Risk Management in motorway PPP projects: Empirical-based guidelines

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Abstract

This paper deals with the topic of risk management in PPP. The analysis of the related literature reveals that risks must be analyzed and managed on a context-specific approach and that there is a lack of a comprehensive study on the more suitable risk mitigation strategies for each risk embedded in PPP projects. Focusing on the transport sector, based on the results of a Delphi survey, the paper provides a guideline for both public and private parties in defining a list of significant risks in PPP motorway projects, preparing a practical risk allocation framework and identifying the most suitable mitigation strategies. Results of the Delphi survey have been compared with the common practices on risk management applied in eight real motorway PPP projects.

Keywords: Risk management, Guidelines, PPP, Motorway sector, Delphi survey, Case studies.

1. Introduction

In recent years, the increasing need for the development of infrastructure and budgetary constraints in several developing and developed countries have led governments to seek new ways of financing facilities of public utility. One of the options is to involve private sector finance and expertise in the provision of public infrastructure and services through Public Private Partnership (PPP). PPP can provide a variety of benefits to the government, by providing more-efficient, lower-cost, and reliable public facilities; by improving the quality and efficiency of infrastructure services, and by promoting local economic growth and employment opportunities. However, at its heart, it remains the risk-management problem due to the high degree risks affecting PPP projects that usually are characterized by many stakeholders, huge amounts of investments, long concession periods, and so on. These risks are not borne by one party, but should be allocated to the party (public or private) who is best able to manage them.

In last years, an interesting volume of literature on risk management in PPP projects, both academic (Bing et al., 2005; Li, 2003; Grimsey and Lewis, 2004; Ng and Loosemore, 2007 and technical (see, for instance, technical reports provided on the US Federal Highway Administration web site), has been developed. Yet, the analysis of the literature reveals that risks must be analyzed and managed on a context-specific approach and that there is a lack of a comprehensive study on the more suitable risk mitigation strategies for each risk embedded in PPP projects. Focusing on a specific PPP sector, namely the transport sector, the present

paper aims at filling this gap by providing a guideline for both public and private parties in defining a list of significant risks in PPP motorway projects, preparing a practical risk allocation framework and identifying the most suitable mitigation strategies.

With this aim, a Delphi survey is conducted with two panels of experts representative of both private and public parties, and various countries. Furthermore, results of the Delphi survey have been compared with the common international practices on risk management drawn from a multiple-case study conducted on eight real cases of motorway PPP projects.

The paper is organized as follows. Next section briefly resumes the literature on risk management in PPPs, reviewing the contributions on risk identification, allocation and mitigation. Section 3 presents the research design. Section 4 discusses the Delphi results, while Section 5 compares them with the risk management practices adopted in the analyzed case studies. Conclusions end the paper.

2. Risk identification, allocation and mitigation in PPP: a literature review

PPP projects usually involve higher degree of risks than conventional procurement, since they are characterized by many stakeholders, a huge amount of investments, and long concession periods (Wei-hua and Da-shuang, 2006). Therefore, PPP projects involve not only risks that are project-related but also risks that depend on the inner characteristics of PPP as a procurement method. The importance of this theme justifies the development of several studies on risk management in PPP projects that can be clustered according to the conventional risk management process: identification of risks, risk analysis and risk strategies (Tang et al., 2010). The developed studies on risk identification and categorization in PPPs can be divided into two groups: the first group comprises studies which focus on the nature of

risks, whereas the second one contains studies which focus on the phase of project in which the risk typically appears.

Based on the type of risks, Li (2003) classifies PPP risks as belonging to three levels: macro level risks (i.e., risks sourced exogenously, or external to the project itself); meso level risks (i.e., risks sourced endogenously, or risk events and their consequences occurring within the system boundaries of the project); micro level risks (i.e., endogenous risks which differ from meso risks in that they are party related rather than project-related). Grimsey and Lewis (2004) identify six areas of risk associated with PPP projects, namely: public risk, asset risk, operating risk, sponsor risk, financial risk and default risk. Another approach for risk categorization is based on the project lifetime, namely classifying risks over time. Such an approach is particularly important, since it is widely recognized that the size of the impact of the risk, if it occurs, decreases over time, conversely the probability that the risk occurs raises over time due to the increase of uncertainty in the long run. According to this approach, Tiong (1990) classifies PPP risks based on the construction and operation phases, while the classification of Beidleman et al. (1990) includes an additional phase, the developmental phase. Thomas et al. (2003) consider another phase, the project life cycle phase, in which risks occurring in more than one of the phases are included. Aoust et al. (2000) classify risks by considering three phases of the project: risks arising during the design-construction phase, operational risks, and permanent or indirect risk. In the design-construction phase, technical risks and economic-financial risks can affect the outcome of the project. Risks during the project's operation phase relate to the period when the project generates revenue, but also continues to incur costs. Such risks can be classified as revenue risks, operating cost risks, and financial risks. Finally, the indirect risks relate to the project's environment. These risks are

residual, not pertaining specifically to either party in the contract, and can be classified in three categories: risk of force majeure, macroeconomic risks, and legal risks. Apart from the risks to which any infrastructure investment project is subject to, Aoust et al. (2000) identify several categories of risks that are more likely to arise under a PPP project, i.e., PPP-specific risks. They stem from the particular relationship between private and public entities whose economic interests are distinctively bundled in the project and can be grouped into three categories: fiscal risks, residual value risks, and bidding risks. A different risks' distinction categorizes risks as exogenous and endogenous. The former can be actively managed by changing behaviors, the latter are those where no party can take such active steps in order to reduce either threats or vulnerability (de Vries and Yehoue, 2013).

