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Managing project risk using combined analytic hierarchy process and risk map

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ABSTRACT

The main purpose of the study is to develop an integrated framework for managing project risks by analyzing risk across project, work package and activity levels, and developing responses.
Design/methodology/approach: The study first reviews the literature of various contemporary risk management frameworks in order to identify gaps in project risk management knowledge. Then it develops a conceptual risk management framework using combined analytic hierarchy process (AHP) and risk map for managing project risks. The proposed framework has then been applied to a 1500 km oil pipeline construction project in India in order to demonstrate its effectiveness. The concerned project stakeholders were involved through focus group discussions for applying the proposed risk management framework in the project under study.
Findings: The combined AHP and risk map approach is very effective to manage project risks across project, work package and activity levels. The risk factors in project level are caused because of external forces such as business environment (e.g. customers, competitors, technological development, politics, socio-economic environment). The risk factors in work package and activity levels are operational in nature and created due to internal causes such as lack of material and labor productivity, implementation issues, team ineffectiveness, etc.
Practical implications: The suggested model can be applied to any complex project and helps manage risk throughout the project life cycle.
Originality/value: Both business and operational risks constitute project risks. In one hand, the conventional project risk management frameworks emphasize on managing business risks and often ignore operational risks. On the other hand, the studies that deal with operational risk often do not link them with business risks. However, they need to be addressed in an integrated way as there are a few risks that affect only the specific level. Hence, this study bridges the gaps.
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1. Introduction

The success parameters for any project are on time completion, within specific budget and with requisite performance (technical requirement). The main barriers for their achievement are the changes in the project environment [1]. The problem multiplies with the size of the project as uncertainties in project outcome increase with size [2]. Large-scale construction projects are exposed to an uncertain environment because of such factors as planning and design complexity, presence of various interest groups (project owner, owner's project group, consultants, contractors, vendors etc.), resources (materials, equipment, funds, etc.) availability, climatic environment, the economic and political environment and statutory regulations [3]. Although risk and uncertainty affect all projects, size can be a major cause of risk [4]. Other risk factors include the complexity of the project, the speed of its construction, the location of project, and its degree of unfamiliarity [5].

Although today's organizations appreciate the benefits of managing risks in construction projects, formal risk analysis and management techniques are rarely used due to lack of knowledge and to doubts on the suitability of these techniques for construction industry activities [6]. Managing risks is one of the most important tasks for the construction industry as it affects project outcomes. Today's project managers believe that a conventional approach to project management is not sufficient, as it does not enable the project management team to establish an adequate relationship among all phases of the project, to forecast project achievement for building confidence of the project team, to make decisions objectively with the help of an available database, to provide adequate information for effective project management and to establish close co-operation among project team [5].

The current literature on project risk management consists of empirical researches on risk management practices of the con-

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struction industry, and conceptual and applied frameworks of risk management using various mathematical models [7]. Recently, Thuyet et al. [8] demonstrate risk management practices in oil and gas construction projects in Vietnam, Zayed et al. [2] show management of risks that are inherent in Chinese highway projects, and Dey [9] illustrates risk management in Indian construction projects in oil industry. The Project Management Body of Knowledge [10] introduces a six step method of risk management. The steps are very generic and act as a guide line for managing the risk of any project, but fail to provide a detailed framework for risk management of a specific project in terms of selection and use of specific tools for managing risk. Although various authors introduce tools and techniques for risk identification, risk analysis and risk responses development, there is very little work on developing integrated risk management approach. Moreover in many cases, the tools were developed in the 1960s [11]. Recently, many authors contributed to risk management knowledge with a specific focus on either schedule or cost for addressing construction risk management. Nasir et al. [12] emphasize on schedule risk and whereas Tummala and Leung [13] emphasize on cost risk. Their approaches have limited applications as project risk management needs to consider time, cost and quality in an integrated way. Moreover, although there are a few studies [14] that analyze risk quantitatively, but according to author's knowledge there are very few studies that link risk analysis outcomes with the risk response strategies. An integrated approach to project risk management not only combines the risk management processes (identification, analysis and development of responses) in an analytical framework, but also integrates the risk management processes with the entire project management processes.

