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Risk assessment model selection in construction industry

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ABSTRACT

Construction industry faces a lot of inherent uncertainties and issues. As this industry is plagued by risk, risk management is an important part of the decision-making process of these companies.

Risk assessment is the critical procedure of risk management. Despite many scholars and practitioners recognizing the risk assessment models in projects, insufficient attention has been paid by researchers to select the suitable risk assessment model. In general, many factors affect this problem which adheres to uncertain and imprecise data and usually several people are involved in the selection process. Using the fuzzy TOPSIS method, this study provides a rational and systematic process for developing the best model under each of the selection criteria. Decision criteria are obtained from the nominal group technique (NGT). The proposed method can discriminate successfully and clearly among risk assessment methods. The proposed approach is demonstrated using a real case involving an Iranian construction corporation.

1. Introduction

The research on projects has expanded during the last decades (Naaranoja, Haapalainen, & Lonka, 2007). A project is an organization of people dedicated to the deployment of a set of resources for a specific purpose or objective (Steiner, 1969). Project management is defined as planning, directing, and controlling resources to achieve specific goals and objectives of the project (Fan, Lin, & Sheu, 2008). Managers need to ensure delivery of projects to cost, schedule and performance requirement. To achieve this involves identifying and managing the risks to the project at all project stages from the initial assessment of strategic options through the procurement, fabrication, construction and commissioning stage (Tah & Carr, 2001). The less "predictable" nature of projects makes them riskier than day to day business activities (Elkington & Smallman, 2002). Risk is a possible undesirable and unplanned event that could result in the project not meeting one or more of its objectives (Teneyuca, 2001). As the underlying concept of risk management is to manage risks effectively, risk management is a critical part of project management (Lyons & Skitmore, 2004).

Construction industries, face a lot of inherent uncertainties and issues like company's fluctuating profit margin, competitive bidding process, weather change, productivity on site, the political situation in a country, inflation, contractual rights, market competition, etc. Thus the construction industry, more than others, has been plagued by risk (Carr & Tah, 2001) and there is no construction project with risk free (Lam, Wang, Lee, & Tsang, 2007).

With the rapid advancement in the construction industry, an increased number of uncertainties are bound to occur (Thevendran & Mawdesley, 2004). It is essential that the construction companies conquer these risks and uncertainties in order to assess the effect of these sources in order to decide which of the projects is more risky, plan for the potential sources of risk in each project and manage each source during construction (Zayed, Amer, & Pan, 2008). Therefore it is paramount for construction companies to be sensitive to the issue of embracing and managing uncertainty and risk discussed above.

Project related risk management has attracted steady stream of interest in the academic literature (Bannerman, 2008). One of the major steps in project risk management is to identify and assess the potential risks (El-Sayegh, 2008). Despite many scholars and practitioners recognizing the risk identification methods and assessment models in projects insufficient attention has been paid by researchers to select a suitable risk assessment model. This paper attempts to address this limitation and the gap in the current literature and provide a framework for determining optimal risk assessment model.

In Section 2, some relevant literature is described. In Section 3, the problem of the risk assessment model selection is introduced. Section 4 concentrates on the proposed model. A real case study is presented to illustrate the application of the proposed method in Section 5. In the final section some conclusions are drawn.

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2. Literature review

2.1. Risk

The concept of risk became popular in economics during the 1920s. Since then, it has been successfully used in theories of decision making in economics, finance, and the decision science (Ngai & Wat, 2005). Risk has different meaning to different people; that is, the concept of risk varies according to viewpoint, attitudes and experience. Engineers, designers and contractors view risk from the technological perspective; lenders and developers tend to view it from the economic and financial side (Baloi & Price, 2003).

The traditional view of risk is negative, representing loss, hazard, harm and adverse consequences. But some current risk guidelines and standards include the possibility of upside risk or opportunity, i.e. uncertainties that could have a beneficial effect on achieving objectives (Hillson, 2002). Project risk is defined by Project Management Body of Knowledge (PMBOK) published by the Project Management Institute (PMI) as an uncertain event or condition that, if it occurs, has a positive or a time, cost, span or quality, which implies an uncertainty about identified events and conditions. PMBOK describes risk through the notion of uncertainty; however, these two phenomena are not synonymous (Perminova, Gustafsson, & Wikstrom, 2008). According to the Olsson (2007) and Hillson (2004) attempts to link risk with uncertainty based on the distinction between aleatory and epistemic uncertainty in the following couplet:

- Risk is measurable uncertainty.
- Uncertainty is immeasurable risk.

