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Risk Management Process Applied on Motorway Service Areas

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Abstract
Risk Management, has become a formal and discrete process in the overall management of construction projects. The requirements by project stakeholders for better quality and lower cost in less time require the identification, analysis and subsequent mitigation of potential risks that may jeopardise a construction project. Transportation sector can benefit from the application of Risk Management and both social and financial benefits for motorway users and investors could be derived. The objective of this research is the development of a framework for risk management in the development of Motorway Service Areas, based on evaluation of best practices, and its assessment through a pilot application to an existing Motorway Service Area operating in Greece to prove its validity. Risks related to the development of Motorway Service Areas are identified, analysed with CASPAR software package and appropriate measures of risk mitigation are proposed. First results showed that systematic approach to Risk Management could support potential developers of Motorway Service Areas to make viable decisions about relevant investments.

Keywords
Project Management, Risk, Risk Management process, Motorway Service Areas

1. Introduction

It is common belief that investment in projects involves risks, as very often large amounts are committed in an irreversible decision, with no certain knowledge of the size of the future benefits. The success of any project depends crucially on the effective identification, quantification and management of risk at the earliest stage of the appraisal process to ensure viability and appropriate mitigation. In the past, promoters or project managers used to anticipate risks simply by adding 10 or 15% of the overall cost of the project as a contingency (Thompson and Perry, 1992). Consequently, many projects failed to meet their objectives due to unforeseen events and furthermore, this management practice have led potential investors to abandon good and low-risk projects because net profits seemed inadequate after adding unreasonable contingencies. Nowadays, the business environment has become more competitive and project stakeholders require better quality and lower cost in less time.Therefore, Risk Management, even though a relatively new concept, should be a formal and discrete process in overall management thinking, applied within all sectors and industries worldwide. Transportation sector, and especially Motorway Service Areas (MSAs), can significantly benefit from the application of Risk Management and both social and financial benefits for motorway users and investors could be derived. The continuous improvement of road infrastructures, the increase of motorway users volume as well as the funding of infrastructure development with Public-Private partnerships has changed the thinking behind the development of such facilities (NCHRP Synthesis 317, 2003, AASHTO, 2001). In several cases they are developed by private investors on a concession basis, granted by the Motorway Authority that owns the land and operates the motorway, thus they can be considered as commercial investments and Risk Management can become a useful tool to ensure their financial success.

2. Risk Management process

According to Flanagan (1993) “Risk management is a system which aims to identify and quantify all risks to which the business or project is exposed, so that a conscious decision can be taken on how to manage these risks”. The application of the process of Risk Management takes place in three main stages (Healy, 1981, Al Bahar et al, 1990)

- Risk Identification
- Risk Analysis
- Risk Response

However, it is common acknowledgement that there is also a Risk Management Planning stage preceding Risk Identification and moreover an ongoing Risk Monitoring and Control process. This study will attempt to provide a framework of the Risk Management process to be applied during construction and operation of Motorway Service Areas, based on the principles described in the Project Management Body Of Knowledge Guide (PMBOK, 2000) and the Risk Analysis and Management for Projects method (RAMP, 1998).

2.1 Risk Management Planning

Risk Management planning is the process of deciding how to approach and plan the risk management activities for a project and concerns the methodology, tools and data sources that may be used, the definition of roles and responsibilities of all involved parts in the project, as well as timing, meaning how often the Risk Management process will be performed through the project life cycle. Risk Management Planning is mainly performed by planning meetings and should be developed early enough to affect decisions, and consequently the decisions should be revised periodically during project execution.

2.2 Risk Identification

Risk identification and assessment has the largest impact on the accuracy of any risk assessment and must be undertaken during the early stages of the project, where the decisions have the greatest impact on its performance (Thompson, 1992). Its fundamental aim is not only to identify, as exhaustively as practicable, all significant types and sources of risk, but also the opportunities (upside risks) and uncertainty associated with each of the project objectives and the key parameters relating to these objectives. Additionally in this phase an assessment is made on the interrelation between risks and the way that they should be classified and grouped for evaluation (RAMP 1998). Firstly, a structured review of project plans and assumptions, prior project files and other information is performed. Historical data from similar projects or relevant published information (academic studies, benchmarking etc) can initially provide helpful knowledge and then, a series of information gathering techniques like brainstorming, interviews with experts, and S.W.O.T. analysis can be applied to the process.

