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A Review of Infrastructure Project Risk Management

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Abstract: Every successful project is highly dependent on the effective management of related risk exposures. The challenge is obviously the task of identifying and assessing the potential risks for projects to ensure that such risks could possibly be mitigated effectively with managerial efficiency. This study provides, a discussion of the various types of potential risks encountered during and throughout the entire course of project management. For that matter, managing infrastructure projects on a large scale, especially those projects which are being funded by Sukuk (Islamic Bond) can be rather complex primarily when dealing with both the project and Sukuk risks during the implementation of these projects. Rigorous review on earlier literature on risk-related were conducted to identify the different types of risk exposures. The types of risk can be identical and possibly encountered when managing infrastructure projects. With the identification of the various types of risk, the stakeholders (owners, joint venture partners, consultants, clients, sponsors and the financiers) could possibly have a much better understanding of the various types of risk involved in managing infrastructure projects, especially at the intiation stage of the projects and also during the preparation of the project charter for infrastructure projects which are being funded by the Islamic capital market.

Key words: Project management, risk management, infrastructure project, Islamic capital market, literature

INTRODUCTION

Risk management is crucial for any project to complete on time in accordance with the schedule set, quality expected and with the estimated budget allocated. Risk identification and the formulation of risk management program for projects is crucial for the ultimate achievement of objectives for the entire project carried out by the party or parties concerned. It is highly important that all the potential risk exposures of such a project are well identified and assessed. In turn, as such a process could possibly assist the party concerned in the effective management of projects from the simple category to even the most complex ones. The owners, joint venture partners, consultants, clients and the financiers of such projects have to mitigate the potential risk exposures effectively to ensure that all the projects carried out are being well implemented and successfully completed on time according to the schedule set. There are numerous studies on risk management involving new types of risk in relation to infrastructure projects (Craciun, 2011). The construction industry is one particular industry that is seen, as being able to complete on time many of the various types of infrastructure projects worldwide. Among these projects are risk management related projects such, as the risk modeling projects faced by the Indian construction companies in their task of assessing the various types of international projects (Jha and Devaya, 2008), risk assessment for construction joint venture in China (Shen *et al*., 2001), risk management in the oil and gas construction projects in Vietnam (Nguyen *et al*., 2007), key risk identification in construction projects, operational risks for highway projects in Malaysia, risk assessment model for the railway reconstruction project in Taiwan (Lu *et al*., 2010) and risk-related projects in respect of the construction project procurement process and mitigation methods (Khumpalsal, 2007). Nevertheless, the available literature suggest that studies in this particular area of infrastructure project risk management is still lacking, especially the aspect of looking into the specific risks pertaining to infrastructure projects from both the

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technical and social viewpoints. This study, therefore provides an analysis and critical insight of the various types of risk exposures and appropriate classifications or risk including the challenges in carrying out the infrastructure projects effectively and successfully.

INFRASTRUCTURE PROJECT RISK EXPOSURES

According to Chapman and Cooper (1983), risk is defined as exposure to possible economic or financial loss or gains, physical damage or injury, delay as a consequence of the uncertainty associated with pursuing a certain course of action. Risk can also be referred to exposure to losses that occur in a project (Webb, 1994; Chapman and Ward, 1997). Risk can also mean, as unexpected events that occur in projects that could result in either positive or negative outcomes causing deviation from the original plan of the project (Webb, 1994; Chapman and Ward, 1997). As positive outcomes are opportunities, negative outcomes can be viewed as a threat to the well-being of the project which can result in a loss. Williams (1995) on the other hand, suggests that risk focuses on the avoidance of loss from unexpected events.

It must be mentioned that risk essentially occurs at the different stages of an infrastructure project. In some cases, however the effect of risk can be observed from the patterns of cash flow. This can be seen mainly from the implementation stage that is during the construction stage of the infrastructure project itself. In this regard, Sorge (2004) asserted that for an infrastructure project, the risks encountered in the construction stage are technological and environmental risks while market risks are the most common type of risk during the operation stage (fluctuations in the prices of inputs or outputs) and political risks. This explains why capital expenditures are the main focus in the initial phase of construction and when revenues start to accrue only during the operation phase of the entire infrastructure project. It is interesting to note that this situation is most common in the concession of highway projects, privatized state water projects and independent power plants.