To best allocate risks two questions need to be answered (OECD, 2008): 1) which party is best able to prevent the risky event; 2) in the case where no party can prevent the risky event (i.e. an exogenous risk), which party is best able to manage the consequence of the adverse occurrence. To answer these questions, researchers have investigated the risk strategies adopted by the public and the private sectors. For example, Bing et al. (2005) conduct a survey to explore preferences in risk allocation in PPP/PFI construction projects in the UK. Ke et al. (2010) have conducted a two-round Delphi survey with experienced practitioners, to analyze the risks and their preferred allocations for PPP projects in China. By furthering this study, Ke et al. (2011) have conducted a series of face-to-face interviews to collect actual risk allocations in some completed Chinese PPP projects. By comparing the preferred and actual allocations and discovering the reasons behind the differences, they develop an equitable risk allocation schema applicable in China, and then evaluate the impact of risk misallocation (if any) on project performance (Ke et al., 2013). Another study involving an empirical

questionnaire survey concerning PPP risk management in China, was carried out by Chan et al. (2011). Focusing on a total of 34 risk factors for PPP projects, they identify the major risks for the delivery of PPP projects in China and investigate the perceptions of industrial practitioners and academics on risk allocation. Ng and Loosemore (2007) discuss risk allocation in the private provision of public infrastructure. Medda (2007) develops an analytical model based on game theory to examine the process of risk allocation between the public sector and the private sector in transport PPP agreements. Carbonara et al. (2014a) develop a model for setting the concession period at a value able to satisfy both the private and public sector while fairly allocating risks between them. Nisar (2007) discusses two strategies of transferring risks, i.e., implicit and explicit transfer of risk in PPP/PFI contractual arrangements. Roumboutsos and Anagnostopoulos (2008) present the survey results regarding preferred risk allocation of prime stakeholders, i.e., the public client, the construction companies and the financing institutes, and their respective risk ranking in the Greek PPP market. They found that the risks to be allocated to the public sector are: all political and legal risks, as well as risks concerning archaeological findings. Construction, operation, relationship and third party risks are better handled by the private sector. Project finance risks and design risks, with the exception of availability of finance and permits, should also be assigned to the private sector. Finally, the public and private sectors preferably share macroeconomic, natural and social risks. Grimsey and Lewis (2002) state that successful risk allocation should take into account the differing (and conflicting) needs of the main participants involved in PPPs, i.e., the procuring entity, the project sponsors and the senior lenders. Later, Grimsey and Lewis (2004), drawing on practical experience, present a risk matrix for the allocation of risks in PPP projects and applied it to a case study. In this matrix, no category is assigned in total to

a specific party. Also, a number of standard risk allocation matrices have been produced to guide appropriate risk allocation in PPP projects (Milner, 2004; Smith, 1996).

All these studies recognized that there is not a list of risks and a risk allocation strategy that are applicable to all PPP projects and universally agreed to as the best. They found that the risks a PPP project may be exposed to are affected by a number of factors, such as the type and scale of the project, the country where the project is located, and the sector. Therefore, the importance of a particular risk and the preferred risk allocation can differ from sector to sector and/or from country to country.

A less number of studies has dealt with risk mitigation strategies. Generally speaking, since risk is often defined as a measure of the probability and severity of adverse events (Lowrance, 1976), mitigation strategies are aimed at reducing either the probability of occurrence of risk events, by acting on risk sources, or consequences of the risk event, when it occurs. Strategies traditionally adopted for risk mitigation in PPP are in the form of guarantees, insurance, possibility of changing contractual terms/clauses, etc. Such strategies can involve different parties, e.g., the private party and the government, as in the case of revenue guarantee; the project company and the contractor who executes the works, as in the case of the majority of construction risks; or the project company and the client, as in the case of “take and pay” or “take or pay” agreements. Most of the studies on risk mitigation strategies have focused on specific strategy to mitigate specific risk. In particular, there are a number of risk mitigation strategies for technical risks. These mitigation strategies are, in general, defined as clauses in the agreement or some forms of guarantees provided by one of the participants. For example, to mitigate construction risks and referring to standard construction contract, Pfeffer (2010) proposes a Guaranteed Maximum Price agreement, where the private party and contractor

agree to cap the price; whereas referring specifically to project financing contract, Nevitt and Fabozzi (2005) propose completion guarantee extension to debt maturity, where the debt will be guaranteed until maturity in the event that completion is not achieved by a certain date.

Several strategies have been proposed to mitigate commercial risks, either in the form of guarantees, options (i.e., to expand or contract project capacity), or mechanisms. These mechanisms essentially present an agreement between the public and the private parties which defines rights and obligations if a certain event occurs. For example, with a revenue sharing mechanism, the public sector would have a right to claim the percentage of the revenue if the project internal rate of return exceeds a given value and the private party has an obligation to fulfil this claim (Gomez-Lobo and Hinojosa, 2000); with minimum revenue guarantees, the concessionaire has the right to recourse to Government to receive compensatory payments whenever the revenue is below a pre-established level (Carbonara et al., 2014b). Finally, specific mitigation strategies are proposed for economic and financial risks. For example, interest rate guarantee is released by government in order to ensure the PPP project's financial closure (Wibowo, 2004).

Studies focusing on risk identification and allocation in PPP projects agree that a comprehensive view of risks associated with PPPs cannot be developed given that the relevance of a risk and the preferred risk allocation is context-specific (sector and/or country). Furthermore, the contemporary literature does not provide evidence on the more suitable risk mitigation strategies for each risk embedded in PPP projects. This paper aims to fill this research gap. In particular, recognizing that the relevance of risks and the choice of the appropriate risk mitigation strategies depend on the specific PPP sector, we focus on the motorway sector and provide guidelines for both public and private parties in defining a list of

significant risks in PPP motorway projects, preparing a practical risk allocation framework and identifying the most suitable mitigation strategies.

3. Research design

The present study adopts a mixed-methods research that combines quantitative and qualitative research methods. Combining quantitative and qualitative research has several advantages, since it enables researchers to be more flexible and holistic in their investigative techniques (Onwuegbuzie and Leech, 2005) Also, mixed-methods research addresses much more comprehensive research purpose than quantitative or qualitative research alone (Newman et al., 2003). Indeed, by combining quantitative and qualitative approaches within the same inquiry, investigators are able to probe further into a matter and to use one method to enhance the interpretation of findings stemming from the other method.

In our study, the mixed-methods strategy of inquiry is a sequential procedure, where the study begins with a quantitative methods, the Delphi survey, and follows up with a qualitative method involving exploration with a few cases, multiple-case analysis.

Being aware that a number of contextual factors are likely to influence potential risks, their allocation and mitigation, we chose the case study approach, since it takes into account these contextual factors much more than the quantitative research alone (Yin, 1993).

