	Insufficient Safety Management Plan - uneducated / inexperienced personnel	0.52	3	23	M

Table 6. Relative Importance Index (RII) and Importance Level

5.2.5. Perception of Risk Relevant to the Working Experience

After performing the Relative Importance Index (RII) analysis and evaluated the risk impact perception in a highway project, further statistical analysis may be done. This further evaluation can refer to the perception of risk categories depending on the working experience of the sample. The sample can be divided in three groups regarding the years they are working in road construction sector. These three groups are showing in table 7.

Working Experience (years)	Frequency	Percent (%)	Cumulative Percent (%)
0-10	6	12%	12%
10-20	17	34%	46%
>20	27	54%	100%
Total	50	100%	

Table 7: Sample distribution regarding the years of experience

After grouping the survey results, regarding the working experience, calculations of the mean and standard deviation for each risk category were performed. At the same time, the risk categories were ranked based on the mean value, as shown in table 8.

Risk Category	Years of Experience									Total		
	0-10			10-20			>20					
	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank	Mean	Standard Deviation	Rank
DESIGN	3.22	1.11	5	2.96	1.13	4	3.16	1.05	4	3.10	1.09	4
CONSTRUCTION	3.46	1.02	1	3.46	1.03	1	3.32	1.13	3	3.38	1.08	2
OPERATIONAL	3.17	1.03	6	2.41	1.08	8	2.69	1.10	6	2.65	1.10	8
TIME	3.30	1.09	3	3.41	1.06	2	3.59	1.10	1	3.50	1.09	1
COST	3.44	1.10	2	3.12	1.07	3	3.43	1.07	2	3.33	1.08	3
QUALITY	3.06	1.11	7	2.86	1.23	5	2.48	1.04	8	2.68	1.13	6
ENVIRONMENT	2.83	1.15	8	2.63	0.94	6	2.84	0.99	5	2.77	0.99	5
SAFETY	3.25	1.22	4	2.59	1.18	7	2.57	1.17	7	2.66	1.19	7

Table 8. Means and St. Deviations of the respondents according to their working experience

The result that can be drawn from the above ranking attempt is that among the created groups, there is an agreement for the three most significant risk categories in a highway

project, and these are threats relevant to time, cost, and the construction stage of the project. The only difference is the ranking place of these categories.

I addition to the above calculations and ranking attempt, a step forward to the statistical analysis will be attempted. There will be investigated any probable relationship between the newly created subsamples. In a few words, the hypothesis that the risk perception in a highway project is the same among the employees regardless their working experience will be stated.

The one-way Analysis of Variance (ANOVA) at 95% confidence interval and 5% level of significance was adopted to investigate the strength of the stated hypothesis. The main hypothesis was splitted in eight sub-hypotheses, one for each risk category. Eight ANOVA tests were run, to test the difference in the mean value for every risk category (design, construction, operation, time, cost, quality, environment, and safety), regarding the working experience. The Ho hypothesis was that there is no difference in the mean value for each risk category (design, construction, operation, time, cost, quality, environment, and safety) regarding the working experience. The alternative hypothesis Ha was that there is a difference in the mean value of each risk category regarding the working experience. Table 9 shows the results of the eight ANOVA tests that were performed. Analysis results showed that for every risk category, the F statistic is smaller than the F_{crit}, and the P value is greater than 0.05. Hence, the Ho hypothesis cannot be rejected with 95% confidence interval, and the conclusion that is drawn for every risk category is that there is no difference in the perception of risk factors in a highway project, regardless of the working experience.

Risk Category	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Design	Between Groups	1.553740015	2	0.776870007	0.656523981	0.52016501	3.057620652
	Within Groups	173.94626	147	1.183307891			
	Total	175.5	149				
Construction	Between Groups	0.952632297	2	0.476316149	0.405864947	0.666958923	3.041990235
	Within Groups	230.0222421	196	1.173582868			
	Total	230.9748744	198				
Operation	Between Groups	5.199891068	2	2.599945534	2.220999338	0.113989786	3.090186675
	Within Groups	113.5501089	97	1.17061968			
	Total	118.75	99				
Time	Between Groups	3.015172113	2	1.507586057	1.27752401	0.280561686	3.032361496
	Within Groups	291.4808279	247	1.180084323			
	Total	294.496	249				
Cost	Between Groups	3.378228032	2	1.689114016	1.463901225	0.234684394	3.057620652
	Within Groups	169.6151053	147	1.153844254			
	Total	172.9933333	149				
Quality	Between Groups	7.434117647	2	3.717058824	2.982478729	0.05374224	3.057620652
	Within Groups	183.2058824	147	1.246298519			
	Total	190.64	149				
Environment	Between Groups	1.498184459	2	0.749092229	0.757673272	0.470577472	3.057620652
	Within Groups	145.3351489	147	0.988674482			
	Total	146.8333333	149				
Safety	Between Groups	4.819070281	2	2.409535141	1.732645409	0.182299073	3.091191259
	Within Groups	133.504162	96	1.390668355			
	Total	138.3232323	98				

Table 9. Results of ANOVA tests for every risk category

Chapter 6

Conclusions

In this final chapter of this "Master's dissertation" will be summarized the findings, and conclusions and will be stated.

