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A Review Paper on Identification, Analysis and Management of Risks Involved in Construction of a Highway Project

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Abstract

Risk events associated with road construction and highway construction projects have a major impact on is-sues related to cost, time and quality of project. The various major risks associated with the highway project in India are, financial risk, design risk, operational risk, contractual risk, land acquisition, accidents etc that impact on the objective of project. This paper covers the various risk identification and mitigating techniques such as A.H.P method that gives the impact of severity and its probability of occurrence. Statistical Package for the Social Sciences (SPSS) software will be used for analysis of various risk factors from Questionnaires survey data for preventive measures or mitigation techniques for various risks on construction site. The responses provided both quantitative and qualitative data from several highway construction projects completed in the past. Statistical dependency correlation analyses are showed that the use of risk assessment in the reported projects has improved quality of project and construction management.

Keywords: *Risk management, highway projects, SPSS, Risk priority matrix AHP*

1. Introduction

Risk management is the systematic process that identifies, analyse, and respond the risk in project. It includes maximizing the consequences and probability of positive events and minimizing the consequences and probability of negative events to project objectives. Risk management is one of the most critical factors in project management practices to verify a project successfully completed. Risks that occur in highway projects will lead to inability to achieve desired project objectives. Delays, cost overruns and reduction of availability of resources are negative effect of risk in highway projects. Ashley et al. (2006)[1] have emphasized the importance of risk assessment, risk allocation, and risk management in effective management of highway construction projects.

A risk is defined as the combination of probability of an event and its impacts on project objectives. A positive event indicates opportunity whereas a negative event indicates threat. Risk can also be defined as an uncertain event or condition that, if it occurs, has a positive or a negative effect on a project objective. Project risk management includes the processes concerned with identifying, analyzing, and responding to road project risk. It includes maximizing the results of positive events and minimizing the consequences of adverse events

An effective risk management method can help to understand not only what kinds of risks are faced, but also how to manage these risks in different phases of a project.

The benefits of the risk management process include identifying and analyzing risks, and improvement of construction project management processes and effective use of resources.

Project Management Institute (PMI 2004)[2] defines project risk as an uncertain event or condition and that its occurrence has positive or negative effect on at least one project objective, such as time, cost, scope, or quality.

2. Literature Review

The review of literature includes internet, books, journal articles, and magazines articles, on Risk Management in Construction of Highway Projects. Specifically, the research is divided in three areas of Risk Management for discussion that are:

1. Project risk Management
2. Risk management in highway construction project
3. How to turnaround a project in success.

Risk identification is the first step to conduct and collect a list of the most significant uncertainty factors and their descriptions. Tah (2001)[3] tells in HRBS the project risks are categorized to internal and external risks. External risks are those which are relatively uncontrollable and due to their nature there is a need for continual scanning and forecasting of these risks as like as economic risks, political risks, etc. internal risks are relatively more controllable and vary between projects. Internal risks are divided to local and global risks.

Flanagan & Norman (1993)[4] has differentiated between risk and uncertainty. Risk has place in calculus of probability, and lends itself to quantitative expression. Uncertainty, by contrast, might be defined a situation in which there are no historic data or previous history related to the situation being considered by the decision maker.

If the probability of occurrence of Event of any project is 100% then the event is said to be Certain but it is totally uncertain if the probability of occurrence is 0%. The uncertainty varies quite widely in between these extremes.

Abdou (1996)[5], classified construction risks into three groups, i.e. construction finance, construction time and construction design.(Bennett J.C. et al. 1996), told that the techniques to analyse risk can be either qualitative or quantitative depending upon the information available and the level of detail that is required. Statistical approach is the main idea for quantitative techniques. Some tools for this technique are Monte Carlo Simulation (D.White, 1995), Fault and Event Tree Analysis (Bennett J.C. et al. 1996, D.White, 1995), Sensitivity Analysis (D.White, 1995), Annual Loss Expectancy (R.K.J.R. Rainer, et al. 1991), Risk Exposure (B.W. Boehm, 1989), Failure Mode and Effective Analysis (D.White, 1995) etc.