3.1 Delphi Methodology

The research uses a Delphi technique for primary data collection. The Delphi technique is a method of eliciting and refining group judgments. It is a widely used and accepted method for

achieving convergence of opinions concerning real-world knowledge by using a series of questionnaires to collect data from a panel of selected subjects. Contrarily to other research techniques used to collect expert judgments and opinions, such as focus group, nominal group, survey, and semi-structured interview, with the Delphi method there is no need for participants to meet up and, hence, it is a relatively inexpensive method of gaining responses. It also allows the involvement of participants from disparate geographical areas, which are generally contacted by e-mail, thus facilitating international research. Furthermore, the Delphi method overcomes some problems of group interaction and does not allow individuals to dominate the discussion (van Teijlingen et al., 2006).

The Delphi method employs multiple iterations to reach a consensus of opinion concerning a specific topic (Hsu and Sandford, 2007). Three main critical aspects have to be dealt with when adopting the Delphi technique.

The first concerns the sampling, namely the choice of the number of participants and the profile of the panel of experts. Witkin and Altschuld (1995) note that the approximate size of a Delphi panel is generally under 50. Ludwig (1997) documents that the majority of Delphi studies have used between 15 and 20 respondents. In sum, the size of Delphi subjects is variable (Delbecq et al., 1975), obviously the larger the sample size, the greater the generation of data, which in turn influences the amount of data analysis to be undertaken. This will lead to issues of data handling and potential analysis difficulties, particularly if employing a qualitative first round approach.

The second critical aspect refers to the consensus level. Unanimity is not required in the Delphi technique; instead, a consensus level has to be pre-determined. Dajani et al. (1979) suggest that consensus is achieved when there is the majority of agreement on an item, that is at least 51% of the respondents are in agreement, Sumsion (1998) recommends 70%, while

Green et al. (1999) opt for an 80%. Alternatively, Scheibe et al. (1975) question the value of using percentage measures, suggesting that the stability of the response through a series of rounds is a more reliable indicator of consensus. However, measuring the percentage of votes that fall within a prescribed range is a common approach to assess consensus (Bobeva and Day, 2005).

The third issue concerns the number of rounds that depends on the amount of time available, whether the researcher has indicated the Delphi sequence with one broad question or with a list of questions, and consideration of levels of sample fatigue. The literature demonstrates that three iterations are often sufficient to collect the needed information and to reach a consensus in most cases (Brooks, 1979; Custer et al., 1999; Cyphert and Gant, 1971; Green et al., 1999; Ludwig, 1997; Rowe and Wright, 1999). A criterion generally used to set when to stop the procedure is based on the consensus level. The researcher must be aware of what the definition of 'consensus' is in relation to the study's findings (Williams and Webb, 1994). If, for example, only those opinions that received over 50% agreement in round two were fed back to respondents in round three, this may bias the range of opinions from successive rounds. Outside factors such as limited resources may also influence the level of consensus selected by the researcher.

The three discussed issues can affect the validity of the Delphi results. The literature suggests that a valid approach to check the robustness of the findings is to undertake a Delphi study on two panels, where feedback is not exchanged between the two panels. The similarity of the two panels' independently developed findings would prove the validity of the results (Ono and Wedermeyer, 1994; Woudenberg, 1991).

3.1.1 Questioned Research topics: Risks and Risk mitigation strategies for PPP Projects

In the present research each expert was asked to anonymously express his/her perception on the relevance of risks; the preferred risk allocation between public and private sectors and the suitability of specific strategies in mitigating risks, focusing on the motorway infrastructure sector in Europe, using a Likert scale. Key risks and risk mitigation strategies to be rate have been identified from the literature.

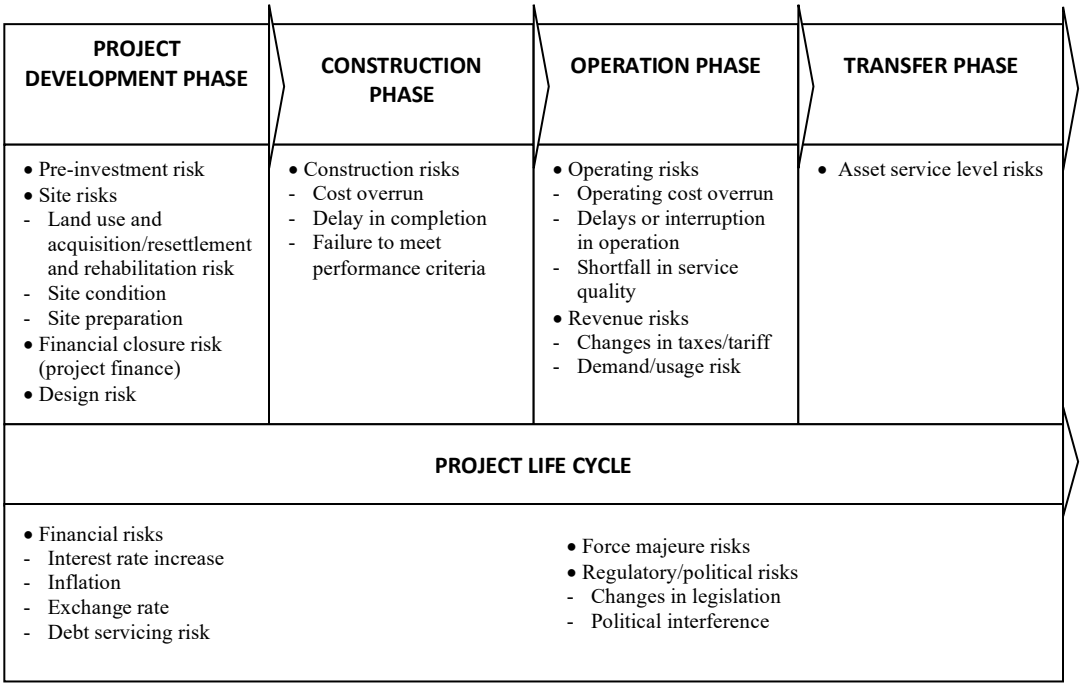

Figure 1. Risks in PPP projects by phase.

