CRITICAL RISKS IN SERBIAN INFRASTRUCTURE PROJECTS*

Miljan Mikić, M.Sc. Civ.Eng., Ph.D. student, teaching and research assistant
Department of Management, Technology and Information Technology in Construction Industry, Faculty of Civil Engineering, University of Belgrade, Serbia
mmikic@grf.bg.ac.rs
Zorana Petojević, M.Sc. Civ.Eng., Ph.D. student, teaching and research assistant
Department of Management, Technology and Information Technology in Construction Industry, Faculty of Civil Engineering, University of Belgrade, Serbia
zjovanovic@grf.bg.ac.rs
Prof. Nenad Ivanišević, Ph.D. Civ.Eng., Lawyer
Department of Management, Technology and Information Technology in Construction Industry, Faculty of Civil Engineering, University of Belgrade, Serbia
nesa@grf.bg.ac.rs

Abstract

Infrastructure projects are usually followed by numerous standard, but also specific risks associated with project cost, schedule, quality, performance, health and safety aspects, environmental aspects, as well as with other, non-tangible factors. They, if not timely identified, treated and controlled cause that project actual performance significantly varies from planned values. This paper presents results of a conducted infrastructure construction project risks survey for projects settled in Serbia. The survey includes evaluation of major risks in relation to infrastructure project cost and schedule performance and the analysis of usage, necessity and problems with construction Project Risk Management (PRM) practice in Serbia. Risks in the offered risk list were divided into: General Market Risks, Risks in Feasibility and Design Phase and Risk in Construction Phase and evaluated using Probability-Impact matrix. Based on the results, the proposal is given for the development of an advance planning cost and schedule performance prediction model.

Keywords: Infrastructure, Risk, Project Risk Management

* The complete text is available on CD-ROM / Mikić, Petojević, Ivanišević

Introduction

The realization of an investment project, especially large one, is an extremely complex undertaking both from technical and technological, as well as the organizational, legal and financial standpoint (Ivkovic & Popovic, 2005). Such organizational and technological complexity causes great amount of risks (Zou et al. 2007). Project risk is defined as an uncertainty with a possible positive or negative impact on at least one project objective (PMI, 2008; BS 2010). Risk has traditionally been described with a probability of event occurrence and a possible impact that it might have on project goals (Bunni, 2003).

Success in a project can be regarded as provision on time, on budget, of a required performance or achievement (Williams, 1995). Managing risks in construction projects has been recognized as very important for achieving project success (Zou et el. 2007). As one of construction project management (PM) areas, Project Risk Management (PRM) in construction is extended well beyond the confines of insurance and helps to analyse, mitigate and control risks associated with project cost, schedule, quality, performance, health and safety aspects, environmental aspects but, as well, with other, non-tangible factors, such as corporate image, employee satisfaction, increased customer service (Williams, 1995; Ali, 2005; Mikic & Arizanovic, 2012).

On figure 1, the PRM procedure is shown as defined by *Project Management Institute* (PMI) (PMI, 2008; PMI, 2009).

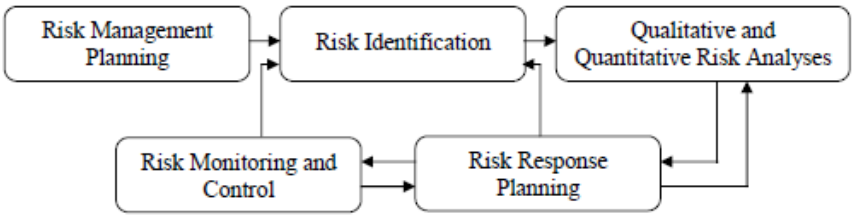

Fig. 1) (adapted from PMI, 2009)): Project Risk Management (PRM) Processes

Risk Management Planning is the process of defining how to conduct risk management activities for a project. In Risk Identification, it is determined which risks may affect the project. Qualitative Risk Analysis is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact. Quantitative Risk Analysis is numerical analysis of the effect of identified risks on overall project objectives. Risk Response Planning develops options and actions to enhance opportunities and to reduce threats to project objectives. Finally, Risk Monitoring and Control is the process of implementing risk response plans, tracking residual and new risks and evaluating risk process effectiveness throughout the project.

