Impact of most correlated risk factors into actual construction price in PPP projects

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ARTICLE INFO

ABSTRACT

The basis of the formulation of most of the Public-Private Partnerships (PPP) is the reasoning that the public authority authorizes the design, construction, operation, maintenance, and funding of a public infrastructure project from a private group through a single contractual agreement. In general, PPP project risks consist of developing and building a new asset and ensuring that it remains functional for many decades. Exceeding the cost and time limits is possibly the most severe implication of risks throughout the construction period. Such events are the most extensively discussed situations in value for money risk analysis. There are changes in the sources of risk across the life cycle of a PPP project. In certain situations, the importance of construction and development risks in infrastructure projects is quite high. It is believed that projects pertaining to IT, rehabilitation/refurbishments, and complex agencies' interaction have considerably greater risks compared to other assets. PPP construction risks have been categorized by Standard and Poor in accordance with the kind of assets, indicating that the funding bodies acknowledge the presence of a relationship between construction risks and kinds of PPP assets. Usually, all price distress has to be covered by the public sector from these risks in conventional procurement. There is sufficient evidence to imply that in a few of the projects that are completed under the public procurement systems, public distress is normal. The effect of risk factors on the precise construction price in PPP projects will be determined in this paper. In addition, it will present the correlation between the risk factors and the precise construction price units in PPP projects.

1. Introduction

The private sector has been involved in fulfilling public infrastructure projects for a long time; however, it has only been in the past thirty years that their involvement has increased substantially, in scope as well as extent. Different kinds of developments have occurred in different regions and countries, in accordance with the distinct legal systems and economic conditions; however, the main reason for the establishment of such public-private contracts has been to shift the long-term risks related to the provision of public infrastructure assets and services from the public to the private sector. Such arrangements have managed to transfer risk to the contractor to a lesser extent in conventional procurement; however, it has been shown in studies that there are greater cost and time uncertainty in PPP projects. Nonetheless, attaining value for money will transfer the entire risk to whoever is capable of tolerating it, and not to the private sector (Davies, 2006). PPP projects essentially take into account the issues related to value for money and transfer of risk. There is a relationship between these two concepts (Gao and Handley-Schachler, 2004). It is believed that appropriate risk allocation between the contracting parties in construction projects is a critical decision that brings about the success of the project. On the basis of the theory that the party that has the greatest control over the situation is most likely to be able to decrease the possibility of risk and to manage the risk in case it occurs, risk allocation essentially seeks to decrease the cost and risk of the project. This is done by assigning the risk to the party that can control it in the best way. Hence, if any risk is present and it is not possible for any party to

bear it and control it on their own, then the best thing should be to divide the risk between the public and the private sector (Ke et al., 2010).

The reason for developing a significant majority of the PPPs is that the design, construction, operation, maintenance, and financing of a public infrastructure project is authorized by the public authority through a private group as part of a single contractual agreement. The project risks involved in a PPP project usually involve the establishment and construction of new infrastructure, and its continued operation for many years.

Exceeding the cost and time deadlines is possibly the most significant causes of risks experienced during the construction period. Witt (2010) asserted that when risk is effectively transferred to a party that can manage it most appropriately, it becomes possible to carry out a construction project within the projected budget and to attain value for money. In value for money analysis of risks, there is extensive use of such scenarios. Across the life of a PPP project, there are variations in the sources of risk. In certain situations, construction and development risks in infrastructure projects are quite substantial. It is believed that projects pertinent to IT, rehabilitation/restorations and interaction of complex agencies have more significant risks in comparison to other assets. PPP construction risks have been categorized by standard and poor's in accordance with the type of asset, indicating that the prevalence of a relationship between construction risks and PPP asset types has been acknowledged by at least the funding parties. The overall price distress experienced from these risks usually has to be covered by the public sector in conventional procurement. In a few of the projects completed as part of the public procurement

systems, there is sufficient evidence to indicate that price distress is a common phenomenon. Therefore, this paper has the objective of determining how PPP project risks are related to the actual cost of construction in these projects. The organization of the rest of the paper is as follows: An outline of risk classification is put forward. After this, a short description is provided of the technique used by the researcher. The research finding is then presented, followed by a discussion of the results and finally, the conclusion.