In particular, based on the literature review resumed in Section 2 (Aoust et al., 2000; Beidleman et al., 1990; Li, 2003; Thomas et al., 2003; Tiong, 1990), a total of 22 risks associated with PPP projects were identified. Figure 1 shows these risks grouped by project phase.

The following Tables (1-4) report the risk management strategies for the most important risks in PPP projects. These have been sourced in much of the relevant PPP and non–PPP risk management literature (see Pellegrino et al. (2013) for a comprehensive review).

Table 1. Mitigation strategies for risks in the Project development phase.

Risk category	Risk mitigation strategy
1. Pre-investment risk	● Provision for refunding the bidding cost by Government
	● Conditional bidding allows for setting certain logical conditions to be met before a bid is placed
	● Detailed market analysis before bidding so that the investment will be made only if the market conditions indicate a good scenario
	● Bid as a consortium involving two or more buyers
2. Site risks	
2.1 Land use and acquisition / Resettlement and rehabilitation risk	● Compensation clause in concession agreement
	● Provision for increase in construction/concession time
	● Contingency fund for increased land cost
	● Exit clause in concession agreement
	● Clause of effective start date and contingent effective start date in concession
2.2 Site condition	● Site inspections and testing
2.3 Site preparation	● Government can commission contamination reports, given that government should also have greatest knowledge of the past uses of its site
3. Financial closure risk (project finance)	● Provision for alternate promoter/lender
	● Provisions for grant/subsidy from Government
	● Alternate technology for cost reduction in case of non-availability of full debt: Choose a technology less expensive than the original one in order to decrease the amount of debt required
4. Design risk	● Defect liability clause in contract

Table 2. Mitigation strategies for risks in the Construction phase.

Risk category	Risk mitigation strategy
5. Construction risks	
5.1 Cost overrun	● The sponsor or investors must agree to come up with the additional capital
	● Contingency fund is a percentage assigned to the budget for overruns or unforeseen costs
	● Fixed price (lump sum) contracts: the contractor/construction company agrees to do the described and specified project for a fixed price
	● Cost-Plus Fee Contract: the owner/concessionaire agrees to pay the cost of all labor and materials plus an amount for contractor/construction company overhead and profit (often a set monthly fee or a fee based on a percentage of the cost of the work)
	● Guaranteed Maximum Price agreement: an owner/concessionaire and contractor/construction company can agree to cap the price once the project's design is substantially complete. Thus, a contractor who exceeds the capped amount is responsible for the difference, and if the total cost of the project is below the capped cost, the owner and contractor often agree to a "shared savings" benefit
	● The sponsors provide an escrow account containing sufficient funds to complete the project
	● Take out of lenders: the loan agreement can require the sponsor to purchase the asset and take out the lenders if the project is not completed and operating according to specification by a certain date
5.2 Delay in completion	● Completion guarantee extension to debt maturity guarantees that debt will be guaranteed until maturity in the event that completion is not achieved by a certain date
	● Completion/performance guarantees insure against financial loss from a delay in project completion attributable to specified causes, such as a failure of a party to perform on time
	● Penalties or liquidated damages state an amount or rate calculated in advance, usually payable by the contractor/construction company, for a delay to a project or performance failure. It is usually expressed in the contract as a fixed sum, daily or weekly rate.
	● Supply guarantee: the contractor/construction company insures himself that the supply (i.e., material or equipment) will be available where it's needed, when it's needed
5.3 Failure to meet performance criteria (quality, innovation, …)	● Performance guarantees are forms of financial security provided by a party to secure the performance of the contractual obligations of the other. It usually provides for a monetary amount that may be called upon by the beneficiary of the guarantee in the event of a failure of the contractor/construction company to perform its obligations under the contract

Table 3. Mitigation strategies for risks in the Operation phase.

Risk category	Risk mitigation strategy
6. Operating risks	
6.1 Operating cost overrun	● Maintenance bonds
	● Maintenance reserves
	● Fixed price and fixed duration operation contracts

6.2 Delays or interruption in operation	● Insurance for accidents and clean-up operations
	● Fixed price and fixed duration operation contracts
	● Retainage accounts (for contractor/construction company default)
6.3 Failure to meet service quality	● Performance guarantees from operator
	● Proven technology for operation and toll collection
	● Warranties for hidden defects
	● Performance bonus
7. Revenue risks	
7.1 Changes in taxes, tariffs	● Tariff guarantees
	● Traffic/revenue guarantee
	● Defer payments of the concession fees
7.2 Demand/ usage risk	● Revenue sharing mechanism: The government has a right to claim the certain percentage of the revenue if the rate of return on the project's investment is above a specified value
	● Revenue distribution mechanism: The government provides a guarantee of extra revenues. In turn, the concessionaire will make additional investments in the project and the concession will end when the guaranteed value of revenue is collected
	● Least present value of revenue mechanism: The concession ends when a specified level of LPVR (least present value of the accumulated revenues) had been reached.
	● Defer payments of the concession fees
	● Expand project capacity
	● Contract project capacity
	● Minimum revenue guarantee
	● Usage guarantee

Table 4. Mitigation strategies for risks in the Project life cycle.

Risk category	Risk mitigation strategy
8. Asset Service level risks	● Option to abandon for salvage value
9. Financial risks	
9.1 Interest rate increase	● Interest rate guarantee, futures, options and swaps
9.2 Inflation	● Adjust concession price; debt guarantee
	● Compensation payment
	● Inflation caps/floors
9.3 Exchange rate	● Exchange rate guarantee
9.4 Debt servicing risk	● Flexible price formula to meet traffic revenue deficiencies
	● Provision for revenue shortfall loan from Government
	● Debt reserve accounts
10. Force majeure risks	● Government indemnities for force majeure; suspending clauses
11. Regulatory/political risks	● Compensation from Government
	● Government assurances
	● Offshore escrow account
	● Extension of concession
	● Compensation clauses from Government

3.1.2 Questionnaire design

The above presented catalogue of risks and mitigation strategies has been used to build the questionnaire used in the Delphi survey to explore participants' perceptions on: i) the relevance of risks in the motorway PPP projects; ii) the preferred risk allocation between public and private sectors; and iii) the suitability of specific strategies in mitigating risks.