2. Background of the study

Large infrastructure projects, due to their nature, specific construction sites, project surrounding, numerous stakeholders, multidisciplinary character, being often complex and international are followed by many uncertainties. When considering project costs, the recent literature confirms that the cost overrun in transport projects is a global problem. In the work of Jenpanitsub (2011), the review of recent researches in relation to cost overruns in transport projects is given. Most of the studies focus on the problems on a national level and it is showed that the problem exists – in the U.S., Canada, the Philippines, South Korea, India, Sweden, England and Slovenia. In road projects, the mean cost overruns range between 4.5% (2,668 road projects in Indiana, USA) and 86% (8 road

projects in Sweden). In rail projects, the cost overruns are between 14% (rail projects in Sweden) and 95% (122 railway projects in India). Only one of the researches is across continents, looking at 258 infrastructure projects (i.e., roadways, rail, fixed links) worldwide (Flyvbjerg, 2003). It reported that 90% of the projects experienced cost overrun with an average cost escalation of 27.6%. The average escalation for roadway projects was 20.4%.

In Serbia, as a developing country, heading towards EU, there is a need and a plan for upgrading infrastructure capacity and availability. Although Serbia is in the process of a constant infrastructure upgrading and development, significant infrastructure works are still to come. If example of highway network is considered, Serbia at the moment possesses a highway network of 650 km, of which 188 km is constructed in period from 2009 until 2012. Additional 700 km is still to be constructed, of which 165 km is designed and is in the construction phase at the moment, for 290 km there are designs, but construction has not yet started and the rest of 240 km is planned in the Spatial Plan of Republic of Serbia (1996).

In feasibility, design and construction phases of an infrastructure project, it is very important for all stakeholders to be aware of possible threats to the project goals and overall project success. This is especially important for advance planning stage (Figure 2), in which up to 98% of all savings on the project could be made (Ivkovic & Popovic, 2005). Much more attention in project management research and practice has been paid to construction, while much less has been focused on advance planning and design phases (Le *et al*., 2009). It is showed in recent researches, that it is possible to predict project cost and time performance even in these, early project phases, by using the Project Development Rating Index (PDRI), developed by Construction Industry Institute, USA (Le *et al*., 2009; Son *et al.* 2012; Wang & Gibson 2010).

This paper seeks to identify sources of risks affecting cost and time goals of infrastructure construction projects in Serbia. It further analyses the usage, necessity and problems with Serbian construction Project Risk Management (PRM) practice. Finally it explores the possibility of using PDRI for the front-end cost and schedule performance prediction model development.

The remainder of the paper is structured as follows: firstly we develop a research question through a salient literature review; next we set out the method employed for the survey; thirdly, we present the findings of the survey; the findings are then discussed, followed by some concluding remarks, limitations and areas for further work.

3. Risk Identification Studies

Previous surveys in relation to construction risk management based on questionnaires and interviews were done in direction to:

- Examining tools for risk management (Raz & Michael, 2001; Lyons & Skitmore 2004; Ali, 2005; Adams, 2008). Since the authors started from the hypothesis that construction PRM practice in Serbia is generally at the basic level, no PRM tools were examined in the survey. Only the existence and the problems with PRM practice at general level were explored, comparing it to the project management practice.
- Examining sources and priority of risks. Major outcomes of these attempts are the identification of the project objectives related risks and the project phase related risks (Zou et al. 2007). Some of the previous surveys on construction projects risk perceptions, based on questionnaires with predefined risk list were those conducted by: Adams (2008), comparing perceptions of risks between UK and Ghana contractors; Andi (2006), exploring the importance and allocation of risks on projects in Indonesia; De Camprieu (2007), examining the perceptions of risk among Chinese and Canadian large-scale projects practitioners; and Zou *et al.* (2007), identifying the key construction projects risks in China and Australia. Thomas *et al.* (2003), and Bryde and Volm (2009) explored, respectively, the

most critical risks of an Indian BOT road projects in an unstructured interview and perception of risks of owners in German construction projects in a semi-structured interview based surveys. However, in predefined risk lists in these researches there is a lack of advance planning phase risks consideration. In this survey, risks in all phases of infrastructure construction projects were analysed, with special attention to project early phases risks and market risks in Serbia. For predefined risk list generation, apart from mentioned, researches which employed construction risk modelling using Analytical Hierarchy Process (AHP) (Zayed *et al*. 2008), Analytical Network Process (ANP) (Bu-Qammaz *et al*., 2009) and Alien Eyes-Risk Model (Wang *et al*., 2004) were also studied.