The relative importance index analysis regarding the risk factors in a highway project, as extended described in the above paragraphs, shows that between 25 proposed risks, the most significant are relevant to the construction stage of the project and related to the time the project must be completed. From the respondent's answers and the evaluation of them seems that risks relevant to environmental, operational, safety, and quality issues worry less the construction sector. So, in details, the significant risks are:

Risk Category	Risk No	Risks	RII	Rank
Construction	R4	Struggling with the Timetable	0.81	1
Time	R13	Bureaucracy	0.76	2
Construction	R5	Financial Risk Factors (cash flow, delay in payments, etc.)	0.76	3
Time	R14	Unpredictable Issues - weather conditions, strikes, economic crisis, archaeological findings, etc.	0.76	4
Time	R12	Initial Time schedule failure	0.72	5

Table 10. Overall top 5 risks

And the less significant risks are:

Risk Category	Risk No	Risks	RII	Rank
Environment	R21	Natural Disasters	0.53	21
Operation	R8	Maintenance Issues	0.52	22
Safety	R25	Insufficient Safety Management Plan - uneducated/inexperienced personnel	0.52	23
Environment	R22	Changes to Environmental Legislation	0.51	24
Quality	R20	Hardware Failure/Defective Material	0.46	25

Table 11. Less significant five risks

The significant risks are relevant to the time schedule, either the initial one (No5) or to keep up with the revised one (No1) during the construction. Bureaucracy (No2) is an issue, especially in Greece, which is not well known for the strength, validity of the procedures, and the well-organized public services. Financial issues (No3), like problems in cash flow or delay in payments, are in direct connection with the time schedule. So, an increased probability of one of these risks to occur creates a "domino" effect, which is very difficult to be confronted. The fourth major risk that equally agitated the respondents is the unpredictable issues (No4), like severe weather conditions, labor strikes, economic crisis, archaeological findings, etc. From the 5 most significant risks, the second, third, and fourth have almost the same importance to the respondents of the research as their RI index is 0.76.

The following five risks are relevant to cost issues (preliminary design-need of modification-No6, faulty budget estimation-No9, and funding problems-No10), to time issues (need of modification the design-No8) and design stage (opposition of the local communities-No7).

From the RII analysis the five last risks are considered the natural disasters (No21) and changes to environmental legislation (No24) from the environmental section, various maintenance issues (No22) from the operational stage, the insufficient safety management plan (No23) from the safety section, and finally the risk of hardware failure or the existence of defective material (No25) from the quality section.

From the RII analysis can be easily be noticed that the most significant risks are relevant to Construction, Time, and Cost categories while the less significant originate from more categories (Environment, Operation, Safety, Quality). So it can be assumed that during the construction of a highway project in Greece, the primary concern of the employees of all stages (managers, engineers, designers, etc.) are issues relevant to time and cost. At the same time, they feel more comfortable to deal with environmental, quality, and safety issues.

It is also interesting to try to compare the relevant importance as it occurs from the RI index (RII) and from the first approach impression (FA), which is based on the categorization regarding the more answers received for each question and can be seen from the previous graphs and "Table 4 Respondents answers first approach classification." The findings of this comparison are in Table 12.

This comparison table resulted that 8 risk's importance level is equal among the two ways of calculation. In contrast, 13 risks partly match, and only for 4 risks, the first approach impression is entirely different from the one calculated from the RII analysis. So, 52% partially match, 32% completely match, and only 16% are different. Of course, the result of this comparison cannot lead us to a conclusion that can be implemented in all cases, but it needs more research without any particular results.

Finally, investigated the perception of risk factors of the respondents according to their working experience. For the three groups that were created (0-10, 10-20, and above 20 years of experience), the following hypothesis was stated. There is no difference in perception of risk factors regarding the working experience of an employee in a Highway project. The verification of this hypothesis was done using the Analysis of Variance (ANOVA) were it was tested if there is no difference in the mean values for each risk category among the three samples. The result of this analysis turned that there is no significant difference in how the employees in a highway project evaluate the likelihood of a risk to occur regarding their working experience.