The questionnaire was divided into five parts. With the aim of making uniform the interpretation of risks used in the questionnaire, the first part provides a description of each

risk associated with PPP projects. The second part comprises questions about the respondents' background. The third part is designed to evaluate the relevance of risks in the motorways sector. To do this, according to traditional method for evaluating risks, participants were asked to express their opinion about both the probability of risk occurrence and the risk impact on the project when it occurs. A five-point Likert scale is used as a measurement scale. Regarding the probability of occurrence and impact, the five-point Likert scale represents 1 = very low, 2 = low, 3 = average, 4 = high, and 5 = very high, with "1" responding to "almost never occurring"/"almost no impact" to "5" corresponding to "almost certainty"/"heavy losses", respectively. Respondents can also select "not applicable" (N/A) when not sure about the score.

The fourth part concerns the risk allocation. A three-point Likert scale is used to measure how participants perceive the allocation among contracting parties, with 1 = mainly allocated to the public sector, 2 = equally shared between the public and private sectors, 3 = mainly allocated to the private sector.

The last part of the questionnaire provides a list of risk mitigation strategies and registers how participants consider each the mitigation strategies suitable for mitigating risks in the motorways sector. A five-point Likert scale is used, where 1= strongly suitable, 2 = suitable, 3 = neutral, 4 = unsuitable, and 5 = strongly unsuitable. For all the questions we ask the participants to justify their choices.

3.1.3 Procedure

To strength the robustness of the findings, we have conducted the Delphi survey with two groups, that are independent, namely, feedback is not exchanged between the two groups, and

differently sized, with the second double. The similarity of the two groups' findings would prove the validity of the results.

The target survey respondents belong to three categories: i) practitioners in the public sector, and ii) practitioners in the private sector; and iii) experts who have experienced PPP projects with different roles, namely bank or financial advisors, users, academics, and consultants. For each category we have identified and invited to participate in the Delphi procedure 5 experts for the first panel and 10 for the second. Two primary criteria were devised to identify the eligible participants for this survey: (1) having extensive working experience in PPPs (in fact respondents have at least 5 years of experience in PPPs); (2) having been involved in motorway PPP projects.

Before running the procedure with the two groups of experts, a pilot test has been run on a small group of experts whose selection is based on their availability to go through the procedure and to provide a detailed feedback on the clarity of the questions.

The result of the first round survey was consolidated and presented in the second round questionnaire. By doing so, the respondent could see how his/her choice is, compared with the mean value of the rest of experts. She/he could change her/his mind or to maintain her/his original view in the second round survey.

Once we have reached the 70% of consensus level on the scores above average (4-5), below average (1-2) and average (3), for the 70% of the questions in each part of the questionnaire we stopped the procedure. Notice that, as for the analysis of results, we have considered and reported all the responses where the majority of opinion (51% agreement among respondents) has been reached, since considered representative of the panel opinion.

3.2 Multiple-case analysis

Multiple-case study is used to study how risk is managed in real motorway PPP projects, in order to seek convergence and corroboration of findings stemming from the Delphi study. In fact, a case-based research method allows in depth, multi-faceted explorations of complex issues in their real life settings (Yin, 2009). Also, case studies allow researchers to learn about the state of the art and to generate or test theories from practice (Benbasat et al, 1987), thus having high validity with practitioners (Voss et al., 2002).

We adopt a multiple case study approach in order to make comparison across cases. Being aware that the decision on how to select the cases is a very important issue, we have selected eight motorway PPP projects that reflect different contexts and have been carried out by following the same protocol of investigation. The selected cases have been developed within the COST Action TU1001 on Public Private Partnerships in Transport: Trends and Theory (Roumboutsos et al., 2013). This choice is convenient because of the set of few cases, representative of different and heterogeneous contexts, offers the possibility of making comparisons among countries and drawing relevant results.

4. Delphi survey findings

The experts who accepted to participate and completed the Delphi procedure were 6 for the first panel and 10 for the second one. Table 5 shows the background information of the respondents. Consensus for panel 1 was achieved after the first round, while the second Delphi panel required two rounds for consensus to be achieved. The administration of the Delphi study was completed in about one year: the Delphi survey for the panel 2 was carried out from March to June 2013, for the panel 1 from May to June 2014.

Table 5. Background Information of the experts.

	(1) Perspective of the expert						
Perspective	Public sector	Private sector (partner)	Banking/Financing Institution	Venture Capitals	User of services	Academic	Consultant

Panel 1	-	2	-	-	-	1	3
Panel 2	7	2	-	-	-	-	1

(2) Transport modes of the PPP that the expert has been involved with

Mode	Motorways	Ports	Airports	Urban Transport	Rail	Other
Panel 1	6	4	-	-	1	-
Panel 2	10	3	1	3	-	1

(3) Country of the PPP project that the expert has been involved with

Country	Europe	North America	South America	Africa	Asia
Panel 1	6	1	1	1	2
Panel 2	10	-	-	-	-

(4) Background of the expert

Field	Economics	Engineering	Financing	Banking	Law
Panel 1	2	4	1	-	-
Panel 2	5	6	2	1	1

(5) Years of experience in PPPs of the expert

Years	6-10 years	11-15 years	over 16 years
Panel 1	1	2	3
Panel 2	6	4	-

Table 6 shows the assessments provided by the experts of the two panels on the probability of risk occurrence and the risk impact on the project, reporting only the answers where a 51% agreement among respondents has been reached. We label the scores below average (1-2), average (3) and above average (4-5) for the probability as *Unlikely, Likely and Very Likely*, respectively, and for the impact *Minor*, *Moderate* and *Major*, respectively.

Table 6. Summary of the risk assessment.