Akintoye and MacLeod (1997)[6] studied the identified risks and found that contractors and project managers in the UK use identified risk as the liability or probability of unforeseen factors occurring, which could negatively affect the successful completion of a project in terms of cost, time, and quality, and concluded that analyzing and controlling risks are the key to improving profit. Kangari (cited in Rwelamila & Lobelo, 1997) described the cause of risk threat:

(1)Industry highly sensitive to economic cycles

(2)Brutal competition as result of an over-capacitated market

(3)Management problems

(4)Accounting, where inconsistencies occur in the financial data generated for management

(5)Increase in project size.

(6)Moving into new type of construction

(7)Unfamiliarity with new geographic area.

(Wang and Dulaimi, 2004)[7] concluded that Risk Management process is a formal process, by which we can obtain identification, analysis and response to risks, throughout the lifecycle of a project, in order to obtain the optimum degree of risk elimination, mitigation and control.

(Turnbaugh, 2005)[8] stated that a simple, common and systematic approach to risk management, suggested by Turnbaugh, has three basic stages:

i. Risk Identification – determining the types of risks, identify, and impose the potential risks in the project.
ii. Risk Quantification – the probabilistic characteristics and the degree of the impacts for their impacts.
iii. Risk Response and Development Control – defining opportunities for managing changes in risk during the project life cycle.

In project management context, Niwa (1989)[9] and Wideman (1992), Project Management Institute (PMI 2000), the Association for Project Management defined project risk as the chance of certain occurrences negatively affecting project objectives or cause a failure to meet the project's objectives. Several definitions of project risk given by Baloi and Price (2003)[9], Barber (2005)[9], (Osipova 2008)[9], Chapman and Ward (2002), Flanagan and Norman (1993), IEC (2001)[9], Jaafari (2001), PMI (2000)[9], Smith et al. (2006)[9] have a common feature: they define risk in terms of uncertain events and their impact on a project's objectives. Project risks are uncertain events or conditions that may have an impact on one or several project objectives.

Risk classification is an important step in the risk management process, In order to manage risks effectively; many approaches have been suggested in the literature for classifying risks. According to Smith et al. (2006)[10] all project risks can be divided into three main categories: known risks, known unknowns and unknown unknowns. The difference between the categories is the decreasing ability to predict the risks. A known is an item or situation containing no uncertainty. Unknowns are things we know but we do not know how they will affect us. A known-unknown is an identifiable uncertainty. An unknown-unknown is simply an item or situation whose existence has yet to be encountered or imagined. Taking into account the probability of the occurrence and the consequence for project objectives, those events that have high probability and high impact are subject to risk management.

The PMI (2000)[11] classified risks as internal or external. Internal risks are those that arise within the scope and control of the project team. Most internal risks can be referenced to a specific project document such as a cost estimate or a schedule. Internal risks usually refer to items that are inherently variable External risks are items that are generally imposed on the project from establishments beyond the limits of the project. Interactions with regulators are typical external risks. Funding constraints and restrictions are other common external risks. External risks tend to refer to items that are inherently unpredictable but generally foreseeable (Caltrans 2007). (J.H.M Tah and V.Carr, 2000)[12] uses a hierarchical risk breakdown structure to classify risks according to their original and to the location of their impact in the project. The hierarchical risk breakdown structure (HRBS) allows risks to be separated into those that are related to the management of interval resources and those that are prevalent or standard in the external environment .External risks are relatively uncontrollable and internal risks are relatively more controllable and vary between projects. Also Hertman stated that contract clauses are estimated to raise project lost by 8-20% of the total cost.

Boehm (cited in Raz & Michael, 2001)[13] suggested a process consisting of two main phases: risk assessment, which includes identification, analysis and prioritization, and risk control which includes risk management planning, risk resolution and risk monitoring planning, tracking and corrective action.

Chicken and Posner (cited in Greene, 2001)[14] provide their clarification of what a risk constituents: Risk = Hazard x Exposure.

They defined hazard as “the way in which a thing or a situation can cause harm”, and exposure as “the extent to which the likely recipient of the harm can be influenced by the hazard”. Harm is taken to imply injury, damage, loss of performance and finance, whilst exposure infuses (imbues) the notions of frequency and probability. Risk is the triple characteristic of any project decision in the situation of uncertainty. It can be defined as a trinity of risk event (A), risk probability (P) and function of risk losses (u):

R = (A, P, u).