Risk Category	Risk No	Risks	Importance Level (RII)	Importance Level (FA)	Comparison
Design	R1	Environmental Issues	H-M	H-M	match
	R2	Feasibility Study Issues	M	M	match
	R3	Risks implemented from Local Communities	H-M	M	partly match
Construction	R4	Struggling with the Timetable	H	H-M	partly match
	R5	Financial Risk Factors	H-M	H-M	match
	R6	Quality issues (construction, material, resources quality)	M	M	match
	R7	Concessionaires Relations implemented risk	M	M	match
Operation	R8	Maintenance Issues	M	L-M	partly match
	R9	Heavy Traffic Issues due to outdated traffic models	M	L-M	partly match
Time	R10	Faulty Design of the Project	M	L-M	partly match
	R11	Modification of the Design	H-M	L-M	different
	R12	Initial Time schedule failure	H-M	H-M	match
	R13	Bureaucracy	H-M	H	partly match
	R14	Unpredictable Issues	H-M	H	partly match
Cost	R15	Faulty preliminary Design - Need of modification	H-M	H-M	match
	R16	Misjudge on Budget Estimation	H-M	M	partly match
	R17	Project Funding Problems	H-M	H-M	match
Quality	R18	Insufficient Funding	M	H-M	partly match
	R19	Risk Factors relevant to Quality, Lack of Human Resources	M	L-M	partly match
	R20	Hardware Failure/Defective Material	M	L	different
Environment	R21	Natural Disasters	M	L-M	partly match
	R22	Changes to Environmental Legislation	M	L-M	partly match
	R23	Local Communities' Opposition	H-M	M	partly match
Safety	R24	Accidents at Work	M	L	different
	R25	Insufficient Safety Management Plan	M	L	different

Table 12. RII Importance Level and First Approach Importance Level comparison

Chapter 7

Limitations and Future Research

Obviously, the findings of this "master's dissertation" represent a snapshot of reality. Conclusions can "produced," and anyone interested in further investigation of the risk factors that may occur in a highway project can rely on for a start. Nevertheless, there are certain limitations to this attempt. The sample, despite it is a random one, is quite small regarding the population of all the employees in the highway construction sector. It is not very proportional relevant to the current position of respondents, and there are not included the employees of foreign construction companies or designing firms with activities in Greece.

Finally, future research can rely on this attempt and also examine the degree of impact of the identified risks. Also, if the proposed classification of the risks is proportional to their impact on the project. Another sector of further research is if the perception of risk changes according to the educational level, or the age of the respondents, or even regarding their position in the construction process (designer, constructor, supervisor, etc.).

Appendix A

Questionnaire

Risk Factors in Highway Construction Projects

Αξιολόγηση των επιπτώσεων των παραγόντων κινδύνου στην κατασκευή οδικών έργων

Διεύθυνση ηλεκτρονικού ταχυδρομείου *

1.Education Level (Μορφωτικό επίπεδο)

- High School Graduate (Απόφοιτος Λυκείου)
- Technical School Graduate (Απόφοιτος Τεχνικής Σχολής)
- Technical College Graduate (Απόφοιτος Τεχνολογικού Εκπαιδευτικού Ιδρύματος)
- University Graduate (Απόφοιτος Πολυτεχνείου/Πανεπιστημίου)
- Postgraduate Diploma (Κάτοχος Μεταπτυχιακού Τίτλου)
- Doctorate Diploma (Κάτοχος Διδακτορικού Τίτλου)

2.Years of Experience in the construction sector (εμπειρία στον κατασκευαστικό τομέα)

- 0-5 years
- 6-10 years
- 10-15 years
- 15-20 years
- >20 years

3.Which is your current position (e.g., designer, project manager, site engineer, quantity engineer, quality engineer, etc.) Ποια είναι η τρέχουσα θέση σας (μελετητής, διευθυντής έργου, μηχανικός κατασκευής, επιμετρητής κλπ)

4. What is the average budget (in €) of the projects that you have been involved in (ποιος είναι ο μέσος προϋπολογισμός -σε €- των έργων στα οποία έχετε συμμετάσχει)

- < 200.000 €
- 200.001 - 500.000 €
- 500.001 - 1.000.000 €
- 1.000.000 - 5.000.000 €
- >5.000.000 €

5.Are you facing any risks during construction of a highway project? (Αντιμετωπίζετε κινδύνους κατά τη διάρκεια της κατασκευής ενός οδικού έργου

- Yes (Ναι)
-

No (Όχι)

6.The Design stage Risk Factors -Likelyhood of occurence-(Κίνδυνοι κατά το σχεδιασμό του έργου -πιθανότητα εμφάνισης)

	Very Low	Low	Medium	High	Very High
Environmental Issues (Περιβαλλοντικά θέματα)					
Feasibility Study Issues (Θέματα σχετικά με τη μελέτη σκοπιμότητας του έργου)					
Risks implemented from Local Communities (Αντιδράσεις Τοπικών Κοινωνιών)					

7.The Construction stage Risk Factors -Likelyhood of occurence-(Κίνδυνοι κατά την κατασκευή του έργου -πιθανότητα εμφάνισης)

	Very Low	Low	Medium	High	Very High
Struggling with the Timetable (Καθυστερήσεις στο Χρονοδιάγραμμα)					
Financial Risk Factors -cash flow, delay in payments etc- (Χρηματοδοτικοί κίδυνοι -χρηματοροές, καθυστερήσεις πληρωμών-					
Quality issues -construction, material, resources quality- (Προβλήματα Ποιότητας -Ποιότητα κατασκευής, υλικών και πόρων-					
Concessionaires Relations implemented risk (Κίνδυνοι εισαγώμενοι από προβλήματα στις σχέσεις των παραχωρησιούχων)					