Moreover, both business and operational risks constitute project risks. In one hand, the conventional project risk management approaches emphasize on analyzing business risks in the project selection phase and often ignore operational risks and on the other hand, the risk analysis during implementation phase emphasizes on operational risk analysis without any consideration to business risks. Actually, business risks affect project as a whole and operational risks affect specific work package and/or specific activities. Therefore, an integrated approach that helps analyzing risk in every level (project, work package and activity) across project feasibility, detailed planning and implementation phases must be adopted. The current approaches to project risk management lack this. The objective of this study is to develop an integrated framework for managing project risk covering project, work package and activity levels.

The paper has been organized in the following way. Section 2 demonstrates the literature review and identifies the gaps of knowledge in the area of project risk management. Section 3 elaborates the methodology for this research. Section 4 introduces the conceptual framework for project risk management. Section 5 demonstrates the application of the proposed framework. Section 6 provides a detailed discussion and conclusion on the application of the proposed framework.

2. Literature review

Risk management is the systematic process of identifying, analyzing and responding to project risk. It includes maximizing the probability and consequences of positive events and minimizing the probability and consequences of adverse events to project objectives. Risk management has six steps. They are risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, risk monitoring and control [10]. The detailed description of the above steps is available in Project Management Body of Knowledge (PMBoK), 2000 [10]. The AS/NZS ISO 31000 [15] sets out five steps for risk management – establish the context, identify the risks, analyze the risks, evaluate the risks, and treat the risks.

In the past, a number of systematic frameworks have been proposed for use in the risk-evaluation phase of the risk management process. Kangari and Riggs [16] classified these methods into two categories: classical models (i.e. probability analysis and Monte Carlo simulation), and conceptual models (i.e. fuzzy-set analysis). They noted that probability models suffer from two major limitations. Some models require detailed quantitative information, which is not normally available at the time of planning, and the applicability of such models to real project risk analysis is limited, because agencies participating in the project have a problem with making precise decisions. The problems are ill defined and vague, and they thus require subjective evaluations, which classical models cannot handle. There is, therefore, a need for a subjective approach to project risk assessment, with there being the necessary objectivity in the methodology. The analytic hierarchy process as shown by Mustafa and Al-Bahar [17] and Dey et al. [18] provides both a subjective and objective approach to risk analysis using expert judgement. However, their approaches fail to integrate risk analysis with the project management processes. Tummala and Leung [13] developed a methodology for risk management governing risk identification, measurement, assessment, evaluation and risk control and monitoring. They have applied the framework for managing cost risk for an EHV transmission line project, but did not integrate cost risk with schedule and project quality. Dey [4] proposed a combined AHP and decision tree approach to manage risk, which quantifies both probability and impact of risk. This framework deals with both time and cost parameters of projects. However, it cannot be applied in analyzing project level risk for selecting least risky project. More recently, Dey and Ogunlana [31] applied risk management for managing build-operate-transfer projects and suggested a framework for selecting most suitable risk management method. However, this does not help much to manage risk across each level of projects. Mohanty et al. [19] proposed a fuzzy-ANP-based approach to R&D project selection, Zayed et al. [2] applies the AHP for assessing risk in Chinese highway projects, and Chin et al. [30] proposed an evidential reasoning-AHP system for NPD project screening model. These frameworks prioritize risk factors and ranks alternative projects. However, their approaches does not discuss on managing projects effectively using risk management methodology.

In summary, there are two approaches to project risk management – project level risk analysis and work package level risk analysis, which are carried out during the feasibility analysis and implementation phases, respectively. Project level risk analysis helps select least risky project and eliminate the residual risks. However, project level risk analysis reveals mostly the business risks, which are external in nature covering market, economical, technological, environmental and political factors. Although it helps identify the least risky project, but it fails to identify operational risk factors that become vulnerable in the later phase of the project. On the other hand, work package level risk analysis in the implementation phase of the project reveals mainly operational issues. This has two concerns – business issues identified in this phase are too late to address as there may not be any feasible solution other than abandoning the project and the response development for addressing operational risks are often constrained by the business risks. Moreover, the current literatures demonstrate applications of various tools and techniques in managing project risk, but none of the research reports risk analysis across various levels in an integrated way, which helps identify the least risky project alternative, critical work packages and activities along with the associated risks during the early project phase. This study is for bridging this gap.

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