Dubois and Gadde (2001)[15] found that complexity in construction projects emerged from two basic sources: independence of tasks and uncertainty. Uncertainty has four main sources: unfamiliar management with local policy and environment, lack of detailed specifications about the tasks at the construction site, lack of uniformity of materials, work and teams and unpredictability of environment. The most characteristic paradigm of a structured risk allocation is the Risk breakdown Structure (RBS). The RBS defines as a hierarchical structure of risk sources in a project, in which every lower level of it contains a specific risk group. (Hillson, 2002). It is an open, flexible and easily updateable structure, in which all types of risks can be classified and categorized, and finally helps the risk grouping for better cause-effect determination.

According to Smith et al. (2002)[16], Risk is an unforeseen event that occurs during the process of construction projects. Study shows that construction industry is subjected to more risk and uncertainties than any other industries. The reason for that is mainly due to complex nature of construction business activities, process, environment and organization. Risks that occur in highway projects will lead to inability to achieve desired project objectives. Delays, cost overruns and reduction of availability of resources are negative effect of risk intrinsic (inherent, essential) in highway projects.

Tzavi, Aaron J. Shenhar and Dov Dvir (2002)[17] have analyzed about risk management tools and techniques (PROBABILITY IMPACT MATRIX) which have been developed to improve project success. They found that the risk management practices are not widely used and also found that risk management practices were more applicable to higher risk projects. They found some differences according levels of technological uncertainty. They took interviews for data collection and did SWOT analysis, Probabilistic risk analysis and methodical trade-off analysis. The assessment were measured along four dimensions such as meeting functional specification, meeting technical specifications, meeting schedule and meeting planned budget. They suggest that all risk management practices are positively correlated with meeting budget goals in the high uncertainty group, while for the low risk group the correlation is weaker and less likely to be statistical significant.

Project risks are uncertain events or conditions that may have an impact on project objectives (Baloi and Price 2003, Barber 2005, IEC 2001, PMI 2000, SOU 2002, Ward and Chapman 2003)[18]. A risk has a cause and, if it is triggered, also a consequence. Risk management is a formal process directed at identification and assessment of and response to project risks (Baloi and Price 2003, Del Cano and De la Cruz 2002, Flanagan and Norman 1993, PMI 2000, Uher and Toakley 1999, Ward and Chapman 2003). The overall goal of the risk management process is to maximise the opportunities and minimise the consequences of a risk event. Risk identification is aimed at determining potential risks, i.e. those that

may affect the project. There are several approaches to classifying project risks and risk sources (Baloi and Price 2003, Leung et al. 1998, Li et al. 2005, Tah and Carr 2000). In general, the sources of risk in construction projects may be divided into external risks (e.g. financial, economic, political, legal and environmental), internal risks (e.g. design, construction, management and relationships) and force majeure risks. During risk assessment, identified risks are evaluated and ranked. The goal is to prioritise risks for management.

Skitmore and Lyons (2004)[19] noted that usage of risk management varies in the construction industry. They further noted that brainstorming and team analysis for identifying risks are the most frequently risks techniques, computer aided methods are rarely used. Chen *et.al*. (2004) proposed 15 risks concern with project cost and divided them into three groups: resource factors, management factors and parent factors.

Molenaar (2005)[20] emphasized the importance and the effectiveness of using risk management and other cost control processes in lowering the expected costs of projects.

Klemetti (2006)[21] stated that risk management in the construction industry still rely heavily on contract and the industry has the bad reputation of involvement in numerous dispute and claims. He supports and motivates effort to find alternatives methods in managing risks. He further stated that the biggest barrier in construction project risks management are a drive for cost effectiveness; risk management is seen only to consume resources and benefit are difficult to measure in financial terms. Lack of risk management resources and know how restricts the use of risk management techniques. Several studies have shown that there are not enough capable personnel to conduct the risk management process and risk management is only in the hands of a few key people. Hence, this study has the following objectives:

1) To assess factors affecting implementation of risk management practices of highway projects in India

2) To assess if there is any difference in the way stakeholder's management risks associated with highway projects in India.