8.The Operational stage Risk Factors -Likelyhood of occurence-(Κίνδυνοι κατά την λειτουργία του έργου -πιθανότητα εμφάνισης)

	Very Low	Low	Medium	High	Very High
Maintenance Issues (Προβλήματα Συντήρησης)					
Heavy Traffic Issues due to outdated traffic models (Κυκλοφοριακά προβλήματα λόγω αστοχίας κυκλοφοριακών μοντέλων)					

9.Risk Factors relevant to Time (Παράγοντες κινδύνου σχετικοί με τον Χρόνο)

	Very Low	Low	Medium	High	Very High
Faulty Design of the Project (Ελλατωματικός σχεδιασμός του Έργου)	☐	☐	☐	☐	☐
Modification of the Design (Τροποποίηση Σχεδιασμού)	☐	☐	☐	☐	☐
Initial Timeschedule failure (Αστοχία Αρχικού Χρονοδιαγράμματος)	☐	☐	☐	☐	☐
Bureaucracy (Γραφειοκρατικά θέματα)	☐	☐	☐	☐	☐
Unpredictable Issues - weather conditions, strikes, economic crisis, archaeological findings etc- (Απρόβλεπτες καταστάσεις- καιρικές συνθήκες, απεργίες, οικονομική κρίση, αρχαιολογικά ευρήματα κλπ)	☐	☐	☐	☐	☐

10.Risk Factors relevant to Cost (Παράγοντες κινδύνου σχετικοί με το Κόστος) *Να επισημαίνεται μόνο μία έλλειψη ανά σειρά.*

	Very Low	Low	Medium	High	Very High
Faulty preliminary Design - Need of modification (Αστοχία Προμελέτης, ανάγκη τροποποιήσεων)	☐	☐	☐	☐	☐
Misjudge on Budget Estimation (Αστοχία Προϋπολογισμού του έργου)	☐	☐	☐	☐	☐
Project Funding Problems - economic crisis, delay on payments, reduced toll fees income, inflation fluctuations- Προβλήματα Χρηματοδότησης οικονομική κρίση, καθυστερήσεις πληρωμών,	☐	☐	☐	☐	☐

11.Risk Factors relevant to Quality (Παράγοντες κινδύνου σχετικοί με την ποιότητα)

	Very Low	Low	Medium	High	Very High
Insufficient Funding (Ανεπαρκής Χρηματοδότηση)					
Lack of Human Resources - understaffedd sites, inexperienced personnel - (Έλλειψη ανθρωπίνων πόρων - υποστελέχωση ή μη έμπειρο προσωπικό)					
Hardware Failure/Defective Material (Αστοχία Εξοπλισμού - Ελλατωματικά υλικά)					

12.Risk Factors relevant to Environmental Issues (Παράγοντες Περιβαλλοντικού κινδύνου)

	Very Low	Low	Medium	High	Very High
Natural Disasters (Φυσικές Καταστροφές)					
Changes to Environmental Legislation (Αλλαγές στην Περιβαλλοντική Νομοθεσία)					
Local Communities' Opposition (Αντιδράσεις Τοπικής κοινωνίας)					

13.Risk Factors relevant to Safety Issues (Παράγοντες κινδύνου σχετικοί με θέματα Ασφάλειας στην εργασία)

	Very Low	Low	Medium	High	Very High
Accidents at Work (Εργατικά Ατυχήματα)					
Insufficient Safety Management Plan - uneducated / inexperienced personnel (Ανεπαρκές Σχέδιο Ασφαλείας -μη έμπειρο / ανεκπαίδευτο προσωπικό)					

14. Any other Risk Factor relevant to the construction of a Highway Project (Άλλος παράγοντας κινδύνου σχετικά με την κατασκευή ενός έργου οδοποιίας)

15.Evaluate your answer of question No14 (Αξιολογήστε την απάντηση της ερώτησης No14)

	Very Low	Low	Medium	High	Very High
Question 14 Risk Factor-1					
Question 14 Risk Factor-2					
Question 14 Risk Factor-3					