2.3 Risk Analysis

The purpose of Risk analysis is to apply objective probabilities to risks identified during the risk identification stage and then understand and quantify the potential impact of such risks in terms of time, cost and quality by using analytical techniques. It consists of two parts, the qualitative risk analysis and the quantitative risk analysis. Qualitative analysis, usually carried out at the appraisal stage of a project or in cases where numerical data is not available, intends to prioritize risks according to their potential effect on project objectives, determine the importance of addressing specific risks and guide risk response measures. An evaluation of the quality of the available information on risks takes place, and the probability and impact of these risks are estimated by analysing and describing two basic dimensions of risk in qualitative terms such as very high, high, moderate, low, and very low. These are the likelihood that a risk will occur (Risk probability), and its effect on the project objectives (Risk impact). A probability/impact risk rating matrix that assigns risk ratings to risks or conditions based on combining probability and impact scales is developed. Table 1 provides an example of this matrix. Risks with high probability and high impact may require further analysis, including quantification, and aggressive Risk Management.

Table 1: Probability – Impact Matrix for a specific risk

Probability	*Risk Score = P x I*				
0.9	0.05	0.09	0.18	0.36	0.72
0.1	0.01	0.01	0.02	0.04	0.08
	Impact on an Objective (e.g. cost, time, or scope) (Ratio Scale)				

Quantitative analysis process aims at analysing numerically the probability of each risk and of its impact on project objectives, as well as the extent of overall project risk. The frequently used tools and techniques for quantitative analysis are: Decision tree analysis, Sensitivity analysis, Probability analysis, Simulation. A combination of sensitivity and probability analyses is very popular in the construction sector. Sensitivity analysis examines the effect that a change of a single risk variable should have on the project cost and time, whereas in probability analysis the relationship between different risk variables is examined, as they are treated altogether.

2.4 Risk Response

Risk response planning is based on the outcomes of Risk Analysis and concerns the development options and determination of appropriate actions to enhance opportunities and reduce the impact of risks on the project's objectives (PMBOK Guide, 2000). This must be appropriate to the severity of the risk and cost-effective, as well as timely and realistic within the project context in order to be successful. There are four main strategies available to respond to risks: Risk avoidance, Risk Transfer, Risk mitigation and Risk retention. Risk avoidance is changing the project plan to eliminate the risk and occasionally abandoning the initial approach, whereas risk transfer is seeking to transfer risk to a third party together with ownership of the response. Transferring liability for risk is most effective when dealing with financial risks and it nearly always involves payment of a risk premium to the party taking on the risk through the use of insurance, performance bonds, guarantees or appropriate contracts (fixed price or cost reimbursable contracts) (Thompson and Perry, 1992). Risk mitigation is about reducing the probability or impact of a risk to below an acceptable level by taking early action, e.g. adopting less complex processes. It may also involve changing conditions, e.g. adding resources or time to the project schedule, or staging the development of the project. Finally, risk retention is adopted when the risk's impact is not severe, or when other strategies are not suitable. As the risks continuously change as the project matures there is a need for risk monitoring and control processes to ensure effective execution of the risk response plans. Thus, periodic project risk reviews scheduled during the life cycle can be helpful in monitoring the risks.

3. Motorway Service Areas and related risks

3.1 Definition and institutional set-up

According to the Hellenic Highway Fund and the Australian Road Authority the Motorway Service Areas (MSAs) are defined as "Developments along motorways or other trunk roads which have only vehicular access to the motorway and which are designated to provide a range of goods and services related to the needs of the traveling public only and may include a multi-functional convenience center comprising a service station" (City of Ryde, 1999, Hellenic Highway Fund, 1999). They mainly consist of physical infrastructure, (petrol station, car park area) and the rest area roads to connect the facilities provided, as well as road access to the motorway. A MSA could offer a number of services (restaurant, coffee shop, super market, or even a motel) usually in a main building. Their methods of ownership and control are the same in most countries. The responsible Road Authority, a public organization, is the planning and controlling authority for the MSAs. They set minimum requirements (technical and financial) and decide on potential developers to construct and operate the facilities, through tendering procedures (Scottish Office-NPPG9, 1996). The MSA is leased/rent to the developers for a period of usually 25-30 years and at the end of this period the facility passes to the state, which could renew the lease with the same operator or seek a new one.