	Probability		**Impact**	
	Panel 1	**Panel 2**	**Panel 1**	**Panel 2**
Risk category				
1. Pre-investment risk	likely	-	minor	-
2. Site risks				
2.2 Site condition	unlikely	-	moderate	-
2.3 Site preparation	unlikely	unlikely	moderate	moderate
3. Financial closure risk (project finance)	likely	likely	major	major
4. Design risk	-	unlikely	-	moderate
5. Construction risks				
5.1 Cost overrun	likely	likely	moderate	moderate
5.2 Delay in completion	-	unlikely	-	moderate
5.3 Failure to meet performance criteria (quality, innovation…)	unlikely	unlikely	moderate	moderate

6. Operating risks				
6.1 Operating cost overrun	-	unlikely	-	moderate
6.2 Delays or interruption in operation	-	unlikely	-	minor
6.3 Failure to meet service quality	-	unlikely	-	minor
7. Revenue risks				
7.1 Changes in taxes, tariffs	likely	unlikely	moderate	minor
7.2 Demand/usage risk	very likely	very likely	major	major
8. Asset Service Level risks	unlikely	-	moderate	-
9. Financial risks				
9.1 Interest rate increase	very likely	very likely	moderate	major
9.2 Inflation	unlikely	likely	moderate	major
9.3 Exchange rate	unlikely	unlikely	minor	minor
9.4 Debt servicing risk	likely	likely	major	major
10. Force majeure events	likely	likely	major	major
11. Regulatory/political risks				
11.1 Changes in legislation	likely	unlikely	moderate	major
11.2 Political interference	-	unlikely	-	moderate

As shown in Table 6, among the 22 risks listed in the questionnaire, panel 1 has reached consensus for 15 risks and panel 2 for 18 risks, while 12 of the 22 risks (54,5%) show a majority opinion (>50%) for both panels, indicating a consistent degree of similarity between the two panels.

In order to define a list of significant risks in PPP motorway projects we have considered both the probability of risk occurrence and the risk impact on the project if a risk event occurs. Figure 2 shows the Risk Probability-Impact Matrix where the probability of occurrence is plotted on the y-axis and the risk impact on the x-axis.

The matrix includes 12 of 22 risks listed in the questionnaire, which are those showing a majority opinion (>50%) for both panels. The two panels have provided a different assessment to the probability and the impact of some of those risks. Therefore, we build the matrix on the judgment expressed by panel 2 and use the arrows where the assessment of panel 1 differs.

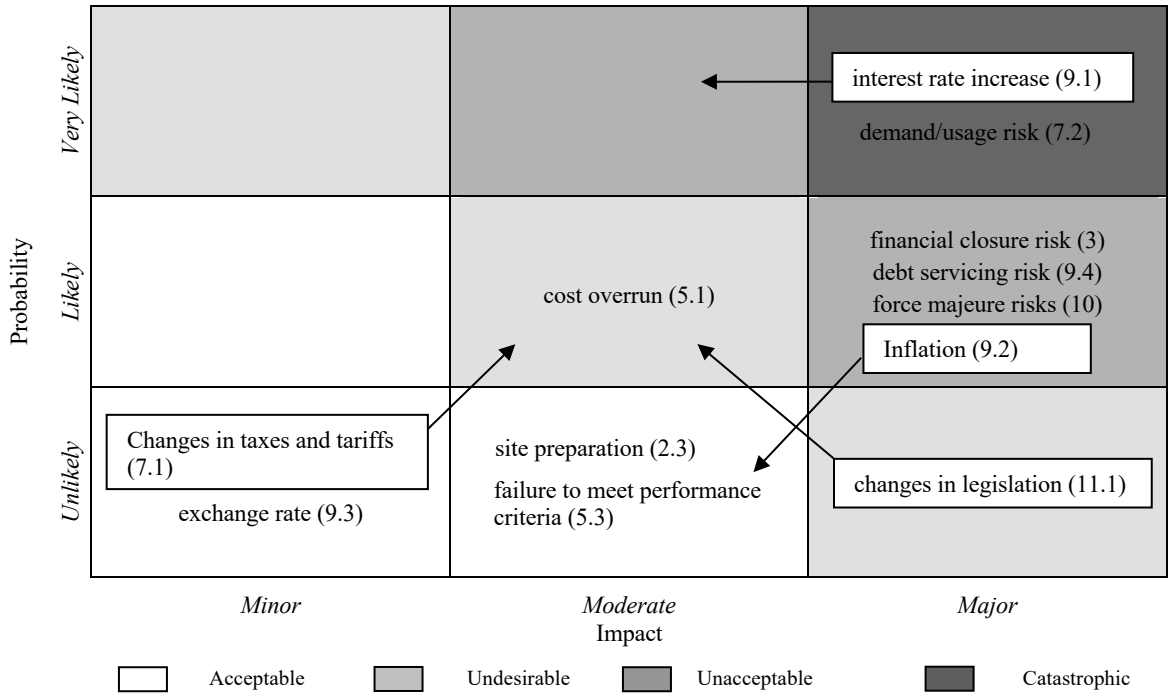

Figure 2. Risk Probability-Impact Matrix.

The matrix shows that the two panels express the same opinion for 8 risks. In particular, a total of 3 risks are classified as acceptable, two risks as undesirable, a total of 3 risks as unacceptable, and only one risk is classified as catastrophic by both panels.

Among this list of risks, considering as key risks those classified by both panels as unacceptable, undesirable, and catastrophic, we identify seven most significant risks in PPP motorway projects. Notice that other two risks can be considered critical since one of the two panels retains it as key: panel 1 includes changes in taxes and tariffs (7.1), while panel 2 inflation (9.2). That's why we include these risks in the further analysis.

Looking at the list of key risks, it is interesting to note that five out of nine are risks that span the entire life-cycle of the PPP project, hence they are perceived as critical by the experts since they constantly threaten the project success. For all the other key risks of the list, except for financial closure risk, the judgments expressed by the experts are driven by the

characteristics of the specific sector we focused on, namely the motorway sector. In fact in the motorway sector, given the complexity and the uncertainty affecting the construction phase, actual costs are likely to be higher than the budgeted costs. Furthermore, revenue risks are perceived as key because of the great uncertainty that makes an accurate estimation of the future level and composition of traffic volumes a difficult task. At the same time a wrong estimation of traffic forecasts strongly affects the profitability of the project, especially if direct user charges, such as tolls, are the main source of cash flow for the PPP project.