Appendix B
Data Analysis

B.1 Cronbach's Alpha Calculations

Respondents	Environmental Issues	Feasibility Study Issues	Risks implemented from Local Communities	Struggling with the Timetable	Financial Risk Factors	Quality issues	Concessionaires Relations implemented risk	Maintenance Issues	Heavy Traffic Issues	Faulty Design of the Project	Modification of the Design	Initial Time schedule failure	Bureaucracy	Unpredictable Issues	Faulty preliminary Design	Misjudge on Budget Estimation	Project Funding Problems	Insufficient Funding	Risk Factors relevant to Quality	Hardware Failure/Defective Material	Natural Disasters	Changes to Environmental Legislation	Local Communities' Opposition	Accidents at Work	Insufficient Safety Management Plan	Sum of Respondents responses
No1	3	3	4	5	4	2	3	2	4	4	5	5	5	4	5	5	4	3	2	2	3	4	4	4	3	92
No2	5	3	4	5	5	2	2	1	4	5	5	5	5	4	5	5	4	4	2	1	4	4	4	4	3	95
No3	5	5	4	4	5	2	1	1	4	5	4	4	4	4	5	4	4	3	2	1	4	4	4	5	3	91
No4	3	4	2	3	3	2	2	3	2	2	2	2	2	3	4	3	3	2	3	2	3	2	2	3	3	65
No5	5	4	5	5	5	4	5	4	5	4	5	5	5	5	4	5	5	4	4	4	5	4	5	4	4	114
No6	4	2	4	4	4	3	2	3	2	2	3	3	3	4	3	2	3	2	3	3	3	2	3	2	2	71
No7	2	5	5	4	4	4	4	4	3	3	3	4	4	4	3	3	4	4	2	3	3	3	4	3	2	87
No8	4	3	5	4	3	2	2	2	3	2	3	2	4	3	2	3	3	2	1	2	1	2	3	1	1	63
No9	3	3	1	2	2	2	1	1	1	1	2	2	2	2	2	2	2	2	3	1	1	2	2	1	2	45
No10	5	3	3	4	5	4	3	2	4	2	3	4	5	4	4	5	5	4	3	2	3	4	3	2	2	88
No11	3	2	4	5	5	3	3	3	3	3	3	4	3	4	3	4	3	3	2	2	3	1	4	3	2	78
No12	1	1	2	4	5	3	2	3	3	3	4	4	5	5	3	2	5	4	5	5	2	1	2	2	4	80
No13	3	1	1	5	5	4	4	3	1	5	5	5	5	5	5	5	4	3	2	1	3	3	1	1	1	81
No14	4	4	5	4	4	4	3	3	5	5	5	5	3	3	5	4	4	4	3	2	2	2	3	3	4	93
No15	3	4	3	4	5	2	3	2	2	3	3	2	3	4	4	4	4	4	4	3	2	2	2	2	2	76
No16	4	3	3	4	4	4	3	4	3	4	3	3	2	4	4	4	4	5	3	4	4	3	2	3	4	88
No17	1	1	5	3	4	2	3	2	2	2	2	3	4	4	2	2	4	4	4	3	2	2	3	2	4	70
No18	2	2	3	4	3	2	3	2	2	2	2	4	4	3	3	3	3	3	3	2	2	2	4	1	2	66
No19	2	1	3	4	4	2	3	1	1	3	3	3	1	3	2	3	2	3	4	2	1	1	2	1	1	56
No20	4	3	4	3	3	4	3	4	4	2	2	3	3	4	3	3	4	3	4	3	4	3	4	3	4	84
No21	3	3	2	5	4	3	3	2	4	3	5	4	5	4	4	3	4	4	3	2	3	3	3	3	3	85
No22	3	3	5	5	5	5	5	4	4	4	4	3	5	3	5	4	5	4	5	5	4	3	5	5	5	108