2. Risk classification

Risk management is a very important factor for a PPP project. There are various risks that affect PPP projects; however, each project is affected by different risks, and to a different degree. Some risks are pertinent to given sectors; a few may be relevant for a specific country; and some may be general (Bond and Carter, 1994). Risk classification was put forward by the authors on the basis of the way the risks affected the cost of construction. The classification used in this study is shown in Fig. 1. The risk factor is differentiated by this classification into two categories. These include exogenous risks that consist of legal risks, political risks, natural risks, economic risks and market risks. The second group of risks is endogenous risks, which consist of project finance risks, project selection risks, relationship risks, construction risks and operational risks. Other researchers have also employed this technique, for example (Ibrahim et al., 2006; Bing et al., 2005; Grimsey and Lewis, 2002; Hodge and Greve, 2007; Karim, 2011).
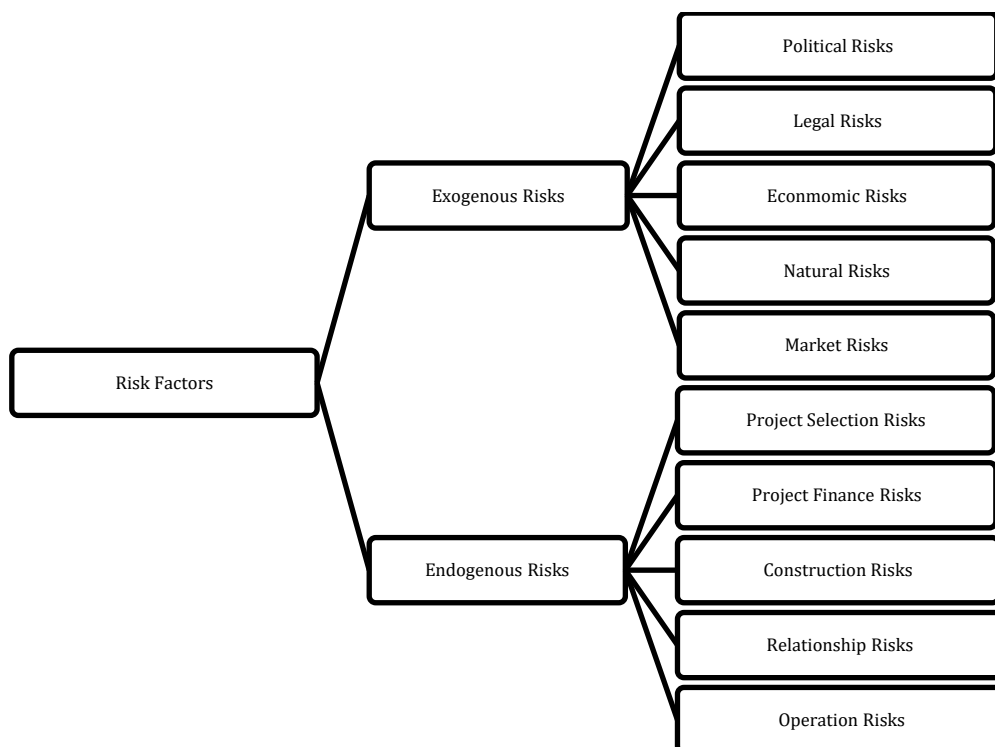

