Project risk management adaptation of infrastructures in the Greek context

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Abstract. Last years in Greece there has been an increase in the number of “Small and Medium Enterprises, SMEs” active in the construction of infrastructures and specifically in the telecommunications sector. The research methodology was done with an appropriate questionnaire which is addressed mainly to construction companies. Large companies, for both operational and financial reasons, prefer to outsource projects and services related to their network infrastructure to third companies rather than using their own resources. SMEs undertake to implement many of these services. They are more flexible in terms of operation but also adapt faster to the requirements of the projects they undertake. However, unlike large companies, they lack in procedures and have limited administrative resources. This makes them more vulnerable to the risks presented in the various phases of the projects they undertake. Risk Management, as a process, includes the identification of risks, the prediction of the probability of occurrence and its consequences and finally proposes solutions to treat them. The research investigates the current situation regarding risk management by Greek SMEs. The results showed up that although the use of relevant risk management procedures is limited, the participants believe to the usefulness of the process according to international standards for the projects that SMEs implement.

1. Introduction

The European Union's strategy in the field of telecommunications is the digital transformation of Member States with the aim of connectivity, i.e., the possibility for all citizens to be able to access the internet and related applications [1]. To achieve this objective, there needs to be the appropriate infrastructure for the operation of the relevant technological equipment. So, the Telecommunication Providers have scheduled to upgrade their infrastructures constructing new fiber optics networks, datacenters, wireless base stations etc. In Greece, these projects are undertaken mainly by Small and Medium-sized Enterprises (SMEs). According to the European Commission yearly report (SBA2019) [2], SMEs play a key role in the Greek economy, producing 63.5% of value added and securing 87.9% of employment, exceeding in both these sectors the European average (56.4% and 66.6% respectively). An enterprise is classified as SME on the basis of two characteristics. Firstly, the total number of staff employed, which must not exceed 250 employees, and secondly the annual turnover , up to a maximum of EUR 50 million or the annual total balance sheet, which must not exceed EUR 43
million [3]. Comparing the data of each business with the above limits can determine whether it is a micro, small or medium-sized enterprise.

Since the professional environment has strong competition with changing technological developments, increased project implementation requirements, usually limited completion time as well as incomplete procedures and resources, significantly increases the occurrence of risks. Risk Management (RM), as a process, includes the recognition of risks, the ability to predict their occurrence and consequences and finally proposes solutions to address them. Companies that have adopted an effective risk management plan have a comparative advantage. They can effectively address the emerging risks that have a clear influence on the three main axes of a project, the time, cost, and quality of the project. Also, if the project is implemented by an external organization, then there is a fourth factor - which is good relations with customers - reputation of the company [4]

This study helps to recognize which way Greek SMEs face the risks that appear in infrastructure development projects. In addition, it will investigate whether they use RM procedures and whether there are related dependencies in relation to the business category.

2. Theoretical background

2.1. Risk Definition and Characteristics

Any project, whatever it produces (product, service, program, etc.), consists of several stages. These stages concern separate parts of the life of the project and are generally called project life cycle. The common theoretical approach states that the stages in which a project's life cycle involves are define, plan, execute and close out [5]. Each stage can consist of either a simple or complex process without being completely sure of achieving the result. Moreover, there are interactions between phases, which means that any change in the previous one can affect the next one, and so on. It is therefore obvious that in each of the phases there is the concept of uncertainty and the emergence of one or more risks that will affect the implementation of the project. In 2018 the World Standardization Organization (ISO) adopted a revised framework on RM [6]. This Directive describes the concept of 'risk' as a consequence of uncertainty about an objective. Consistency may result in a deviation from the expected result, positive or negative. In order to be able to deal with the potential risks, the most important element is to be able to identify them. To do this, we categorize them so that they can be used as a tracking tool. The separation of risks is mainly based on two main categories: their nature and origin [7]

As far as reference to their nature is concerned, the risks can have either a positive effect on the objective of a project or a negative one; in the case of a positive effect, we usually mention the word "Opportunity" because the result does not affect the objective of the project or has such an effect that allows us to exploit other parallel situations. In the case of negative impact, we usually mention the word "Threat", because the risk affects other related situations or objectives of the project itself. This is why a special basis is given to.