4. Methods

In order to provide the opinion of construction professionals on potential risks sources regarding infrastructure project cost and time performance, as well as about risk management practice, a survey of the Serbian market is conducted. Within this research, infrastructure projects were defined as: road, railroad network projects, water supply and sewage system, gas infrastructure, electricity and telecommunication projects. Although some of recent scholars underlined there is a lack of researches that look at two sides nature of risks, as uncertainties that could have either positive or negative impact on project objectives (Bryde & Volm, 2009; Zou *et al.,* 2007; Ward & Chapman, 2003), for the purpose of the survey, risk was defined only as a threat, i.e. only as an event with possible negative impacts.

In the survey, existence of risk management practice in Serbia was examined through the structured questionnaire. The most significant goal was to identify major risks to infrastructure project performance. The questionnaire in this research consisted of four parts:

- The PART 1 contained 7 general questions.
- In the PART 2, there were 11 questions which examined the practice of construction project management in Serbia, as well as the usage, necessity and problems related to construction project risk management practice.
- 5 (five) questions in the PART 3 aimed to point out the main sources of risks on infrastructure construction projects in Serbia.
- The PART 4 consisted of 6 questions which analysed the problems and potential application of BIM (Building Information Technology) technology as a risk avoiding technique. Results of this part will not be presented in this paper, but are given by Mikic *et al*. (2012).

After initial structured questionnaire forming, to get feedback on the questions, the questionnaire was taken by three construction professionals with both practical and scientific experience in construction project management of more than twenty years. Based on this feedback, slight modifications to the wording of some questions were made.

In order to conduct the third and crucial part of the survey, identification of potential risks was performed prior to the survey, through a literature review and an iterative process of predefined risk list generation. In a literature review, similar previous surveys stated in section 2 were studied. Existing risk lists, developed in considered literature, were the basis for a risk list for the survey, which was made to fit infrastructure construction project surrounding and specific conditions of Serbian market, similar to the conditions in other developing countries, especially in South East European region. After initial risk list forming and construction professionals' feedback, definite predefined risk list was offered for a qualitative risk analysis in the third part of the survey.

Risk list consisted of risks grouped into three risk areas: General market risks, Risks in Feasibility and Design phase and Risks in Construction phase (Figure 2). Apart from the cited literature, this type of

risk division was partly also based on chronological risk classification, suggested by Bunni (2003), supporting the plan to examine risk sources in pre-construction phases more carefully.

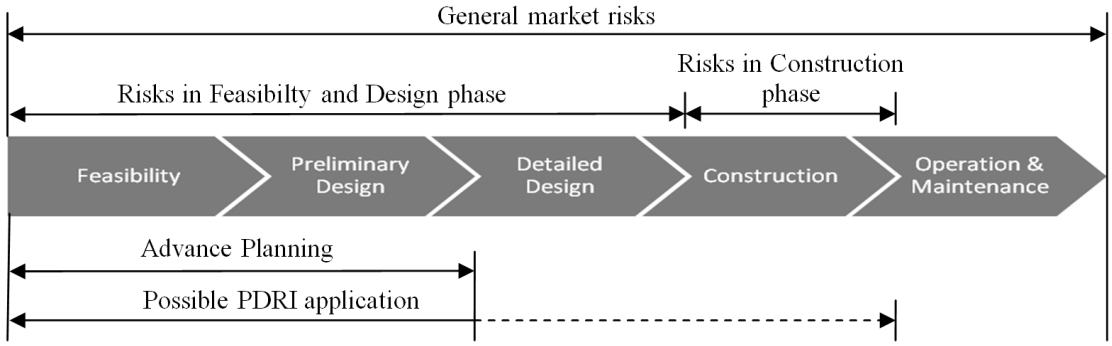

Fig. 2) (adapted from (Le et al., 2009)): Infrastructure construction project phases, risk areas and phases of possible PDRI application

As general market risks, the following were in the list:

- Political risks in Serbia (instability of political conditions, political pressure and impact)
- Domestic market financial risk (instability of economic conditions)
- Legal risk in Serbia (change of regulations, delay of approvals)
- Corruption

As risks in Feasibility and Design phase, there were:

- Inadequate initial surveys conducted (location, geology, geotechnics, hydrology)
- Inadequate Terms of Reference
- Design contract issues (deadline, price)
- Design company organizational issues (weak design project management, lack of qualified design engineers, lack of business standards and organization)
- Design technology issues (lack of standards and technical guidelines, lack of knowledge and appliance of advanced methods, technologies and software)
- Inadequate control from customer in design phase

As risks in Construction phase, in the list there were:

- Unforeseen ground conditions
- Design defects (incl. BoQ) which lead to numerous changes and variations
- Contractual issues (inadequate contract model, strict conditions towards contractor, tight deadline, low prices, inadequate advance payment structure, bad wording, incompleteness, potential claims and disputes)
- Contractor company organizational issues (weak project management performed by contractor, lack in management and engineers skills and know-how, lack of business standards and organization)
- Construction technology issues (lack of knowledge and application of advanced methods, technologies, equipment, materials and software)
- Resource issues (problems with borrow pits, specific materials and equipment procurement, change of material prices, lack of engineers, lack of qualified labour force)
- Bad quality of materials
- Lack of control and support from the Engineer, Engineer's incompetence
- Expropriation problems
- Unforeseen extremely adverse climatic conditions
- Accidents on construction site (health and safety issues, environmental issues)
- Force Majeure

The survey feedback in the third part included two groups of data, the probability of occurrence of

each risk and its impact of consequence on basic project objectives (cost and time). The respondents were asked to evaluate the probability of occurrence and the impact of risks from the list on infrastructure construction project cost and time performance. The qualitative five-point scales were offered for evaluation of each risk in both of these groups of questions. Data analysis method, adopted as the method from previous researches (Camprieu *et al*., 2007; Zou *et al.,* 2007; Baccarni *et al.*, 2001) is further described.

The qualitative scales were converted into numerical scales, where both for probability and impact "very high" takes value of 1, "high" takes value of 0.75, "medium" takes value of 0.5, "low" takes value of 0.25 and "very low" takes value of 0.1. Further steps were: 1) averaging the evaluated probability for occurrence of each risk; 2) averaging the evaluated impact of each risk on project cost, and time; 3) deriving a risk rating, separately for cost and time, by multiplying their respective probability and impact average scores.

The survey was distributed to 85 construction professionals with experience on infrastructure construction projects in Serbia. It was also available for the Linkedin IPMA and PMI Local Chapters Serbia and Association of Consultant Engineers of Serbia (ACES) group members to take part in. In the survey 46 respondents took part, 37 of which responses were complete. Only complete responses were analysed. Both the reliability and the validity of the survey data were checked, where methodology of Andi et al. (2006) was applied and minimum response rate has been considered. Because of that criteria, there was no possiblity to compare risks evaluation of different groups of respondents.

Preliminary results of the survey, while the survey was still on-going, were published by Mikic *et al*. (2012). The results of the survey for Serbian market, regarding sources and priority of risks, are in the section 5 of this paper compared to the results of some of the previous studies.

5. Results

5.1. Results of General Questions

In the first part, respondents were asked about their profession, professional experience, types and values of infrastructure construction projects they have taken part in. 95% of respondents were construction or civil engineers. The rest were architects and electric engineers. 54% of all respondents confirmed that in their career they have worked as a project manager, 41% that they have worked as a designer, 38% confirmed they have worked as a contractor, 38% as a consultant, 24% in company management team, 24% as a supervising engineer, 22% as an investor, 16% have worked the other as well.

In Figure 3(a) working experience of respondents is presented, in preparation of studies and design and, separately, on construction sites and related activities. The lack of respondents could be noticed in the group 10-15 years of experience, and this could be, at least partly explained by the “brain drain” phenomenon that has been significantly present in Serbia and the region in the last twenty years. As seen, the highest response rate was among the younger professionals, as the 32% of respondents have less than five years of experience.

Figure 3(b) shows that 71% of respondents were involved in road projects, 43% in water supply & sewage system, while significantly less have participated in railroad network, electricity and telecommunication and gas infrastructure projects (14% of respondents for each).