Fig. 1: Risk classification in PPP projects

3. Methodology

Mapping procedures are a form of qualitative research technique. Risk mapping is an interactive method that uses prevailing knowledge to generate visual and non-visual risk maps and data for examining situations of project risk. The mapping research technique enables us to demonstrate the way particular risk determinates influence project prices or other features, as well as the variations in these maps with the passage of time by observing the way risks' interaction varies with internal and external project environment. When this research process is followed, rich and astonishing risk interaction outcomes are attained. Following this step, the complex impact of risk factors on one another will be evaluated. To determine the effect of these risks on the actual cost of construction, the system dynamics model will be used. Fig. 2 demonstrates the process employed by this paper to identify the correlations among the construction costs and their related risk determinateness. Obtaining knowledge regarding the risks and their interaction is the foremost step. This was followed by performing an extensive literature review to obtain extensive understandings regarding appropriate risk factors categorization which provides increased capacity for more precise risk control to attain VfM. A matrix of the impact of risk factors on one another and on the construction price unit is developed in the subsequent step. Risk maps are then drawn in the third step. Lastly, the system dynamics model is applied through the VENSIM software to achieve project risk outcomes.
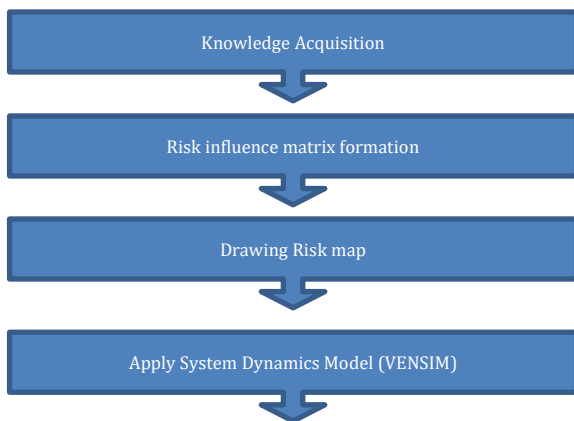

Fig. 2: Research methodology

3.1. Mapping risks into construction price

The complexity of the arrangement pertaining to technicalities, documenting, financing, taxation and sub-agreements that are involved in a PPP project give risk to the majority of the risk in a PPP project, while there are changes in the character of the risk across the life of a project. For example, risks will be involved during the construction stage of a project, and these are different from those inherent in the operating stage (Grimsey and Lewis, 2002).

Throughout the course of a PPP project life cycle, the risks are likely to alter. Sometimes, the infrastructure projects involve major construction and development risks. Usually, highly risky projects include those concerned with IT, restoration of already constructed infrastructure and those involving interface between complex agencies. PPPs mostly involve the assigning of a public sector project's design, structure, functioning, preservation, and investment by the public sector to a private association under a contractual framework. The consideration of risks associated with a PPP project is not only limited to its construction but covers the risks that may emerge during the use of that project by the public over the years. During the construction, a PPP project may face the issue of price and time overruns leading to severe impacts if the risks are not managed in the appropriate manner. The parties involved in the PPP project must be aware of accountability for risk, risky circumstances and risk preferences and they must have the expertise to manage risks.

3.2. System dynamics model

System Dynamics or SD is a recognized strategy that was formulated in the 1950s for managers of the organizations with the aim to assist them in comprehending the systems and processes applied in industries. Presently, it is employed for analyzing and designing policies. It allows managers to frame, comprehend and examine the issues facing the organization.

Presently, the computer simulation used most extensively for the management of complex issues is none other than System Dynamics. System Dynamics aims to identify the circumstances which are favorable for the development of the concerned system. The models representing the system reality act as tools in this method. This system simultaneously and collectively takes into account the associations between various parts of a system instead of considering them individually.

System Dynamics is considered to be highly efficient due to its property of overcoming the barriers of unexpected and uncertain behavior of a system. System Dynamics offers dual benefits of being uncomplicated and sustainable simulation modelling tool which makes its application and testing convenient for modelers. Moreover, this tool can be learnt to be used in some days or months according to the caliber of the user.

The initial step in the working of system dynamics involves the detection of risk. This is followed by considering all trends of the impact that are the major causes of the risk factor. These trends of impact are then simulated to come up with system behavior. This cannot be done by inefficient models. Next, the response of the system in various conditions is observed by placing diverse values for variable factors and by establishing various policies. This strategy can detect the main factors responsible

for a particular issue in the behavior of a system since the external events cannot cause an issue, they can only aggravate an issue associated with system behavior. The VENSIM software is the most extensively employed application of the system dynamics which has become a preference for most of the analysts, professionals and experts around the globe for designing models for multiple domains.

VENSIM offers the professionals a combination of various tools for the generation, testing, analysis and distribution of models. Monte Carlo sensitivity analysis, cause-and-effect diagrams, development of graphical and textual models, a simple simulation of models through subscripts, optimization, application interfaces and data management are some of the tools offered by this application. Advanced features of this application offer superior model resolution and reliability. VENSIM offers original techniques which enable the professionals to identify and avoid errors and to quickly understand the complexities.