3.2 Risks related to Motorway Service Areas

During the construction phase of a MSA some major risks are related to its location. The geotechnical features of the land where it will be constructed should be considered (California Department of Transportation, 2000). Also, its distance from large urban areas, as well as from other MSAs has to be carefully examined, in order to forecast accurately the number of vehicles that will stop at the MSA. A recent research in Greece has revealed that the optimum place to develop a service area is approximately in the middle of the distance between two large urban areas (Evgenikos P. Strogyloudis A, 2001). Moreover, motorway service areas must be available roughly every thirty miles throughout the motorway network (Highways Agency, 1998). Legislative restrictions, land acquisition, as well as environmental restrictions, may constrain the development of such areas. (Scottish Office-NPPG9, 1996). Another factor to be considered is whether the service area is built on an existing motorway or on a motorway that is developed at the same time, because potential delays in the construction of the motorway will surely affect the financial operation of the service area and possibly its construction. Moreover, the performance of the contractors can lead to delays and therefore to financial losses by additional costs or loss of expected revenues. Finally, land-planning and technical issues concerning the construction (access to utility networks, parking area and services provided designed to meet the demand for the next 15-20 years) should be carefully considered.

During the operation phase of a MSA, which are considered as commercial projects, entirely market-driven, the most important risks that may occur are: inadequate forecasting of revenues due to inaccurate traffic forecasting, not updated O-D (origin-destination) surveys on the motorways that reveal the composition of traffic and the requirements of the motorway users, fraud, high operating costs due to high maintenance costs, potential natural disaster (e.g. hurricane or earthquake), as well as managerial incompetence on behalf of the MSA operator.

4. Risk Management on Motorway Service Areas

In order to examine how and to what extent the Risk Management process can be applied to the construction and operation of Motorway Service Areas, the proposed framework, which was developed in the previous section, was applied to “Sirios”, a service area operating in Greece, situated on the Athens-Lamia national motorway. A complete economic evaluation and risk analysis was conducted, the main risks that occurred during the construction period and others related to the operation were identified and assessed and the main points of this application are presented in the study. The initial stage of the risk management planning was not considered during the appraisal of the project and therefore it is omitted.

4.1 Risk Identification

In “Sirios” the most important risks were identified through interview with the general manager. During the construction phase of the project significant delays related to the innovative technology used for the construction of an aerial bridge connecting the main buildings on both sides of the motorway construction and the import of materials from the USA occurred. Designs were changed during the implementation of the project, while a higher than expected water-table in the area caused a series of problems. All these factors resulted in additional works that increased significantly the initially estimated construction cost but also led to important delays to the original completion program. Delays had enormous impact on the total cost of the project, as the company had pay to the government according to the contract, a penalty clause for loss of operation revenues. Furthermore, loss of revenues due to delayed start of operation affected the original financial estimates and eventually the profit margin of the project. Finally, high maintenance costs and lack of managerial competence and coordination between different parties at the first months of operation, affected the quality of the services provided and therefore the revenues of the project.

4.2 Risk Analysis

In the case of “Sirios” the quantitative risk analysis approach was used, aided by CASPAR, (Computer Aided Simulation for Project Appraisal and Review), a software package for engineering project appraisal and management, developed at UMIST. CASPAR simulates the interaction between time, resources, cost and revenue over the entire project life and the results of the analysis are in form of financial parameters, such as the IRR, NPV, Payback Period. The software can also simulate the effects of risks and produce sensitivity analysis of individual risks or combine the effects of project risk in a probabilistic analysis utilising the Monte Carlo simulation technique. Firstly, a base case model was developed estimating several economic parameters like the Net Present Value (NPV), the Internal Rate of Return (IRR) and the payback period, without considering any risk variables, in order to evaluate the profitability of the project. The calculated NPV was 69.187.968 €, the payback period was 11 years and the IRR was 14,17%. The investigation of the impact of the identified risks on the forecasted economic parameters of the project was the next step of the analysis. The risk variables were grouped into six categories to facilitate the process and a range of variation for each of these variables was estimated according to interviews with the managers of the service area and previous experience. The results are presented in the following Table 2.