As for the risk allocation, a consensus level higher than 51% has been reached for all the questions by both panels. Focusing on the identified key risks, the panels agree that financial closure risk, cost overrun, interest rate increase, inflation, and debt servicing risk should be allocated to the private sector; while force majeure risks and changes in legislation should be equally shared between the two parties. A different opinion has been expressed by the two panels for the allocation of the demand/usage risk: panel 1 (p1) allocates it to private sector while panel 2 (p2) retains it equally shared between the two parties (Table 7). Results are coherent with the widely accepted principle of allocating risks to the party best able to manage them. Even for the other risks not listed in the table, namely those judged acceptable, the answers on their allocation seem to be based on the same principle. For example, political interference is the only risks allocated to the public sector.

The different opinion expressed by the two panels on the allocation of the demand/usage risk can be explained by the different composition of the two panels, panel 1 that allocates the risk to the private party is in fact made by practitioners in the private sector and consultants.

Table 7. Key Risks Allocation matrix.

	Private	Equally shared	Public
3. Financial closure risk (project finance)	✓		

5. Construction risks		
5.1 Cost overrun	✓	
7. Revenue risks		
7.1 Changes in taxes, tariffs		✓
7.2 Demand/usage risk	✓ (p1)	✓ (p2)
9. Financial risks		
9.1 Interest rate increase	✓	
9.2 Inflation	✓	
9.4 Debt servicing risk	✓	
10. Force majeure risks		✓
11. Regulatory/Political risks		
11.1 Changes in legislation		✓

Finally, as concerns the identification of the most suitable mitigation strategies, Table 8 shows the mitigation strategies judged "Suitable" (S) by both panels for the identified key risks.

Notice that we have also retained strategies judged suitable by one panel and neutral by the other, being the score "Neutral" (N) not discriminant

Table 8. Suitable mitigation strategies for key risks

Risk category	Risk mitigation strategy	Panel 1	Panel 2
Financial closure risk (project finance)	● Provision for alternate promoter/lender	N	S
Construction risks			
Cost overrun	● Additional capital	S	S
	● Fixed price (lump sum) contracts	S	S
	● Guaranteed Maximum Price agreement	S	S
	● Escrow account to complete the project	S	S
	● Take out of lenders	S	N
Revenue risks			
Changes in taxes tariffs	● Tariff guarantees	S	N
	● Traffic/revenue guarantee	S	N
	● Defer payments of the concession fees	S	N
Demand/usage risk	● Revenue sharing mechanism	S	S
	● Revenue distribution mechanism	S	S
	● Least present value of revenue mechanisms	S	N
	● Minimum revenue guarantee	S	N
	● Usage guarantee	S	N
Financial risks			
Interest rates increase	● Interest rate guarantee, futures, options and swaps	N	S
Inflation	● Adjust concession price; debt guarantee	N	S
	● Compensation payment	S	N
	● Inflation caps/floors	N	S
Debt servicing risk	● Flexible price formula to meet traffic revenue deficiencies	S	S
	● Debt reserve accounts	S	S
Force majeure risks	● Government indemnities	S	N
Regulatory/political risks			
Changes in legislation	● Compensation from Government	S	S
	● Government assurances	S	S
	● Extension of concession	S	S
	● Compensation clauses from Government	S	S

N = neutral
S = suitable

The two panels have expressed the same opinion on about half of the risk mitigation strategies listed in Table 8. As for the others, it does not emerge a divergence of opinion since "Neutral" does not mean unsuitability.

The results of the Delphi study show a substantial convergence of opinions among the experts of the two panels on the identification, allocation and mitigation of key risks, although the different composition of the two panels in terms of experts perspective.

5. Risk management in practice: Delphi results vs. multiple-case analysis

The results of the Delphi survey are compared with the common practices on risk management applied in eight real road and motorway PPP projects. Cases range from conventional toll motorways in Greece through a road tunnel in the Netherlands financed by availability payments, to an airport access road built by the Flemish Government using a public sector corporate entity and a shadow Design-Build-Finance-Maintenance (DBFM) agreement. Table 9 synthetized the main characteristics of the eight PPP projects.

Table 9. Projects overview.

Name	Country	Type	Contract duration	Budget	Source
A19 Dishforth DBFO	UK	Brownfield	30 years	GBP 29,4M	Boles and Liyanage, 2013
Attica Tollway, Athens Ring Road	Greece	Brownfield Greenfield	25 years	Eur 1300M	Halkias et al., 2013
Coen Tunnel	The Netherlands	Brownfield Greenfield	30 years	Eur 571M	Voordijk, 2013
Ionia Odos Motorway	Greece	Brownfield Greenfield	30 years	Eur 1200M	Nikolaidis and Roumboutsos, 2013
BNRR M6 Toll	UK	Brownfield Greenfield	53 years	GBP 900M	Boles and Liyanage, 2013
M80 Stepps to Haggs DBFO	United Kingdom	Brownfield Greenfield	33 years	GBP 251,4M	Boles and Liyanage, 2013
Olimpia Odos Motorway	Greece	Brownfield Greenfield	30 years	Eur 2200M	Roumboutsos and Nikolaidis, 2013
Via-Invest Zaventem	Belgium	Brownfield Greenfield	30 years	Eur 219,85M	van den Hurk and Van Gestel, 2013

The multiple-case study analysis provides interesting insights if compared with the Delphi survey results.

As concern the relevance of risks in PPP motorway projects, the cases show that the revenue risks during the operation phase, and in particular the demand/usage risk, have a severe impact on the project and remain one of the major issues driving the renegotiation process. The perception of the criticality of the revenue risks has induced in the A19 Dishforth Design-Build-Finance-Operation (DBFO) and in the M80 Stepps To Haggs DBFO projects to use shadow tolls as the mechanism for repayment the concessionaire, while in the BNRR M6 Toll project, to protect the concessionaire from drop of revenues in a period of economic decline, the SPV has a high degree of autonomy in how it sets the level of tolls, specifically the SPV is allowed to review tolls on a six-monthly cycle. In the Attica Tollway project, because sponsors considered that the road traffic levels and the tolls the users were prepared to pay were not enough to provide an adequate return on the investment, a strong financial help from the Greek Government was necessary. The traffic volume drop due to the Greek sovereign debt crisis has affected the demand risk both in the Ionia Odos Motorway and in the Olympia Odos Motorway projects as perceived by the private sector, and is expected to have a decisive role on the final renegotiated contract structure, mainly through the amendment of the toll revenue sharing mechanisms during the operational period.