Vaidya and Kumar (2006)[22] shows AHP(Analytical Hierarchy Process) can be used on six types of decisions; selecting one alternative from many, evaluation of alternatives, benefit-cost analysis, resource allocations, planning and development, and priority and ranking. Fuzzy logic has been applied for risk evaluation in other projects: Mustafa and Al-Bahar firstly applied AHP to evaluate risks in construction projects in uncertain environment in Bangladesh.

Ashley et al. (2006) have emphasized the importance of risk assessment, risk allocation, and risk management in effective management of highway construction projects. Risk management must be forward looking and identify potential problems. Contingency has been used to manage uncertainty and risk in construction projects. To adequately calculate the project contingency, planners should focus on analysing the potential risk drivers. Contingency amount is greatest in the beginning of a project and is gradually reduced as the project is designed, risks are resolved, or the contingency amount is spent.

Wang and Elhag (2007)[23] applied the fuzzy group decision making approach to assess the risks in constructing the bridge. They showed that the fuzzy group decision making approach is flexible, operational, and effective in modelling the risks in bridge construction. Zayed et al. (2008)[23], through identifying two major scopes affecting on highway projects (organization and project as the main level and lower level, respectively) and evaluating their effects on risks, provided a risk model facilitating the evaluation and ranking of the organization's projects. Zayed et al designed the risk model using AHP. Wang et al. (2008) used an integrated AHP and data envelopment analysis (DEA) to evaluate risks in the bridge construction projects.

Azuma and Miyagi (2009)[24] presented a new approach based on AHP for the risk evaluation. In their proposed approach, the traditional AHP evaluation was considered as the utility. Then, degree of importance related to each risk was replaced with the value of utility.

Sharmila Mane and Dr. S.S. Pimplikar (2012)[25] listed the various risk faced in BOT projects into three types as Financial Risk, Political Risk and Technical Risk. Avoidance, Transference, Mitigation and Acceptance are the Risk response strategies followed in India. Delays in approval, Change in Law, Cost overrun, Land acquisition and compensation, Enforceability of contracts, Construction schedule, financial closing, Tariff adjustment and Environmental risk are the critical risks in BOT projects. Mohamed F. Diab, Khaled Nassar (2011,2012) discussed about the need of risk assessment to improve highway construction projects. A survey questionnaire was done to collect the quantitative and qualitative data and 660 professionals were chosen for sample and received responses from 246 people and arrived with 31 risk

drivers which are categorized under five broad categories such as project scope, right of way, utility conflicts, A/E services and project construction management. Hypothesis testing was done for these risk drivers and risks which affect cost and schedule growth of construction project were identified.

Risk management is one of the nine knowledge areas propagated by the Project Management Institute (PMI)[26]. The PMBOK® Guide recognizes nine knowledge areas typical of almost all projects. The nine knowledge areas are:

1. Project integration management.
2. Project scope management.
3. Project time management.
4. Project cost management.
5. Project quality management.
6. Project human resource management.
7. Project communications management.
8. Project risk management.
9. Project procurement management.

Each PMI knowledge area in itself contains some or all of the project management processes.

For example, project risk management includes:

- Risk management planning;
- Risk identification;
- Qualitative risk analysis;
- Quantitative risk analysis;
- Risk response planning;
- Risk monitoring and control.

3. Conclusion

The paper aids in the identification, Analysis of various risk management process used in highway construction which should be prioritized by every highway project. The success of every project is mostly determined by the ability of the construction, team management and by analysing the various risk factors for the successful completion of the project . A project considered to be successful by applying the following suggestions based on the literature review:-

- Adequate planning should be provided before the commencement of project construction.
- Safety, rules and regulations in construction site should fully be maintained from the initial to final stage of construction.

From the above discussion it can be considered that the several risk factors can be identified and assessed by using AHP method as it is the most convenient methodologies in order to evaluate risk issues making the evaluation process more realistic. Risk evaluation is not an exact process and has fuzziness in its body. Here, the usage of fuzzy AHP weights makes the application more realistic and reliable. By using this technique we can reduce or mitigate the risk from the highway project.

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