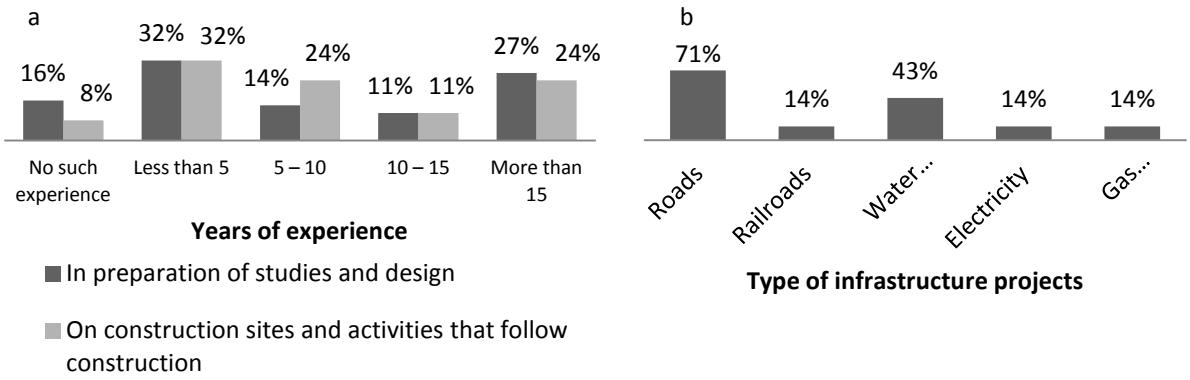

Fig. 3: a) Work experience of respondents (% of respondents); b) Engagement on different type of infrastructure construction projects (% of respondents)

The value of the largest infrastructure projects they have taken part in, for 76% of respondents, was more than 10 EUR millions.

5.2. Analysis of Project and Risk Management Practice in Serbia

Almost all participants agree or strongly agree that project risk management is an important area of project management (98% of respondents), that project risk management application is important for success of the construction project (97%), and that project risk management should be applied on construction projects in Serbia (94%).

However, although the awareness of the project risk management importance and the need for it exist, there is a lack of knowledge on the subject in Serbia. From figure 4(a) it is notable that only 38% of respondents is very familiar or familiar with Project Risk Management (PRM) tools. To compare, 81% of respondents is very familiar or familiar with Project Management (PM) tools. Also, there is a significant difference between the number of domestic companies which have implemented PRM system/standard, comparing to those which have implemented PM system/standard. While more than half of respondents (54%) answered there are some techniques or full system for PM implemented in their company, for PRM it is only 21% (fig.4 (b)).

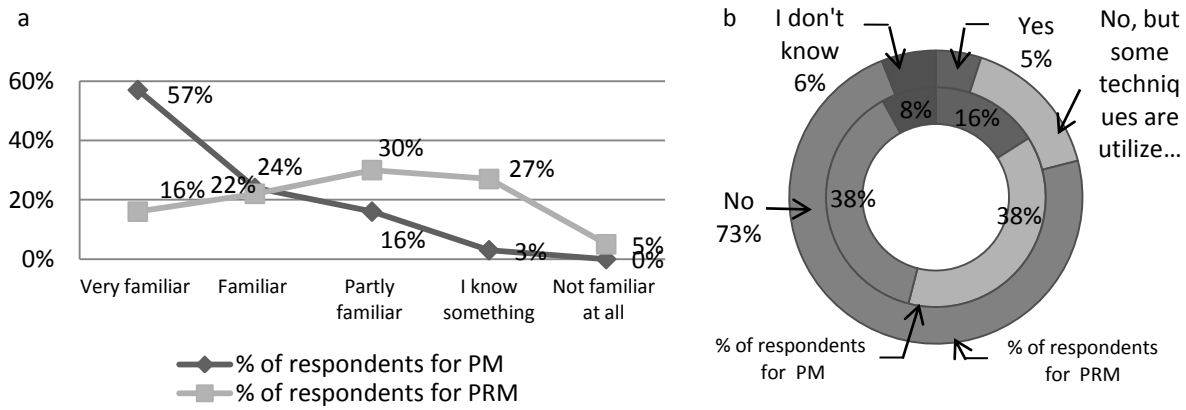

Fig. 4: a) Personal familiarity with PM/PRM tools and techniques; b) Answers to the question: "Does

your company have implemented PM/PRM standard/system?"