The parameter of origin refers to the internal and external risks of an organization or project. 'Internal risks' means risks arising from the organization or project itself, the actions of which affect the likelihood of a risk. In other words, they relate to its operation and the results of which create risks affecting most of the objectives of the project (e.g., financing problem, lack of staff, etc.). Otherwise, 'external risks' are defined as those coming from outside the organization or project. External risks may also be directly and indirectly related to the organization or project. As a direct link we can mention the risks associated with the execution of the project or the operation of the organization. (e.g. permits for construction, transit by third parties, etc.). As an indirect relationship we can mention the risks that although they have nothing to do with the specific area of existence of the project, when they occur, they affect in combination the objectives of the project (e.g. strike of the workers' union, natural disaster, etc.).

In addition to the above characteristics, the risks may also be characterized according to the areas they affect, such as financial, technical, administrative etc. [8]. At this point it is worth mentioning that
the above reports on the risk relate to the consequences caused by its appearance. There is a risk when the consequences of its occurrence should have an impact and affect the objective of the project. Otherwise, there is no existing any kind of risk.

2.2. Risk Management - Framework & Procedures

Technical projects follow the specific axes of a project. They have a specific quality implementation standard in accordance with technical specifications and they must be carried out over a specific period of time with specific financial and human resources. The fact that they are permanently exposed to risks and that there are many involved in implementation has led over the last four decades to research into the development of risk management methods [9].

The need to eliminate risks in the course of a project has led to the creation of standards by various international organizations, which define the principles, rules and procedures required for their implementation. In the international literature we find reports and publications related to risk management in technical projects [10] etc., the development of various methods of analysis [11] etc., as well as related proposed methodologies related to different sectors of technical projects [12] etc. A remarkable context is what Chapman & Ward mentions [13], which reflects the uncertainty around the objectives of shareholders and all parties taking part in the implementation of the project and consists of seven questions that describe them as "7Ws" (because they all begin with the letter "W"): a) Who, b) Why, c) What, d) Which way, e) Wherewithal, f) When and g) Where.

Risk Management Standards and Methods, describe the responses to the above 7Ws. In general, Project Risk Management refers to the coordinated actions taken to control the project, regarding the underlying risk and includes risk assessment procedures with identification, impact analysis methods (qualitative & quantitative), risk responses with relevant actions, and risk monitoring in a project [14]. The goal of Risk Management is to increase the likelihood and/or impact of positive risks and reduce the likelihood and/or impact of negative risks in order to optimize the chances of project success.

The risk management process is iterative, begin with the start of the project, and ends with its completion. It consists of the following basic steps:

- The first step, particularly important, is the identification of risks. The team should place particular emphasis on the way in which they are recorded, so that there is the appropriate treatment.
- The second step is to analyze them. The first approach is qualitative analysis. This step determines the impact of the risk in the project, i.e., the size of the exposure. It can be defined as a function of probability and consequence (impact). The risk table is then created and prioritized on the basis of their exposure. The second analytical approach is quantitative, i.e., the finding of probabilities related to the manifestation of risks and is done through various methods and mathematical models.
- The third step is to treatment the risks. By reference to the list of classified risks of the first step, the team determines how to deal with it - i.e., the preventive or corrective actions that will be taken to avoid the risk or when it occurs, respectively.
- The final stage concerns risk monitoring. The team shall monitor the evolution of the risk during the execution, the effectiveness of the actions that have been taken and act according to the outcome.
- At the completion of the project, the team record the risk situation and the impact they have had on the progress of the project. Evaluates the results of actions and files the process so that the organization can reuse it, get future information, or modify it accordingly in a new project.

All the methods used in the above steps are important tools that help in the decision-making process. The final risk management plan can be customized to each project individually using features and methods from more than one template [15].
3. Research Methodology and Result Analysis

The main objective of the research is firstly to reflect whether RM procedures are being implemented by SMEs in the construction industry and secondly to highlight the level of knowledge of these processes and the evaluation of the process by company executives. The investigation was divided into two categories.

The first category consists of measurements for the use of RM procedures by SMEs in relation to the company’s professional sector and includes:

- What risks are systematically monitored when undertaking a project.
- What techniques follow to Identify Risks in Projects.
- What techniques follow for Risk Analysis in Projects.
- If there are documents defining RM procedures in the projects.
- If it implements a Risk Management Plan.
- Who defines the risks in a project.

