

PAPER • OPEN ACCESS

Identification of Risks for Indian Highway Construction

To cite this article: Abhay Tawalare 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **471** 102003

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the collection - download the first chapter of every title for free.

Identification of Risks for Indian Highway Construction

Abhay Tawalare ¹

¹ Department of Civil Engineering, Visvesvaraya National Institute of Technology, Nagpur, India

abhaytawalare@civ.vnit.ac.in

Abstract. Highway projects carry out higher risk than other construction projects because they entail high capital outlays and intricate site conditions. Although the research currently available provides many valuable insights into the issue, however identification of risks pertaining to Indian highways construction was neglected. This paper presents the findings of questionnaire survey conducted on the critical risk factors affecting the successful performance of highway construction in India in terms of cost, time and quality. The critical risk factors in Indian highway constructions are change of scope of work, land acquisition delay, poor preliminary soil information and investigations, schedule delay caused by rejection of unqualified materials and change orders by political pressure. Further, critical risk factors were explored through factor analysis and categorized them in five factors viz. construction risk, public sector management risk, engineering risk, resource procurement risk and social risk. The identified risks will be useful to the field engineers for design of proper risk mitigation strategy during planning stage.

1. Introduction

Construction projects are of different sizes and of different nature, hence the risk associated with them also varies. All construction projects are unique and carry their own risks. Such projects involve a number of parties concerned, starting with the owner, contractor, designer, suppliers, and others. All parties involved in a project inevitably carry certain risks. Therefore, it is increasingly important to adopt joint risk management strategies by all stakeholders to achieve intended project objectives without time and cost overruns, [1]. Risk management is a systematic controlling procedure for predicted risk to be faced in a project. It is a stepwise procedure consisting of risk identification, risk classification, risk analysis, and risk response tasks. The risk management process helps project financiers and project teams to make informed decisions regarding alternative approaches to risk involved, in order to increase the likelihood of success of the project in terms of cost, time and quality [2]. Identification of risk is first and essential step of risk management. It helps to tackle them before they affect the project negatively. If a risk is not identified it cannot be controlled, transferred or managed. It is impossible to eliminate all possible risks.

Highway projects carry out higher risks than other infrastructure projects due to high capital cost, high involvement of common public and local political leaders during working. Therefore, risk management is a key issue in highway project management [2]. Mahamid [1] identified the common risks affecting time overrun in road construction projects in Palestine. The top risks were financial status of the contractors, payment delays by the owner, the political situation and segmentation of the



West Bank, poor communication between construction parties, lack of equipment efficiency and high competition in bids. Similarly, Alhomidan [3] conducted a study of factor affecting cost overrun in road construction projects in Saudi Arabia from contractor's perspective. He found that internal administrative problems, payments delay, poor communication between construction parties, and delays in decision making were major factors of cost overrun. Diab et al. [4] identified risks impacting the project performance of large infrastructure projects in terms of cost and time in USA. The major factors contributing the cost and time overrun were changes to unforeseen site environment, poor coordination among utility agencies, designers, and contractors, inexperienced professionals for this type of project, inadequate constructability reviews, unforeseen hazard conditions, inexperienced project manager and safety issues. Mousavi et al. [5] ranked the various risks in highway construction in Iran. The top ranked risks were defective design, errors and rework, changes in design, and failure in transmitting data from preliminary design to final design. Zayed et al. [2] studied risk factors in Chinese highway projects. They found that political risk, financial risk, advancement in technology and resource risk were predominant. Similarly, Wang & Chou [6] carried out study of risks in highway projects in Taiwan. In Taiwan some of the risk that contractor has to bear were unexpected disturbance by a third party, illegal waste disposal, threats by gangs, and requests for contributions to local community. Thus, from the previous studies, it could be concluded that the risk factors in highway projects are varying from country to country depending on economical, political and technological advancement in the particular country. Therefore, country specific study is needed to identify risk factors in highway construction projects.

India's road network of 3.34 million km is the second-largest in the world. During 12th five-year plan (2012-2017), it was planned to increase this network by another 18,637 km out of which 1000 km is an expressway. As per the union budget 2016-17, the Government of India targeted to build 15000 km of roads but could achieve only 8200 km (www.india.gov.in). This shows the government determination to bring out radical changes in highway infrastructure sector. However, at implementation stage this sector has not shown promising picture. In order to meet the set target by government, it is essential that government authorities, contractors and subcontractors to understand sources of risk and plan for the potential risk in each project and manage each risk during construction. However, risk and uncertainty of highway construction projects did not receive attention from researchers in India. Therefore, objective of this paper is to identify critical risk factors associated with highway construction projects in India and classify them as per their source.