All projects, however are definitely exposed to both internal risks and external risks. In this respect, internal risks include financial, design, contractual, construction, personal, parties involved including operational risks (Nguyen *et al*., 2007). External risks on the other hand are related to economics, social, political, legal, public, logistics and environmental (Nguyen *et al*., 2007).

Importantly, most of the infrastructure projects are exposed to high risks because of the large capital investment involved and also the involvement of many stakeholders including, the use of complex technology (Nguyen *et al*., 2007). In most cases, however infrastructure projects do have high environmental and social impact (Nguyen *et al*., 2007; Keil *et al*., 1998). This study ranked the various types of risk according to their relative importance in the project managers viewpoints. Out of these risks, the top 5 risk factors which are being ranked include the following: Lack of top management commitment to the project failure to gain user commitment misunderstanding the requirements lack of adequate use involvement and finally failure to manage end user expectation. However, bureaucratic government system and time-consuming project approval procedures, poor design, incompetence of project team, inadequate tendering practices and late internal approval processes from the owners themselves were identified as other major risks in an oil and gas construction project in Vietnam (Nguyen *et al*., 2007) (Table 1).

Table 1: Summary of risk exposures

Researchers	Risks on projects
Sorge (2004)	Construction stage: Technological and environmental risks; operation stage: Market risk (fluctuations in the prices of inputs or outputs) and political risks
Bent (2006)	Major risks: Inaccurate forecasts of project costs, demand and other impact factors
Nguyen *et al*. (2007)	Internal risks: Financial, design, contractual, construction, personal, counterparties and operational risks External risks: Economic, social, political, legal, public, logistical and environmental risks Major risks: Bureaucratic government system and long project approval procedures, poor design, incompetence of project team, inadequate tendering practices and late internal approval processes from the owner were identified
Keil *et al*. (1998)	Major risks: Lack of top management commitment to the project, failure to gain user commitment, misunderstanding of the requirements and lack of adequate use involvement

WHY PROJECT RISK MANAGEMENT IS CRITICAL TO THE OVERALL SUCCESS OF INFRASTRUCTURE PROJECTS?

Infrastructure is the basic physical and organizational structures needed for the operation of a society or enterprise or the services and facilities necessary for an economy to function (O'Sullivan, 2003). The term infrastructure typically refers to the technical structures that support a society among which includes roads, water supply, sewers, electrical grids and telecommunications. Fulmer (2009) defined infrastructure, as the physical components of interrelated systems providing commodities and services essential to enable, sustain or enhance societal living conditions. It is understood that infrastructure function, as supporting

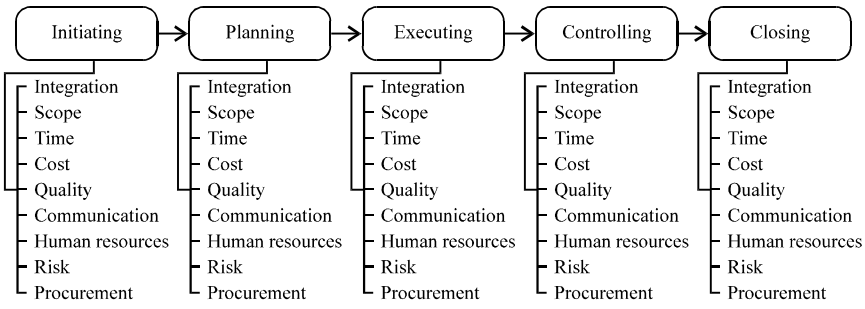

Fig. 1: Risk management process (Kwak and Ibbs, 2002)

facilities to ensure the main activities in the business society can be archived (Fulmer, 2009). For example, the activities of supplying raw material to factory, the facilities needed to transport the raw material to the factory needs good roads, hence the essential construction of roads, as one of the infrastructure projects.