This implies that, when measurable, an uncertainty is to be considered a risk. PMBOK's definition of risk and uncertainty is the considered definition through the entire paper because this definition implies that risk is quantifiable and lends itself to assessment.

2.2. Risk management

If a risk is not identified it cannot be controlled, transferred or otherwise managed (Bajaj, 1997) and trying to eliminate all risks in projects is impossible. Thus, there is need for a formal risk management process to manage all types of risks. The project success usually depends on the combination of all risks, response strategies used to mitigate risks and a company's ability to manage those (Dikmen, Birgonul, & Han, 2007). Hence, the underlying concept of risk management is to manage risks effectively (Thevendran & Mawdesley, 2004). Risk management can lead to a range of project and organizational benefits including: (Bannerman, 2008)

- Identification of favorable alternative courses of action.
- Increased confidence in achieving project objectives.
- Improved chances of success.
- Reduced surprises.
- More precise estimates (through reduced uncertainty).
- Reduced duplication of effort (through team awareness of risk control actions).

PMBOK included risk management as one of the nine focuses in project management and described it as the process concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project (Zou, Zhang, & Wang, 2007). Risk management in construction is a tedious task as the objective functions tend to change during the project life cycle, and the scenarios are numerous due to sensitivity of projects to uncontrollable risks stemming from the changes in the macro-environment, existence of high number of parties involved in the project value chain, and one-off nature of the construction process (Dikmen, Birgonul, Anac, Tah, & Aouad, 2008).

Project risk management is an integrated process which includes activities to identify project uncertainty, estimate their impact, analyze their interactions, control them in the execution stage, and even provide feedback to the maintenance of collective knowledge asset (Williams, 1995). Risk management based on consensus in the literatures, used the following three-step approach (Zayed et al., 2008):

- Risk identification.
- Risk assessment.
- Risk mitigation.

The first step in risk management is risk identification. Before risks can be managed, they must be identified. Identification surfaces risks before they become problems and adversely affect a project. It refers to the evidences from previous experience or similar cases which would apply to the current project, in order to avoid or ameliorate the probability of compromising the project's success.

Construction risks can be categorized in a number of ways based on the source of risk, impact of risk or by project phase (Klemetti, 2006). In the most reference one, project risks are divided into two groups, according to their source, into internal and external. Internal risks are initiated inside the project while external risks originate due to the project environment (El-Sayegh, 2008). In risk identification step all internal and external risks must be identified. After the establishment of a list of risk events that had actually occurred in the process of project performance, these risks must be assessed.

The primary objective of risk assessment is to estimate risk by identifying the undesired event, the likelihood of occurrence of the unwanted event, and the consequence of such event. Risk assessment involves measures, either conducted quantitatively or qualitatively, to produce the estimation of the significance level of the individual risk factors to the project, so as to produce the estimation of the risk of the potential factors to project success. However, this step results will become the input to the determination of the optimum decision. With a better quantification measuring result, the managers can recognize which risks are more important and then deploy more resources on it to eliminate or mitigate the expected consequences.

The identification and assessment of project risk are the critical procedures for projecting success, and they usually become the essential factors in the decision-making process (Williams, 1995). Most authors refer to the processes which include risk identification and assessment, as the stage called "risk analysis". Risk analysis can provide insight to the specific sources of project risk and enable management to devise targeted remedial action.

Several methods have been proposed and utilized thorough research by a lot of scholars to help contractors and subcontractors to evaluate and select the best projects in order to decide which projects are more risky. And so these models help to plan for the potential sources of risk in each project and manage each source during construction. Currently project management teams have more options from which to choose.

Risk assessment methods have ranged from simple classical methods to fuzzy approach mathematical models. Many construction project risk assessment techniques currently used are comparatively mature tools (Zeng, An, & Smith, 2007).

Monte Carlo Simulation (White, 1995), Sensitivity Analysis (White, 1995), Critical path method (Kaufmann & Gupta, 1988), Fault tree analysis (Terano, Asai, & Sugeno, 1992), Event tree analysis (Huang, Chen, & Wang, 2001), Failure mode, effects and