Table 2: Risk variables

Risk Variables	Lower Limit (%)	Upper Limit (%)
Construction period	**-10**	**+30**
Market	**-20**	**+20**
Construction costs	**-5**	**+40**
Operation costs	**-10**	**+20**
Performance of parties	**-30**	**+10**
Weather	**-10**	**+10**

Sensitivity analysis was then performed by varying the value of each risk individually in the base case model and respective sensitivity diagrams were developed for each economic parameter. Indicatively the sensitivity diagram of IRR is presented in Figure 1 and the outcome is that the risks from the most to the least significant for the project’s viability are: Market risks, operation cost, construction cost, construction period, performance of parties and weather conditions. A very interesting point resulting from the sensitivity analysis is that the order of magnitude of the risk variables to the project’s objectives is differs according to the economic parameter that is examined. Sensitivity analysis was followed by Probability analysis in order to examine the effect of the risk variables in combination, and respective diagrams were developed. Indicatively, in Figure 2 the Cumulative Frequency Distribution of IRR is presented and it is evident that there is high probability that IRR will lay between 9,5% - 12,5%, consequently the initial estimation (14,17%) seems highly optimistic.

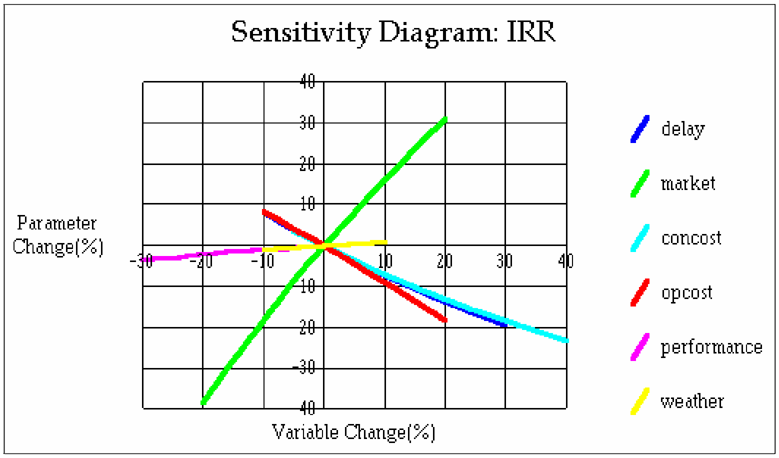

Figure 1: Sensitivity Diagram of IRR

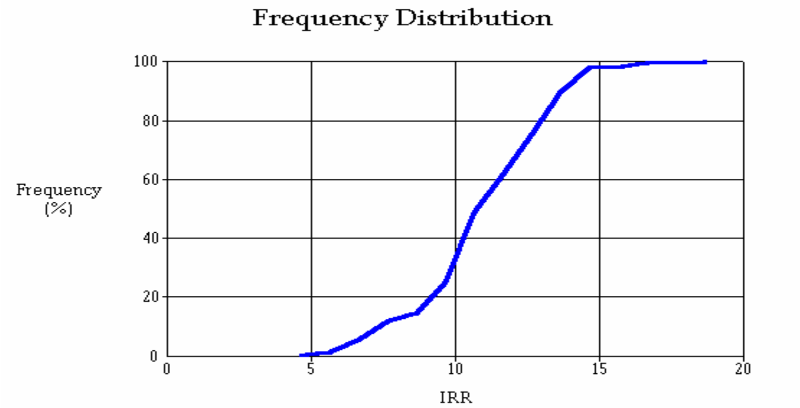

Figure 2: Cumulative Frequency Distribution of IRR

4.3 Risk Response

In the case of "Sirios" risk analysis revealed that market risks have to be treated first, as they can have significant impact on the financial viability of the project. This risk can be mitigated at the appraisal stage by conducting updated traffic volume surveys for the motorway, as well as market surveys among motorway users to identify their needs and requirements concerning the services provided. Furthermore, the development of different scenarios concerning the demand can lead to realistic estimations about future revenues profitability. Risks concerning the operation and construction costs can be mitigated by developing realistic estimations concerning maintenance costs during the appraisal stage and by examining all possible factors that might affect the general management of the service area. The provision of contingencies or the insurance of vehicles, assets, and people against accidents and dangers during the operation phase are some measures that might be considered.

5. Conclusions

The objective of this study was to outline the basic principles of Risk Management, develop an appropriate framework based on best practices and examine its application in the development of Motorway Service Areas (MSAs). The results deriving from the application on "Sirios" an existing MSA operating in Greece showed that Risk Management as part of the overall project management strategy of a MSA, can become a very helpful tool for the identification, analysis and mitigation of potential risks. Unforeseen events that may affect the success of the Service Area can be considered and controlled at a very early stage and appropriate decisions can be made to ensure project's viability. Furthermore, identification of opportunities to enhance project performance is possible. The resulting improvement of MSAs will benefit both the motorway users and the developers, as they will become profitable investments and they will also provide necessary, high quality services to the motorway users.

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