Most commonly, infrastructure project exist in large scale projects. The elements of cost, time, scope and quality of the projects are the primary concern of the project managers and all the stakeholders or owners. A successful project is when the project creating deliverables includes all of the agreed upon by specifications which meet the scope goals. The project in particular should be completed on schedule and predetermined budget (meet both time and cost constraint). Beidleman *et al.* (1990), believed that by formulating the financial package for a complex project and arranging a series of capital market instrument and structures are critically important in financing the project for eventual success. Time and cost overrun during construction may also have a significant effect on the entire operation of a construction project. However, Cervone (2006) stated that when there is excessive schedule pressure, the situation becomes a problem where too much work has to be done but with too little time to ensure the success rate of completion. Compilation task on the schedule and proper time management are pillars of successful project. According to Khumpalsal (2007), changing order profile factors for consideration include cumulative cost, use of money compared with cost-plus and timing frequency. If there are large timing lags between identifying the need and issuance of the order change, this situation therefore heightens the project risk. However, the other consideration of a successful project can be achieved without affecting the project management team (Timothy, 2009).

Project management elements, such as skills, knowledge and techniques are well documented in the literatures known as project management. Project management has been practiced early since civilization. It was in the 1950's that organizations started to systematically apply project management tools and techniques to complex engineering projects. Nevertheless, project management has evolved over time, becoming the principal means of dealing with change in modern organizations.

An important body in the project management defined project management as the application of knowledge, skills, tools and techniques to project activities to meet project requirement (PMI, 2004). Kwak and Ibbs (2002) present project management process in 5 stages:

- Initiating
- Planning
- Executing
- Controlling
- Closing

Figure 1 illustrates the risk management process for a project. It can be noted that at each stage of project management the risk element is inevitably associated with. Risk management is one of the most important elements of project management. As such, risks need to be considered in project management because of the uncertainty and unknown nature of the future problems. Such risks could possibly be avoided or mitigated, as compared to current risks which must be addressed immediately.

Risks differ according to the types of projects (or infrastructure projects) and according to the intensity of the risk exposures to sponsors (Miller and Lessard, 2001). For example, projects for oil platforms are technically difficult. But, they typically have lower institutional risks because of the project locations which are often far from public attention. These projects can be socially desirable and have high revenue for the entire community and country as a whole. On the other hand, although hydroelectric-power projects can be classified moderately risky or difficult, as far as engineering is concerned, it can be very tough in terms of social

acceptability. In contrast, nuclear-power projects will face high technical, social and institutional risks. In other cases, the rock formations in the soil structure usually give road and tunnel systems new road construction very high levels of risk. Market risks faced by infrastructure project like roads, bridges and tunnels are very high, as most of these projects are built by private sponsors under concessionary schemes (Miller and Lessard, 2001). Among the major sources of risks in project management is inaccurate forecasts of project costs, demand and other impacts (Bent, 2006).

Since, a successful project considered the elements of time, cost, scope and quality; project risk management has been seen as a process to manage events which have an impact on project's objectives, such as cost, time, scope or quality (Cooper, 2005; Olofsson and Ohman, 2007; Perminova *et al*., 2008). It is not new that the concept of project risk management involves understanding potential problems that might occur on a project and how these risk impede project success (Tah and Carr, 2000).

Project risk management is the overall process of analyzing and addressing the risk (Charette, 1989). This process has three major components: Assessment, mitigation and contingency planning (Charette, 1989). However PMI (2004), listed 4 elements in the risk management step; risk identification, analysis, response planning and monitoring and control. The latest definition and structured approach can be clearly illustrated in the ISO-31000: 2009 which is the world 1st risk management standard comprising essential features and elements of world's best practices on risk management (ISO-31000, 2009). Timothy (2009), describes that a project manager uses risk management first by identifying all risks in the projects. Once the risks are identified, each risk will then be analysed, according to the levels of critical risks by either using the judgmental or qualitative approach. The most appropriate risk management method will be used to respond to each potential risk exposures.