The major problems of PRM practical application on projects in Serbia are, starting from the most significant, evaluated as: organizational problems, no recognition of importance from top management, political, legal and financial problems. The level of interest in finding out more about PRM on a scale from 0 (no interest) to 4 (very interested) among respondents has a high mean of 3.46.

5.3. Evaluation of Major Risks in Relation to Infrastructure Project Cost and Time Performance

Data analysis method for identification of major risk has been explained in part 3 of this paper. The rating of all risks, separately for project cost and time performance is shown in table 1.

Tab. 1) Ratings of risks for Serbian infrastructure projects

LIST OF RISKS		**RISK RATING**	
No.	RISK	COST	TIME
1	Political risks in Serbia	**0,55**	**0,56**
2	Domestic market financial risk	**0,57**	**0,59**
3	Legal risk in Serbia	0,42	0,44
4	Corruption	**0,57**	**0,54**
5	Inadequate initial surveys conducted	0,49	0,48
6	Inadequate Terms of Reference	0,47	0,45
7	Design contract issues	0,40	0,39
8	Design company organizational issues	0,35	0,35
9	Design technology issues	0,27	0,26
10	Inadequate control from customer in design phase	0,48	0,43
11	Unforeseen ground conditions	0,40	0,41
12	Design defects (incl. BoQ)	**0,52**	0,48
13	Contractual issues	0,47	0,44
14	Contractor company organizational issues	0,44	0,48
15	Construction technology issues	0,33	0,35
16	Resource issues	0,28	0,30
17	Bad quality of materials	0,19	0,18
18	Lack of financial resources for project realization	**0,57**	**0,64**
19	Lack of control and support from the Engineer, Engineer's incompetence	0,31	0,31
20	Expropriation problems	0,48	**0,50**
21	Unforeseen extremely adverse climatic conditions	0,12	0,14
22	Accidents on site	0,17	0,17
23	Force Majeure	0,09	0,11

The risks with ratings above 0.5 are considered critical and their ratings are presented in bold letters in table 1. Since the value "high" in qualitative scales responds to the value of 0.75, the most critical risks are those with values of both probability and impact "high" or "very high", which, because of multiplication, gives ratings of at least 0.56. The highest rating regarding possible project cost

overrun have the risks: Domestic market financial risk (0.57), Corruption (0.57) and Lack of financial resources for project realization (0.57). Then come Political risks in Serbia (0.55) and Design defects (0.52). Inadequate initial surveys conducted, Inadequate Terms of Reference, Inadequate control from customer in design phase, Contractual issues and Expropriation problems are also highly rated.
The risks with highest rating regarding project time performance are: Lack of financial resources for project realization (0.64), Domestic market financial risk (0.59), Political risks in Serbia (0.56), Corruption (0.54) and Expropriation problems (0.50). Then come: Inadequate initial surveys conducted, Design defects and Contractor company organizational issues, as also highly rated.