The measurements of the second category attempt to reflect the cognitive background of the RM processes as well as the general view of the effectiveness of the use by staff in relation to their professional status in the company and describe:

- If there is prior knowledge of the procedures for the creation of a Risk Management Plan
- If they consider it useful for the project a Risk Management Plan

A questionnaire was created by the Google Forms platform, which was distributed via e-mail and telephone information. The period took place in 2021 and lasted two months. The recipients were participants in the Branch of Management and Construction of Technical Works, School of Positive Sciences and Technology of Hellenic Open University as well as employees in technical companies in the professional field active in the field of electromechanical and telecommunications infrastructures. The Chi-square test has been used to analyze the data and investigate relationships between the variables.

The form was sent to 131 e-mail addresses and 58 responded. The response rate was 44%. The analysis rejected 9 replies (15.5%) because they did not belong to SMEs. The responders consist of the Owner of the company (40.8%), Project Engineers (34.7%), Executives/Employees (12.2%) and Technical Staff (12.2%). The professional experience of the responders was measured as 37% with more than 20 years, 40% from 10-20 years and 22% from 0-10 years.

Regarding the sector and size of SMEs, it was found that the final sample came from 37 SMEs grouped into three categories: The Building and Electromechanical Infrastructure Construction sector (Const. BLD/EM, 43.2%), the Telecommunications Construction sector (Const. Telecom, 27.1%) and the Technical Services (TS, 29.7%). Most companies employ up to 10 employees (75.7%), from 10 to 50 employees 10.8%, and from 51 up to 250 employs 13.5%. The total annual turnover of these companies, which is up to EUR 2 million is 75.7%, from EUR 2-10 million 5.4% and up to EUR 50 million 10.8%. Since the majority of responses came from micro-enterprises, the analysis of the use of RM procedures was based on the category of enterprise.

3.1. Results of the First Group of Questions

Participants were initially asked what risks are systematically monitored by their company when undertaking a project. The question was multiple choice and included the answers, I do not know (N/A), Operational risks (OR), Economic risks (FR), Strategy (SR), Compliance with standards (CR), Health & Safety (HSR). The first option for systematic monitoring is the financial risks for Const. BLD/EM and Const. Telecom (37.8%, 51.4%) and Health and Safety for TS (21.6%). The second type of risk for Const. BLD/EM is Health & Safety (35.1%), and for Const. Telecom and TS operating risks (45.9%, 16.2%). The third type for Const. BLD/EM is the operational risk (27%) and for Const. Telecom HSR (43.2%) and financial / compliance for TS (10.8%). The result of Chi-square test (p=0.13 and x^2=21.02) showed that there is no correlation between these two variables.
The result of Chi-square test ($p=0.80$ and $x^2=12.60$) showed that there is no correlation between these two variables.

The second question concerned the techniques utilized by the companies for Risk Identification in the project. The question was multiple choice and included the answers, I do not know (N/A), SWOT Analysis (SW), Scenario Analysis (SC), Assessment/Experience (ES/EX), Risk List from other projects (LR), Expert Group (EXP) and Interview/Brainstorming (INT/BR). The results of Table 2 show that as the main method of risk identification all companies use the Assessment/Experience (37.8%, 54.1%, 24.3%). Moreover, as a second option the Const. BLD/EM and Const. Telecom use the Risk List (16.2%, 29.7%) as well as the TS uses Estimate/Experience (10.8%). The result of Chi-square test ($p=0.77$ and $x^2=18.30$) showed that there is no correlation between these two variables.

The third question concerned which techniques utilized by the companies for risk analysis in projects. The question was multiple choice and included the answers, I do not know (N/A), SWOT Analysis (SW), Scenario Analysis (SC), Assessment/Experience (ES/EX), External Advisor (EXTC), Probability/Consequences Tables (PB/CB), Stochastic Models/Stochastic Analyses (SMM/STA) and finally Risk Analysis Software (RMS). The results of Table 3 show that as the main method of risk analysis, all categories use the Assessment/Experience (37.8%, 48.6%, 18.9%). Alternative, the Const. Telecom use the Probability/Consequences Tables with 16.2% against Const. BLD/EM using Stochastic Models or RMS (5.4%) and TS using an external consultant (10.8%). The result of Chi-square test ($p=0.77$ and $x^2=18.30$) showed that there is no correlation between these two variables.