The impact of applying risk management on the project success is rather inconclusive. Results by Hobbs and Aubry (2006)'s showed that only 29% of the project offices studied considers managing a risk database to be an important function. Elkington and Smallman (2002), found that there is a strong link between the amount/level of risk management undertaken and the level of project success; more successful projects applied more risk management and a structured approach in responding to risks. However, another study by Grant and Witness (2010) with regard to the extent of project risk management implementation being applied in the construction industry revealed that apart from large-sized and experienced construction contractors, all the construction contractors in small and medium size construction (which are in fact the largest players in the construction industry) actually fall in low implementation of project risk management process. Moreover, it is important to note that risk management will not remove all the risks in the project but instead, such a mechanism was in place to manage the potential risk exposures in a proper manner (Anthony, 2001).

Apparently, the weak management in the administration on the project may take a long time to complete the project (Earl, 1996). Earl (1996), suggests that emotional decision-making of project management makes poor performance in the project itself. According to Beidleman *et al*. (1990) when a financial or a project contractor wants to win in the bid of a project, it will be a high risk and expensive for the projectcost. Bing *et al*. (1999) on the other hand, suggest that the lack of management competence and resources could have an impact on the processes in place. Based on a study by Jha and Devaya (2008), their analysis suggests that poor project management emerged as the most influential factor. The other influential factors are financial capability of local partner and project team cohesion. As such, it will have an effect on both the processing part and eventual decision-making of the project on the whole. Nguyen *et al*. (2007) in turn, asserts that in order for the project to complete successfully, it is critical that every member of the project team has a good understanding of the fundamental requirements of the project itself. This includes among which project planning, organizing, motivating, directing and controlling and equally important, positive attitude.

Misunderstanding in respect of project risk management will be critical to the eventual success of the project concerned. According to Chapman and Cooper (1983), failure to consider any activity in a semi-Markov process framework is a simplification of the inherent problem structure which can cost a great deal in terms of lost insight and make qualification of risk much more difficult. Besides that failure to consider any activity in terms of individual sources of risk heavily restricts the ability to model or understand uncertainty somehow in a descriptive sense and thus, greatly limits one's ability to consider preventive and contingency response decisions hence, the misunderstanding of project requirements (Cervone, 2006). The requirement risks are typically caused by a lack of clear vision on the overall project, lack of agreement on requirement, particularly within the organization, requirements which are not prioritized, development within a rapidly changing business environment using a rigid project management

methodology and also, the inadequate change management processes that do not actually provide documentation for some form of reference later on. Important pieces of information with regard to the project concerned need to be delivered and deliberated clearly during regular meetings with the relevant staffs involved in the project on the whole. It is related with management with regard to the performance incentives or communication about the project itself (Craciun, 2011). Bing *et al*. (1999) put forward that a lack of communication and poor relationship could occur with other parties involved in a project, such as the consultant or designer and subcontractors or suppliers. A strained relationship will occur when the partner goes directly to the client without informing their project associates/counterparts, particularly when the matter is closely related to the contractor client reimbursement.

It must be mentioned that both the economic and financial aspects are deemed critical to the overall performance within the construction project industry. Bing *et al*. (1999), suggest that economic slowdown causes the construction market to shrink. The industry would become more competitive and the contractors profit margin would be reduced. The interest rate will change when fluctuations occur in the economy itself. Based on the price of construction materials is always changing in response to inflation and the relationship between supply and demand in the construction material market. The price will change based on the power of supply and demand in economic terms.

CONCLUSION

Project management is a complex process and involves various types of risks. The common risks involved at the construction stage, include both the technological and environment risks. However, the types of risks faced during the operational stage are market risks and political risks. The internal risks to the infrastructure projects include inaccurate forecasts, design, contractual, personal, counterparts and operational risks. On the other hand, the external risks to infrastructure projects, include economic, social, political, legal, public, logistics and environment risks. However, some of the major risks encountered in many infrastructure projects are bureaucratic government system and long project approval procedures, lack of commitment to the project and incompetence of project team itself.

Such risks need to be given special attention by the project owners concerned, as these types of risks will affect the time, cost, quality and the scope of the project. This is the primary reason why risk management for infrastructure projects is considered very crucial for the successful completion of projects. The equally important risk management processes of identifying, analyzing and assessment of risks must be conducted well in advance before the critical stage of selecting the appropriate risk management method and/or approach.

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