6. Discussion

The highest ratings considering both project performance indicators (cost and time) has, as seen, the Lack of financial resources for project realization, after which comes the Domestic market financial risk, Political Risk and the Corruption. The top rated risk is an internal project risk, while the other three are of external nature.
The highest ratings from the internal risks, apart from the top rated, have: Design defects, Expropriation problems, Inadequate initial surveys conducted, Inadequate Terms of Reference, Inadequate control from customer in design phase, Contractual issues and Contractor company organizational issues.
Received results mostly correspond to the results of previous surveys of construction projects risks in developing countries. The highest rated risks for China were, regarding project cost performance: Price inflation and Design variations, regarding time - Project funding problems (Zou et al., 2007), where a significant correspondence was noticed. For Indonesia, the Inflation, Defective design, but also Unforeseen Site conditions were evaluated as risks with the highest impact on construction projects (Andi, 2006), while for Indian road projects the most significant risks were: Delay in land acquisition, Delay in financial closure, Direct political risks (Thomas *et al*., 2003), which are all risks also rated very highly in this study. In relation to highly rated risk of corruption, it is said that the construction industry is the most corrupt industry and there are strong incentives in the sector to engage in collusion (Brockmann, 2009).
Flyvbjerg *et al.* (2003) claims the main shortcoming of the conventional approach to infrastructure megaprojects appraisal and development is the absence of, on the one hand, clear objectives and, on the other, arrangements for: (i) measuring how objectives are being met; and (ii) rewarding good and penalising poor performance. Therefore, they set out four basic instruments for enforcing the accountability: Transparency, Performance specifications, Explicit formulation of regulatory regime and Risk Capital. With this instruments applied, external risks, that could not be controlled from the project team and require not only technical solutions, could be, at least partly mitigated. Other possible solutions for external risks mitigation include developing proactive project team, which can recognize and prepare for risks in the first place, but also, as stated in FIDIC (2012) lead an infrastructure project as a complex adaptive system which responds adequately on uncertainties and is more resilient. These solutions can help for internal risks, as well.
On the other side, all of the highest rated internal risks can be successfully managed by the project stakeholders, and for about all of them, proper Client's and/or Project Manager's involvement is of very high importance. Results presented in part 4.2 in this paper, showed there is a strong support and interest for PRM among construction professionals in Serbia. It was also proved there is a lack of PRM knowledge and practice in the market, mostly because of organizational problems, no recognition of importance from top management and political problems. Therefore, the authors have, in separate research, started with examining the applicability of a front end scope and risk

assessment tool - PDRI for Infrastructure. As said, in some of previous researches it is showed that together with data mining tools, it can be used for the front-end cost and time performance prediction model for construction projects (Le *et al*., 2009; Son *et al.,* 2012; Wang & Gibson, 2010). PDRI basically consists of a list of project scope elements, including descriptions, which are organized in categories and sections. Categories include, *inter alia*, Project Strategy, Project Funding and Timing, Site Information, Project Design Parameters, Land Acquisition Strategy, Procurement Strategy, Project Control, Project Execution Plan, which are all in this research evaluated as areas with sources of highest risks in Serbia. Using a rating mechanism for each element's definition inside the categories, the PDRI allows the project team to determine the level at which a project is defined at any given time during the front end planning process (Le et al., 2009).
Although the PDRI methodology can be applied in different project phases (fig. 2), to measure how project team advances in project development, it puts the highest accent on examining Client's early phase preparation and issues proved as of the highest importance in this research. Because of this, the hypothesis of applicability of a composite PDRI-Data Mining Tools Model for prediction of cost and time performance on infrastructure projects in Serbia has been made.

7. Conclusion and recommendations

In this paper, results of the infrastructure construction project risks survey for projects settled in Serbia are presented. Construction PRM practice in Serbia was analysed and evaluation of major risks in relation to infrastructure project cost and schedule performance was performed. Although there are more advanced techniques for risk analysis and evaluation, in this research Probability-Impact analysis was applied, as a first step toward more complex risk modelling.
It was found out that there is a strong support and interest for PRM application on projects in Serbia, but lack of knowledge on the subject and poor practical application exist. Among the 23 risks in the predefined risk list, domestic market financial risk, corruption and lack of financial resources for project realization were the highest rated regarding possible project cost increasing. Regarding project time performance, it was the lack of financial resources for project realization, domestic market financial risk and political risks in Serbia. The major problems in relation to PRM practical application in Serbia are identified as organizational and no recognition of importance from top management. The study revealed that by perception of construction professionals, the highest risks on infrastructure projects in Serbia come from external environment. Other highly rated risks are mostly from feasibility and design project phases. The limitation of number of respondents did not allow any comparative analysis of different respondents groups view on the subject.
The significance of this result is that it provides an empirical basis for the development of more complex risk models and further systematic analysis and management of infrastructure construction project risks in Serbia. Results of the study provided a base for a new model proposal for an early phase prediction of cost and time performance on infrastructure projects. It is recommended the model should include PDRI methodology and Data Mining Tools. The results can also contribute to developing a basis for more adaptive project teams.
Although the study reported here has to be placed within a clear context of its limitations, it could be recommended for further researches that this type of surveys should be conducted in other developing countries, especially in countries in the South East European region. In that way, the results could be compared and more general conclusions could be made. It is also recommended that future studies in the same area include a qualitative survey as a method.

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