2. Risks in highway construction

The construction related risks may be encountered during the construction phase of the project. Site conditions normally affect the productivity during construction. Highway construction on mountainous regions, in tight work spaces, in extreme cold and heat, on rough terrain, on congested work zones, and in close proximity to adjacent structures would normally slow down workers' productivity. Similarly, highway congestion affects the material delivery [7]. Also the labours are required to work around the traffic conditions at the work zone, often requiring night shifts, poses safety risks. Insufficient labours, rework from poor workmanship, lack of equipment efficiency, unavailable construction material, rework from poor material quality poses risk during construction and delays the project [3]. Resources like materials, labour, and equipment are key players in highway construction projects' risk. Shortage of workers, availability of specialty equipment, and delays of materials supply are major risks for contractors [2]. Lack of skilled supervisors, low level of equipment operator skills in particular geographic market poses major risk in terms of quality of work and productivity [1]. Similarly, the labour disputes and strikes is a common social risk due to non-payment of labour wages by subcontractors. These labour contractors lack the knowledge of management and construction. They fail to establish a contractual relationship between the outside contractors and local labours or local contractors and migrant workers [8].

Also, engineering designs have a high level of influence on project cost. Many times fundamental technical data such as hydrology, meteorology provided by the project owners is not detailed. The tender drawings are poorly designed or there is a big oversight results in major design change during construction process. Poor preliminary soil investigations and inaccuracy of existing utility locations

and survey data may cause change of scope of work during construction increases the cost [4]. In developing country most of the construction projects delayed due delay in payment. Progress payments are of high importance to contractors in order to fulfill the high daily expenses. Due to the delay of payments by the owner, work progress can be delayed because there is inadequate cash flow to support construction expenses especially for those contractors who are not financially sound [1]. Several legal factors such as state-specific local ordinances and restrictions are likely to control construction activity and put constraint on target schedule, such limited working hours and restriction on night working [9].

3. Research methodology

For this research, various risk factors in highway construction were identified through literature review. Through these process initially 46 critical risks factors pertaining to highway projects were identified. The critical risks factors were dependent on economical, political and technological advancement in the particular country, it was necessary to decide the relevance of each risk factor in the context of Indian highway construction. This methodology was adopted by Iyer and Jha [10] to identify factors affecting cost performance in Indian construction projects. Therefore, risk factors identified from literature review were discussed in face to face interviews with three highly experienced industry experts. All the three experts were retired Chief Engineers from government organizations working in the highway construction. In this discussion forty (40) factors were finalized to be part of the survey questionnaire and six risks factors were rejected due to non significance in Indian context.

The questionnaire was consisting of two parts. First part was included personal information of the respondent such as work experience, name of organization and type of organization. Second part was aimed to obtain information about risk level in highway construction industry in India. It was asked to rate the identified forty (40) factors according to their level of importance on the given scale i.e. 1- lowest, 2-low, 3-medium, 4-high and 5-highest. The pilot study questionnaire was finalized for investigations after slight modification. The questionnaire was send through email to 150 people consisting of engineers from public sector organizations working in highway construction such as National Highway Authority and State Highway Authorities and contractor companies working in the highway construction sector. The survey was carried out during January to April 2017. In total 84 valid responses received against the 150 approached. In which 52 respondents were engineers from public sectors and 32 respondents were engineers from contractor companies. All the respondents were having considerable experience in the field of road construction as average experience of all the respondents were 15.6 years. The average experience of all the respondents is considerably good and participant respondents were from different geographic regions of India having relevant experience. In addition, consistency in responses adds the credibility of responses received. The data obtained from questionnaire survey was analyzed initially to rank the risks factors as per frequency index. Though, the top ranked risks factors could be considered important, but to extract critical risks factors amongst them, factor analysis was carried out. Prior factor analysis, to check the reliability of scale Cronbach's Alpha test was carried out. The Cronbach Alpha value was 0.936 which indicated that the scale was highly reliable at 5% significance level. Factor analysis was conducted to extract the critical risk factors. Since the factors extracted using principle component analysis was orthogonal and contains large numbers of factors overlapping with various other factors, it was difficult to understand. So, oblique rotation using varimax was employed to extract five factors. The table 1 explains the factor profile with risk and factor loading. The risk having factor loading below 0.55 were rejected for discussion.