The fourth question examines whether there are documents defining RM procedures in projects. The question was multiple choice and included the answers, I do not know (N/A), Risk Management Manuals (RM Handbook), Business Knowledge from other projects and the Organizational Rules. The results of Table 4 show that all categories use the Company Knowledge from other projects (27%, 51.4%, 18.9%). The survey also recorded that all companies use a Risk Management Process Manual. The result of Chi-square test ($p=0.80$ and $x^2=12.60$) showed that there is no correlation between these two variables.

The fifth question examines whether the company is implementing a management standard. The question was multiple choice and included the answers, I do not know (N/A), Project Management (PM), Risk Management Procedures (ISO31000), Environmental Management (ISO14001), Quality Management (ISO9001), None (N), Health and Safety (ISO45001), Health and Safety based legislation (HS). The results of Table 5 show that all categories of companies apply Health & Safety procedures in accordance with the legislation (32.4%, 51.4%, 18.9%). Regarding other standards,
Const. BLD/EM & Const. Telecom implement quality management procedures (24.3%, 10.8%) and environment procedures (21.6%, 10.8%), depending on their activity. The result of Chi-square test (p=0.94 and x²=6.64) showed that there is no correlation between these two variables.

**Table 4.** Cross Tabulation of “Sector” and “Are there documents which establish RM Process in your company”.

| Sectors                | N/A | RM Handbook | Company Knowledge | Organizational Rules |
|------------------------|-----|-------------|-------------------|---------------------|
| Construction BLD/EM    | 5.4%| 10.8%       | 27.0%             | 8.1%                |
| Construction Telecom   | 5.4%| 27.0%       | 35.1%             | 13.5%               |
| Technical Services     | 8.1%| 8.1%        | 16.2%             | 8.1%                |

**Table 5.** Cross Tabulation of “Sector” and “Does your company applies a management standard”.

| Sectors                | N/A | PM  | ISO 31000 | ISO 14001 | ISO 9001 | N   | ISO 45001 | HS  |
|------------------------|-----|-----|-----------|-----------|----------|-----|-----------|-----|
| Construction BLD/EM    | 0.0%| 8.1%| 2.7%      | 10.8%     | 10.8%    | 2.7%| 5.4%      | 32.4%|
| Construction Telecom   | 2.7%| 27.0%| 5.4%     | 21.6%     | 24.3%    | 0.0%| 16.2%     | 51.4%|
| Technical Services     | 2.7%| 10.8%| 0.0%     | 2.7%      | 2.7%     | 2.7%| 5.4%      | 18.9%|

The last question in this category refers to who defines the risks in a project. The question was multiple choice and included the answers, I do not know (N/A), the Owner (ADMIN), Safety Engineer/Consultant (TSO/CONS), Financial Department (FD) or Project Manager (PM). The results of Table 6 show that in the category of Const. BLD/EM & Const. Telecom the risks in a project are determined by the Project Manager (32.3%, 45.9%) and for TS TSO/CONS (40.5%). On the second level Const. BLD/EM & Const. Telecom use the TS/CONS (24.4%, 40.5%) whereas in TS the Project Manager (10.8%). We also note from the responses that management is in third place as far as risk definition is and the financial department has no substantial involvement. The result of Chi-square test (p=0.96 and x²=15.50) showed that there is no correlation between these two variables.

**Table 6.** Cross Tabulation of “Sector” and “Who define the Risk in a project”.

| Sectors                | N/A | ADMIN | TSO/CONS | FD | PM |
|------------------------|-----|-------|----------|----|----|
| Construction BLD/EM    | 0.0%| 16.2% | 24.3%    | 0.0%| 32.4%|
| Construction Telecom   | 2.7%| 18.9% | 40.5%    | 5.4%| 45.9%|
| Technical Services     | 0.0%| 8.1%  | 16.2%    | 0.0%| 10.8%|

3.2. Results of the Second Group of Questions

The participants answered a new group of questions concerning the level of knowledge of RM procedures as well as the assessment of their effectiveness. The variable is the professional status of the employees in the companies.