Fig. 3 depicts the main idea behind the VENISM model which is the representation of the interrelated risk factors into construction price. Next, the modeler discovers the probable consequences that may emerge from an action by the application of the

Monte Carlo simulation tool. This allows the modeler to recognize the best and worst possible outcomes of action and enables him to identify the actions that may put the entire business at stake. Hence, the modeler can make reasonable decisions in light of the probable consequences of actions.

4. Research finding

Fig. 4 clearly shows the existence of a linear relationship between the extent of risk factors and the actual construction price in case of a PPP project which depicts the change in the estimated price due to the escalation of the impact of risk factors. This study had established an estimated price of 252 SR/m. However, the increase in the risk factor impact increased the estimated price by two folds. Employing VENSIM software and applying 300 iterations in the Monte Carlo Simulation tool, the model performed one simulation followed with 300 more simulations to obtain each probable value of construction unit price for the project under the impact of risk factors.
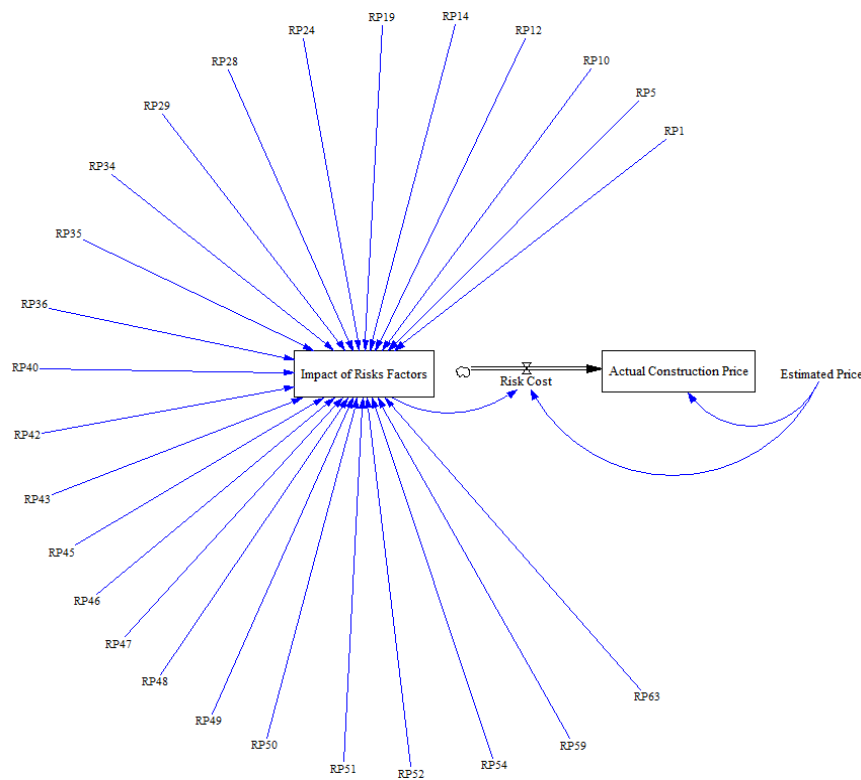

Fig. 3: VENSIM model

5. Discussion

The public and private sectors get numerous opportunities for enhancing their standard of services delivered to the public through the introduction of PPP projects. However, the PPP projects come with a set of risks that may lead to various issues and malfunctioning in the absence of timely detection. Some PPP projects fail to achieve their objectives. Since engineers, designers, and

nature does not behave ideally always, it is sensible to expect some extent of risk. The fact is that we cannot prevent changes from happening but we can make efforts for better management of risks (Karim, 2011). The construction risks associated with a PPP project were categorized on the basis of the asset type by Standard and Poor's (S&P). This indicates the acknowledgment of this relation by investors. It is an established fact that public procurement projects usually face price distress; therefore, it is