4. Results and discussion

It is difficult to draw clear line between risks factors as per categorizations as many risks are overlapping with each other such as the mismanagement of one particular risk is birth source of another risk. The risks are categories in five categories like construction risk, public sector management risk, engineering risk, resource procurement risk and social risk.

4.1. Construction risk

As per factor analysis, change in scope of work is critical risk factor in this category followed by lack of equipment efficiency, bad quality of workmanship and improper construction method. The main reason for change of scope is due to improper site investigation particularly geotechnical investigations. Moreover, most of the times project proposals are prepared in haste due to political pressure to meet the target date for invitation of bid. In addition, during construction local political leaders interfere for change in alignment or demand for additional works changes the original scope. Lack of equipment efficiency, bad quality of work and improper construction methods could be attributed to lack of skilled workers, machine operators, and supervisors. Except, some reputed companies, there is no culture in Indian construction industry to provide training to workers and supervisors from contractor side. There is also shortage of engineers working at junior level who are responsible for most of the site operations. This situation is arising due to availability of more salaried, white collared jobs to engineers in financial and information technology sectors in India. All these factors contribute to adoption of improper construction methods and bad quality of work.

Table 1. Factor profile of critical risk factors

Details of Risk Factors	Factor Loading
Construction risk	
Change in scope of work	0.817
Lack of equipment efficiency	0.728
Bad quality of workmanship	0.681
Improper construction method	0.644
Public sector management risk	
Land acquisition delay	0.737
Lack of coordination between construction parties	0.712
Delay in project permits and approval	0.68
Culture of corruptions and bribes	0.645
Engineering risk	
Poor preliminary soil information and investigations	0.773
Unclear and inadequate details in drawings	0.741
Lack of design quality	0.692
Lack of expert human resources	0.678
Resource procurement risk	
Schedule delay caused by rejection of unqualified materials	0.686
Schedule delay due to late delivery of materials	0.596
Inadequate labour/ skill availability	0.542
Social risk	
Changed orders by political pressure	0.798
Delay due to law suits by land owner's for higher compensation	0.712
Labour absenteeism	0.589

4.2. Public sector management risk

Land acquisition delay is critical risk factor of public sector management risk as per factor analysis. Generally, public sector organizations award contract before 100% of land is acquired or land acquisition process is in progress. While it is sometimes possible to negotiate a price for voluntary sale of a property or Governments have to use their rights to compulsory acquisition (expropriation) of properties for public projects. By its nature, expropriation causes economic loss, social and psychological disruption for the affected individuals and their families. Naturally, the greater the

number of people involved, the greater the disruption and loss or sometimes the owner of land demands for higher compensation. There is lack of coordination among various government departments itself. Though the government authorities such as National Highway Authority and State Public Works Department awards the highway construction in India, contractor has to take various permits and no objection certificate from other Government departments like Revenue Department, Pollution Control Board, Forest department, Electricity Department and Water Supply Department. Similarly, sometimes no objection certificate needs to take from other government authorities like Municipal Corporation and Gram Panchayat. Due to culture of corruption and bribe, contractor has to give bribe to sanction permits. In such situations, contractor adopts various cost cutting measures like use of substandard materials, inadequate deployment of machinery and site engineers to compensate this amount. There is dire need of initiative by government to implement single window clearance system for proper coordination among various government authorities.

4.3. Engineering risk

The critical risk factors in this category are poor preliminary soil information and investigation followed by unclear and inadequate details in drawings, lack of design quality and lack of expert human resources. It is observed that sufficient time is not available to carry out detailed soil investigations as project proposals have to be prepared in very short time due to political pressure. Therefore, the proposals are prepared on limited data of soil investigations. Moreover, there is acute shortage of geotechnical consultancy laboratories at most of the district places and available labs are heavily loaded with works. The government departments adopt standard set of design and drawings for preparation of estimates and same drawings are to be used for construction purposes. These drawings could not show the project specific details. Due to this, contractor has to depend on decisions of Engineer in Charge during execution. This delays the progress of work as well as leave scope for mistakes. To overcome such problems, government department must shift to design build contract from item rate contract.