No23	2	3	4	3	4	3	4	2	2	5	4	4	4	3	4	5	3	3	5	4	2	2	4	2	3	84
No24	4	2	3	4	4	2	2	3	2	2	3	3	4	3	2	3	2	4	3	1	2	2	2	4	3	69
No25	4	3	3	5	5	4	4	3	4	4	4	4	5	4	4	4	5	4	4	4	3	3	3	3	2	95
No26	3	2	3	4	5	3	3	3	3	3	5	4	5	4	5	4	4	3	4	3	3	2	4	5	4	91
No27	1	1	2	2	3	4	3	1	3	2	2	3	4	4	4	4	4	4	5	4	4	3	2		4	73
No28	4	3	3	3	3	3	2	4	3	2	3	4	5	4	3	3	3	2	2	1	2	2	3	2	2	71
No29	4	3	4	3	3	3	2	4	3	2	3	3	4	4	3	3	3	2	2	1	2	2	3	2	2	70
No30	2	2	3	5	5	1	3	1	1	2	2	2	2	5	1	1	3	1	1	1	4	3	2	5	1	59
No31	2	3	4	3	4	2	2	1	1	3	2	3	4	4	2	3	3	4	4	2	3	3	4	4	2	72
No32	3	3	4	4	4	3	3	3	2	2	2	2	2	3	3	2	2	2	1	1	2	3	3	2	2	63
No33	1	2	3	4	4	2		5	1	1	2	2	5	4	3	3	1	3	2	1	3	3	3	2	1	61
No34	4	4	3	4	3	1	1	1	4	5	5	5	4	4	4	5	2	3	2	1	4	2	4	4	3	82
No35	4	2	3	3	1	3	1	2	1	1	3	3	5	4	1	3	1	1	1	2	2	4	3	1	1	56
No36	3	3	3	4	2	3	3	3	3	3	2	3	4	3	3	2	2	1	2	1	2	2	2	2	2	63
No37	2	2	2	5	4	3	3	3	2	3	5	5	4	4	3	3	3	1	3	2	1	2	2	2	2	71
No38	3	2	2	3	2	3	2	3	2	2	2	3	1	2	2	2	2	2	1	2	3	1	1	2	1	51
No39	4	2	5	5	4	4	3	3	4	4	4	4	5	5	4	4	3	3	4	3	4	3	5	2	2	93
No40	3	1	3	4	3	3	3	3	2	2	2	2	4	3	2	2	2	2	2	2	2	2	3	1	1	59
No41	4	4	3	5	3	3	1	2	3	3	3	4	4	4	4	2	3	1	3	2	2	2	3	2	2	72
No42	3	3	3	5	5	4	3	5	2	5	4	5	5	5	5	3	4	2	3	3	2	5	3	4	5	96
No43	3	3	4	5	4	3	2	2	1	2	2	4	4	2	3	2	2	3	2	2	2	1	3	2	2	65
No44	3	3	2	4	5	3	4	3	4	3	4	5	4	4	5	5	5	3	1	3	2	2	3	2	3	85
No45	3	3	5	5	4	3	4	2	2	2	3	4	3	5	2	2	3	2	2	1	2	2	5	1	2	72
No46	4	4	4	3	4	4	5	4	4	5	4	4	5	5	4	4	4	4	5	4	4	4	3	5	5	105
No47	4	3	2	5	3	2	3	3	2	3	4	5	3	2	4	2	4	3	2	2	2	3	3	3	2	74
No48	3	4	5	4	3	3	2	2	2	2	3	3	3	4	3	3	4	2	3	2	2	2	3	4	3	74
No49	4	4	3	4	3	2	2	2	3	3	4	5	3	4	4	4	2	2	3	2	3	2	4	4	3	79
No50	4	1	2	4	2	3	3	2	2	3	3	4	4	4	4	3	2	3	4	3	1	3	4	3	4	75
S_i^2	1.102040816	1.084081633	1.208571429	0.692244898	1.020408163	0.785714286	1.011054422	1.138367347	1.283265306	1.386122449	1.153061224	1.015918367	1.252653061	0.664897959	1.228163265	1.144489796	1.144489796	1.046530612	1.388163265	1.234693878	0.969795918	0.865714286	0.964897959	1.541666667	1.306122449	219.2097959
$\sum Si^2$	27.63312925	S^2	219.2097959	k	25																					
Cronbach's Alpha	0.91036																									