The first question concerned whether there is prior knowledge of the procedures for the creation of a RM Plan. The responders make a choice of knowledge level of the process from 1 (No Knowledge) to 5 (Excellent Knowledge). The results of Table 7 show that the management and technical staff have good knowledge of RM procedures (14.3%, 6.1%) while most Project Engineers have moderate knowledge (10.2%). The result of Chi-square test (p=0.75 and x²=21.60) showed that there is no correlation between these two variables.

The second question referred to whether they consider is it useful a RM Plan. The responders make a choice of useful level of the process from 1 (None) to 5 (Absolutely Useful). The results of Table 8 show that all companies believe that a RM Plan is Absolutely Useful (8.2%, 18.4%, 18.4%, 8.2%) to...
be very useful (2%, 18.4%, 14.3%, 4.1%). The result of Chi-square test (p=0.90 and x²=21.2) showed that there is no correlation between these two variables.

**Table 7. Cross Tabulation of “Professional” and “RM Knowledge Level”.

| Sectors             | 1   | 2   | 3   | 4   | 5   |
|---------------------|-----|-----|-----|-----|-----|
| Executive/Employee  | 2.0%| 4.1%| 0.0%| 4.1%| 2.0%|
| Owner               | 6.1%| 6.1%| 14.3%| 12.2%| 2.0%|
| Project Manager     | 6.1%| 10.2%| 6.1%| 6.1%| 6.1%|
| Technician          | 0.0%| 4.1%| 6.1%| 2.0%| 0.0%|

**Table 8. Cross Tabulation of “Professional” and “Is it useful a Risk Management Plan”.

| Sectors             | 1   | 2   | 3   | 4   | 5   |
|---------------------|-----|-----|-----|-----|-----|
| Executive/Employee  | 0.0%| 0.0%| 2.0%| 2.0%| 8.2%|
| Owner               | 2.0%| 0.0%| 2.0%| 18.4%| 18.4%|
| Project Manager     | 0.0%| 2.0%| 0.0%| 14.3%| 18.4%|
| Technician          | 0.0%| 0.0%| 0.0%| 4.1%| 8.2%|

4. Discussion

The use of risk and environmental management procedures in the field of technical infrastructure is a tool that helps SMEs achieve the objectives of the project. The successful completion of this category of projects also contributes to the environment since recyclable building materials are used for the construction, ecological elements for their operation, in order to achieve maximum energy savings. Relevant research in other countries has highlighted the need for SMEs to use risk management procedures and how much it helps to successfully completion of the project [16]. The literature has revealed that for SMEs there are three main types of risk assessment than concerned by SMEs, financial, operational, and labor. In addition, there is a lack of knowledge for kind of procedures [17]. Another important element is that there is a lack of knowledge of these procedures as well as of the implementation framework [18].

Although the sample was small, the research showed common elements with other relevant studies. With regard to the type of risk SMEs monitoring the most are, financial risks and those risks relating to the Health & Safety which are important elements for its smooth operation, while operational risks follow. As far as procedures are concerned, the Risk Identification is mainly based on experience and knowledge from previous projects and less on other relevant methods. The risk analysis (both qualitative and quantitative) is carried out at a basic level and the use of models through computer programs or other procedures is limited. The fact that the legislation requires the use of Health and Safety procedures from SMEs helps in the existence of the relevant Occupational Management Plans for the prevention of accidents. So, the owners are obliged to inform the staff of the relevant procedures and measures, and this was reflected in the results of the study. However, this is not mandatory procedure for the design or implementation of a project. We also note that SMEs understand the external environment and the market trend for professional certification regarding management and operating standards and we saw for the measurements that almost all of them are starting to adapt these accordingly.

5. Conclusions

The survey revealed that SMEs operating in the infrastructure construction sector in Greece, adopt at a basic level risk management procedure in the projects they undertake. The main reason is the lack of knowledge from owners and executives and engineers about the implementation of RM plans and the benefits it can have in the progress of the project and finally in the company. Moreover, the absence of incentives to help SMEs integrate such activities into projects. Further research is proposed using data
from chambers of commerce and industry of the country in order to investigate indicators regarding the Risk management usage and RM procedures proposals to implement to the projects.

SMEs in the construction sector play a crucial role in the Greek economy development. Participants positively recognize the implementation of Risk and Environmental Management procedures during project execution and evaluate them as a necessary tool for the successful completion of projects and the financial viability of companies. This research highlighted the need for a risk management plan in the projects, which can be adopted by companies as part of their operating procedures.

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