4.4. Resource procurement risk

The critical risks factors in this category are schedule delay caused by rejection of unqualified materials, schedule delay due to late delivery of materials and unavailability of skilled labour. As country has witnessed considerable economic development during past two decades, to sustain the economic growth government has started number of projects in various infrastructure sectors all over the country. If large number of projects is going on particular geographical region then scarcity of resources like man, machinery and material develops. Because of this material delivery is late at site causes schedule delay. It is observed that many times substandard material arrives at site and its rejection causes schedule delay.

4.5. Social risk

The first critical risk in this category is change orders by political pressure. The experts agreed that many change orders are carried out because of political pressure. However, these changes are nominal modifications in original scope within the authority of Engineer in Charge. Still, the change of scope affects the schedule and cost. In Indian democracy many powers for development have been precipitated to village level through Panchayat Raj System. Therefore, in time changes suggested by local politicians cannot be overlooked. The second critical risk is related to land acquisition for project. Land acquisition is major problem in India as 60% of population is dependent on agriculture due to these land owners are never easily ready for land acquisition. Even if government acquires land forcefully, the owners' files law suits for higher compensation and halts the project. Recently government has carried out many legislation amendments in land acquisition bill to remove the bottlenecks. The third risk in this category is stop of work due to labour absenteeism. There is stoppage of work due to labour holidays during festival season. Diwali and Holi are major festivals in India. During these days, labours do not turn out for work for 15 to 30 days. This affects the schedule of work considerably.

5. Conclusions

The objective of this paper was to identify the critical risk factors that have a potential to affect highway construction in India. In this context various risk factors were established through literature review. Factor analysis was carried out to categorize the critical risks in five factors i.e. construction risks, public sector management risks, engineering risks, resource procurement risks and social risk. This categorization of risks will be beneficial to project manager to decide appropriate risk mitigation strategies for each category of risk. The critical risks identified are change of scope of work, land acquisition delay, poor preliminary soil information and investigations, schedule delay caused by rejection of unqualified materials and change orders by political pressure. However, the study is based on the small sample thus, induces the limitation to study for generalization of results over vast geographic area of the country. Still within this limitation study provides general guidelines regarding various risk factors in Indian highway construction to the field engineers.

Acknowledgement

Author acknowledges the efforts taken by Mr. Anup Bishnoi, M.Tech Scholar, for collecting the data from respondents.

References

- [1] Mahamid, I. (2013). Common risks affecting time overrun in road construction projects in Palestine: Contractors' perspective. *Australasian Journal of Construction Economics and Building*, 13 (2): 45-53.
- [2] Zayed, T., Amer, M. and Pan, J. (2007). Assessing risk and uncertainty inherent in Chinese highway projects using AHP. *International Journal of Project Management*, 26: 408-419.
- [3] Alhomidan, A. (2013). Factors Affecting Cost Overrun in Road Construction Projects in Saudi Arabia. *International Journal of Civil & Environmental Engineering*, 13 (3): 1-4.
- [4] Diab, M. F, Varma, A. and Nassar, K. (2012). Using risk assessment to improve highway construction project performance. *Proceedings of 48th ASC Annual International Conference*.
- [5] Mousavi, S. M., Tavakkoli-Moghaddam, R., Azaron, A., Mojtahedi, S. M. H. and Hashemi, H. (2011). Risk assessment for highway projects using jackknife technique, *Expert Systems with Applications*, 38: 5514-5524.
- [6] Wang, M. and Chou, H. (2003). Risk Allocation and Risk Handling of Highway Projects in Taiwan. *Journal of Management in Engineering*, (19): 60-68.
- [7] Chong, W.K., Lee, S.H. and O'Connor, J.T. (2011). Estimating highway construction production rates during design: Elements of a useful estimation tool. *Leadership and Management in Engineering*, 11: 258-266.
- [8] Zhang, X. (2011). Social risks for international players in the construction market: A China study. *Habitat International*, 35: 514-519.
- [9] Sukumaran, P., Bayraktar, M.E., Hong, T.H. and Hastak, M. (2006). Model for analysis of factors affecting construction schedule in highway work zones. *Journal of Transportation Engineering*, 132 (6): 508-517.
- [10] Iyer, K.C. and Jha, K.N. (2005). Factors affecting cost performance: Evidence from Indian construction projects. *International Journal of Project Management*, 23: 283-295.