As for the risk allocation, the cases show a mismatching with the opinion of experts involved in the Delphi survey (Table 10). In fact, only for the construction risks and financial risks we found a full coherence between the practices adopted in the real projects and the opinion of experts. Specifically, in most cases the former are allocated to the private party and the latter are allocated to the private party accordingly to the opinion of experts. Differently, the allocation of the other risks, namely revenue, force majeur, and regulatory/political risks, does not match with the results of the Delphi survey. Particularly, in most of the analyzed projects,

the revenue risks are allocated to the private party, while experts, although do not give a single indication, are inclined towards the opinion that revenue risks are equally shared.

As for the strategies adopted for mitigating revenue risks, the analysis of cases reveals that in those cases where the private bears most of the revenue risk, the preferred mitigation strategies are revenue sharing mechanisms and/or strong financial support provided by the public sector in the form of guarantees. At the same time, those cases where the revenue risks have not been adequately mitigated incurred in costly renegotiation processes, as for the Ionia Odos Motorway and Olympia Odos Motorway projects. Accordingly, the common international practices actually confirm the experts' opinion.

Table 10. Projects' Risk allocation matrix.

Risks	Private	Equally shared	Public
Construction risks	M80 Stepps-Haggs Attica Tollway Ionia Odos BNRR M6 Toll Olimpia Odos Via-Invest Zaventem	A19 Dishforth	Coen Tunnel
Revenue risks	A19 Dishforth Attica Tollway Coen Tunnel Ionia Odos BNRR M6 Toll Olimpia Odos	M80 Stepps-Haggs	Via-Invest Zaventem
Financial risks	A19 Dishforth BNRR M6 Toll M80 Stepps-Haggs Attica Tollway Ionia Odos Olimpia Odos	Coen Tunnel Via-Invest Zaventem	
Force majeur risks	M80 Stepps-Haggs	Via-Invest Zaventem	A19 Dishforth Attica Tollway Ionia Odos BNRR M6 Toll Olimpia Odos Coen Tunnel
Regulatory/political risks		M80 Stepps-Haggs	A19 Dishforth Attica Tollway Ionia Odos Olimpia Odos Via-Invest Zaventem BNRR M6 Toll Coen Tunnel

According to the Delphi results, the force majeur and regulatory/political risks should be preferably equally shared, while in most of the analyzed cases are borne by the public sector. Such a result comes out of the negotiation process where the government, recognizing them out of the private party control, accept to bear these risks to assure the long-term success of the PPP and indemnify the private sector against them. This confirms that mitigation strategies conventionally adopted to mitigate these risks are government indemnities, assurances, and compensation, as pointed out by the experts involved in the Delphi survey.

6. Conclusions

One of the critical aspects that affects the success of a PPP project is the risk management. Recognizing that the relevance of risks, the establishment of an acceptable risk allocation scheme, and the choice of the appropriate risk mitigation strategies depend on the specific PPP sector, we focus on the motorway sector. Based on the results of a Delphi survey, we define a list of significant risks in PPP motorway projects, prepare a practical risk allocation matrix, and identify the most suitable mitigation strategies for each identified key risk.

The research findings indicate that the most critical risks in PPP motorway projects are both endogenous and exogenous to the project. As regards the first category, the most significant, for its high probability of occurrence and its high impact, is the *demand/usage risk* which is one of the revenue risks that occurs during the Operation phase. For this catastrophic risk the two panels provide different opinions (panel 1 allocates it to private sector while panel 2 retains it equally shared between the two parties). This is in line with their different perspective: panel 1 that allocates the risk to the private party is in fact made by practitioners

in the private sector and consultants. The two panels fully agree that the more suitable risks mitigation strategies are *Revenue sharing mechanism* and *Revenue distribution mechanism*. Other endogenous key risks, less severe than the previous one, are *cost overrun* and *financial closure risk,* classified as undesirable and unacceptable, respectively. The former occurs in the Construction phase and, coherently with its nature, the preferred risk allocation is to the private party. Multifarious strategies can be adopted to effectively mitigate this risk. The latter occurs during the project Development phase and, being related to the project financing, should be preferably allocated to the private party. The risk mitigation strategy judged most suitable by the experts is the *Provision for alternate promoter/lender*.

The key risks exogenous to the project, due to factors outside the control of the project parties, can occur during the entire life-cycle of the PPP project. Most of them depend on the economic/financial and institutional contexts where the project is developed while only one refers to force majeure events. Among these, financial risks should be preferably allocated to the private sector and multifarious strategies can be adopted to effectively mitigate these risks. Regulatory and force majeure risks should be equally shared, the former can be mitigated through different strategies while, for the force majeure risks, the panels identify as suitable mitigation strategy the *Government indemnities.*

The results of the Delphi survey have been compared with the common practices on risk management applied in eight real road and motorway PPP projects. The most interesting result, common to all the analyzed cases, regards the *demand risk* which is the one with the greater impact on the project and remains the major issues driving the renegotiation process.

We found that this risk is mostly allocated to the private sector but, in the practice, the public party protects the concessionaire by revenue shortfalls by using shadow tolls as mechanisms

for repayment the concessionaire or by allowing the concessionaire to increase tariffs so as ensuring that the project is self-financed, unless incurring into costly and extensive renegotiation processes between the two parties.

The research findings presented in this paper will support both the public and private sectors in understanding the key risks, establishing an effective risk allocation framework, and adopting the most effective mitigation strategies. Main managerial implications of the study are informing the parties in the negotiation process so as avoiding costly renegotiation and in the more risky phases and activities of the project so as strengthening control and monitoring measures.

A major limitation of this study is that the guidelines are developed without considering the correlation among risks, that is by assuming that each risk is independent of each other. This issue will be addressed in future work by investigating the whether mitigation strategies conceived relatively to the separated risks are still effective once risks occur combined together.

Further researches will be carried out mainly in two directions. Firstly we intend to replicate the study for the other transport modes, thus providing comprehensive guidelines for risk management in transport PPP. Secondly, we intend to investigate if and how the global financial crisis impacts on the risk assessment and thus on the identification of the key risks in PPP motorway projects, their allocation and mitigation.

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