B.2 Relative Importance Index Calculations

Respondent	Environmental Issues	Feasibility Study Issues	Risks implemented from Local Communities	Struggling with the Timetable	Financial Risk Factors	Quality issues	Concessionaires Relations implemented risk	Maintenance Issues	Heavy Traffic Issues	Faulty Design of the Project	Modification of the Design	Initial Time schedule failure	Bureaucracy	Unpredictable Issues	Faulty preliminary Design	Misjudge on Budget Estimation	Project Funding Problems	Insufficient Funding	Risk Factors relevant to Quality	Hardware Failure/Defective Material	Natural Disasters	Changes to Environmental Legislation	Local Communities' Opposition	Accidents at Work	Insufficient Safety Management Plan
No1	Medium	Medium	High	Very High	High	Low	Medium	Low	High	High	Very High	Very High	Very High	High	Very High	Very High	High	Medium	Low	Low	Medium	High	High	High	Medium
No2	Very High	Medium	High	Very High	Very High	Low	Low	Very Low	High	Very High	Very High	Very High	Very High	High	Very High	Very High	High	High	Low	Very Low	High	High	High	High	Medium
No3	Very High	Very High	High	High	Very High	Low	Very Low	Very Low	High	Very High	High	High	High	High	Very High	High	High	Medium	Low	Very Low	High	High	High	Very High	Medium
No4	Medium	High	Low	Medium	Medium	Low	Low	Medium	Low	Low	Low	Low	Low	Medium	High	Medium	Medium	Low	Medium	Low	Medium	Low	Low	Medium	Medium
No5	Very High	High	Very High	Very High	Very High	High	Very High	High	Very High	High	Very High	Very High	Very High	Very High	High	Very High	Very High	High	High	High	Very High	High	Very High	High	High
No6	High	Low	High	High	High	Medium	Low	Medium	Low	Low	Medium	Medium	Medium	High	Medium	Low	Medium	Low	Medium	Medium	Medium	Low	Medium	Low	Low
No7	Low	Very High	Very High	High	High	High	High	High	Medium	Medium	Medium	High	High	High	Medium	Medium	High	High	Low	Medium	Medium	Medium	High	Medium	Low
No8	High	Medium	Very High	High	Medium	Low	Low	Low	Medium	Low	Medium	Low	High	Medium	Low	Medium	Medium	Low	Very Low	Low	Very Low	Low	Medium	Very Low	Very Low
No9	Medium	Medium	Very Low	Low	Low	Low	Very Low	Very Low	Very Low	Very Low	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Very Low	Very Low	Low	Low	Very Low	Low
No10	Very High	Medium	Medium	High	Very High	High	Medium	Low	High	Low	Medium	High	Very High	High	High	Very High	Very High	High	Medium	Low	Medium	High	Medium	Low	Low
No11	Medium	Low	High	Very High	Very High	Medium	Medium	Medium	Medium	Medium	Medium	High	Medium	High	Medium	High	Medium	Medium	Low	Low	Medium	Very Low	High	Medium	Low
No12	Very Low	Very Low	Low	High	Very High	Medium	Low	Medium	Medium	Medium	High	High	Very High	Very High	Medium	Low	Very High	High	Very High	Very High	Low	Very Low	Low	Low	High
No13	Medium	Very Low	Very Low	Very High	Very High	High	High	Medium	Very Low	Very High	Very High	Very High	Very High	Very High	Very High	Very High	High	Medium	Low	Very Low	Medium	Medium	Very Low	Very Low	Very Low
No14	High	High	Very High	High	High	High	Medium	Medium	Very High	Very High	Very High	Very High	Medium	Medium	Very High	High	High	High	Medium	Low	Low	Low	Medium	Medium	High
No15	Medium	High	Medium	High	Very High	Low	Medium	Low	Low	Medium	Medium	Low	Medium	High	High	High	High	High	High	Medium	Low	Low	Low	Low	Low
No16	High	Medium	Medium	High	High	High	Medium	High	Medium	High	Medium	Medium	Low	High	High	High	High	Very High	Medium	High	High	Medium	Low	Medium	High
No17	Very Low	Very Low	Very High	Medium	High	Low	Medium	Low	Low	Low	Low	Medium	High	High	Low	Low	High	High	High	Medium	Low	Low	Medium	Low	High
No18	Low	Low	Medium	High	Medium	Low	Medium	Low	Low	Low	Low	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	Low	High	Very Low	Low
No19	Low	Very Low	Medium	High	High	Low	Medium	Very Low	Very Low	Medium	Medium	Medium	Very Low	Medium	Low	Medium	Low	Medium	High	Low	Very Low	Very Low	Low	Very Low	Very Low
No20	High	Medium	High	Medium	Medium	High	Medium	High	High	Low	Low	Medium	Medium	High	Medium	Medium	High	Medium	High	Medium	High	Medium	High	Medium	High
No21	Medium	Medium	Low	Very High	High	Medium	Medium	Low	High	Medium	Very High	High	Very High	High	High	Medium	High	High	Medium	Low	Medium	Medium	Medium	Medium	Medium
No22	Medium	Medium	Very High	Very High	Very High	Very High	Very High	High	High	High	High	Medium	Very High	Medium	Very High	High	Very High	High	Very High	Very High	High	Medium	Very High	Very High	Very High
No23	Low	Medium	High	Medium	High	Medium	High	Low	Low	Very High	High	High	High	Medium	High	Very High	Medium	Medium	Very High	High	Low	Low	High	Low	Medium
No24	High	Low	Medium	High	High	Low	Low	Medium	Low	Low	Medium	Medium	High	Medium	Low	Medium	Low	High	Medium	Very Low	Low	Low	Low	High	Medium
No25	High	Medium	Medium	Very High	Very High	High	High	Medium	High	High	High	High	Very High	High	High	High	Very High	High	High	High	Medium	Medium	Medium	Medium	Low