essential for such systems to consider price distress during risk analysis. All the parties involved in a PPP project can reap the benefits of value for money project by realizing the dependence of project results on the analysis of risk factors. In case the parties do not acknowledge the significance of risk factor analysis, they are likely to end up with unreasonable pricing and allocation of risk. This calls for the efforts for application of appropriate risk analysis method to certify that the risk analysis is not executed as a formality but actually depicts logical values of project prices and risk prices ultimately leading to the delivery of value for money projects for the public (Victoria, 2001).
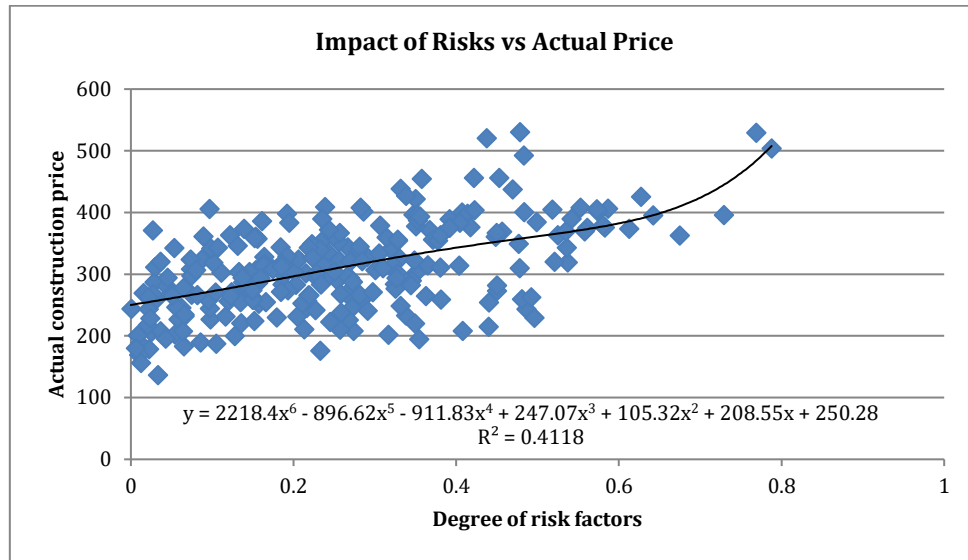

Fig.4: The relationship between risk factors and the actual construction price

System Dynamics proves to be an efficient strategy particularly in case of complex interrelated project risks that could not be mitigated by the conventional approaches. Therefore, System Dynamics has a prominent place in the construction industry due to its ability to manage risks through risk detection, risk estimation, risk pricing and planning the consequences of risks.

As mentioned earlier, the VENISM application includes a Monte Carlo simulation tool which helps the modeler to analyze the risks particularly cost and planning risks. The main feature of this strategy is that it involves multiple simulations that generate data in the form of numerals. Moreover, it allows for making bias-free choices during risk planning. It must be noted that the modeler must ensure the involvement of principal stake-holders associated with the project at the time of using Monte Carlo simulation. The involvement of principal stakeholders is particularly essential when the range values of the risk factors are being established and when deciding on the probability distribution patterns as it leads to the cultivation of stakeholder's trust in the risk management expertise of the project manager and enhances the stakeholder's knowledge regarding the efforts invested by the project manager in context of risk management planning.

6. Conclusion

It is imperative to classify the risks as exogenous and endogenous for the purpose of mapping or analyzing the risks involved in construction projects. Exogenous risks are those that are beyond the control of the organization and stem from external factors. Examples of such risks are weather conditions, fluctuations in market and interest-rate and natural calamities etc. On the other hand, endogenous risks are those that managers can learn to cope with and reduce with their experience and management skills. Such risks can be predicted and controlled and usually arise from the particular contractual aspects of the project. Both these kinds of risks enable the PPP contractors to identify and estimate their risk obligations in the context of the concerned project.

The impact of the risk is intensified with the increase in the interactions among various risk factors. Determining the exact risk through risk analysis becomes complicated while using the conventional model. Hence, we can say that it is appropriate to apply the system dynamics model to precisely analyze the risk.

This assignment intended to highlight the risk analysis and representation of a few risks involved in PPP projects into construction prices. This assignment also highlights the significance of using the system dynamic model as compared to the conventional model by PPP projects for risk analysis particularly regarding the construction price.

Compliance with ethical standards

Conflict of interest

The authors declare that they have no conflict of interest.

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