No26	Medium	Low	Medium	High	Very High	Medium	Medium	Medium	Medium	Medium	Very High	High	Very High	High	Very High	High	High	Medium	High	Medium	Medium	Low	High	Very High	High
No27	Very Low	Very Low	Low	Low	Medium	High	Medium	Very Low	Medium	Low	Low	Medium	High	High	High	High	High	High	Very High	High	High	Medium	Low		High
No28	High	Medium	Medium	Medium	Medium	Medium	Low	High	Medium	Low	Medium	High	Very High	High	Medium	Medium	Medium	Low	Low	Very Low	Low	Low	Medium	Low	Low
No29	High	Medium	High	Medium	Medium	Medium	Low	High	Medium	Low	Medium	Medium	High	High	Medium	Medium	Medium	Low	Low	Very Low	Low	Low	Medium	Low	Low
No30	Low	Low	Medium	Very High	Very High	Very Low	Medium	Very Low	Very Low	Low	Low	Low	Low	Very High	Very Low	Very Low	Medium	Very Low	Very Low	Very Low	High	Medium	Low	Very High	Very Low
No31	Low	Medium	High	Medium	High	Low	Low	Very Low	Very Low	Medium	Low	Medium	High	High	Low	Medium	Medium	High	High	Low	Medium	Medium	High	High	Low
No32	Medium	Medium	High	High	High	Medium	Medium	Medium	Low	Low	Low	Low	Low	Medium	Medium	Low	Low	Low	Very Low	Very Low	Low	Medium	Medium	Low	Low
No33	Very Low	Low	Medium	High	High	Low		Very High	Very Low	Very Low	Low	Low	Very High	High	Medium	Medium	Very Low	Medium	Low	Very Low	Medium	Medium	Medium	Low	Very Low
No34	High	High	Medium	High	Medium	Very Low	Very Low	Very Low	High	Very High	Very High	Very High	High	High	High	Very High	Low	Medium	Low	Very Low	High	Low	High	High	Medium
No35	High	Low	Medium	Medium	Very Low	Medium	Very Low	Low	Very Low	Very Low	Medium	Medium	Very High	High	Very Low	Medium	Very Low	Very Low	Very Low	Low	Low	High	Medium	Very Low	Very Low
No36	Medium	Medium	Medium	High	Low	Medium	Medium	Medium	Medium	Medium	Low	Medium	High	Medium	Medium	Low	Low	Very Low	Low	Very Low	Low	Low	Low	Low	Low
No37	Low	Low	Low	Very High	High	Medium	Medium	Medium	Low	Medium	Very High	Very High	High	High	Medium	Medium	Medium	Very Low	Medium	Low	Very Low	Low	Low	Low	Low
No38	Medium	Low	Low	Medium	Low	Medium	Low	Medium	Low	Low	Low	Medium	Very Low	Low	Low	Low	Low	Low	Very Low	Low	Medium	Very Low	Very Low	Low	Very Low
No39	High	Low	Very High	Very High	High	High	Medium	Medium	High	High	High	High	Very High	Very High	High	High	Medium	Medium	High	Medium	High	Medium	Very High	Low	Low
No40	Medium	Very Low	Medium	High	Medium	Medium	Medium	Medium	Low	Low	Low	Low	High	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Very Low	Very Low
No41	High	High	Medium	Very High	Medium	Medium	Very Low	Low	Medium	Medium	Medium	High	High	High	Low	Medium	Very Low	Very Low	Medium	Low	Low	Low	Medium	Low	Low
No42	Medium	Medium	Medium	Very High	Very High	High	Medium	Very High	Low	Very High	High	Very High	Very High	Very High	Very High	Medium	High	Low	Medium	Medium	Low	Very High	Medium	High	Very High
No43	Medium	Medium	High	Very High	High	Medium	Low	Low	Very Low	Low	Low	High	High	Low	Medium	Low	Low	Medium	Low	Low	Low	Very Low	Medium	Low	Low
No44	Medium	Medium	Low	High	Very High	Medium	High	Medium	High	Medium	High	Very High	High	High	Very High	Very High	Very High	Medium	Very Low	Medium	Low	Low	Medium	Low	Medium
No45	Medium	Medium	Very High	Very High	High	Medium	High	Low	Low	Low	Medium	High	Medium	Very High	Low	Low	Medium	Low	Low	Very Low	Low	Low	Very High	Very Low	Low
No46	High	High	High	Medium	High	High	Very High	High	High	Very High	High	High	Very High	Very High	High	High	High	High	Very High	High	High	High	Medium	Very High	Very High
No47	High	Medium	Low	Very High	Medium	Low	Medium	Medium	Low	Medium	High	Very High	Medium	Low	High	Low	High	Medium	Low	Low	Low	Medium	Medium	Medium	Low
No48	Medium	High	Very High	High	Medium	Medium	Low	Low	Low	Low	Medium	Medium	Medium	High	Medium	Medium	High	Low	Medium	Low	Low	Low	Medium	High	Medium
No49	High	High	Medium	High	Medium	Low	Low	Low	Medium	Medium	High	Very High	Medium	High	High	High	Low	Low	Medium	Low	Medium	Low	High	High	Medium
No50	High	Very Low	Low	High	Low	Medium	Medium	Low	Low	Medium	Medium	High	High	High	High	Medium	Low	Medium	High	Medium	Very Low	Medium	High	Medium	High
Very Low	4	7	2	0	1	2	5	8	8	3	0	0	2	0	2	1	2	5	6	13	5	5	2	8	8
Low	7	11	9	2	4	15	13	15	16	18	14	8	5	4	9	12	11	13	15	19	20	22	11	17	19
Medium	18	21	18	10	13	20	22	17	12	15	16	14	9	11	14	17	14	16	14	10	14	15	20	10	11
High	17	9	12	22	18	12	6	8	12	6	11	17	18	27	16	12	17	15	10	6	10	7	13	9	9
Very High	4	2	9	16	14	1	3	2	2	8	9	11	16	8	9	8	6	1	5	2	1	1	4	5	3
ΣW	160	138	167	202	190	145	136	131	134	148	165	181	191	189	171	164	164	144	143	115	132	127	156	133	130
A	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
N	50	50	50	50	50	50	49	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	49	50
RII	0.64	0.55	0.67	0.81	0.76	0.58	0.56	0.52	0.54	0.59	0.66	0.72	0.76	0.76	0.68	0.66	0.66	0.58	0.57	0.46	0.53	0.51	0.62	0.54	0.52

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