Abstract

The infrastructure industry is the key enabler to any country's economic growth. Infrastructure development pertains to various sectors including energy, logistics, telecom, oil and gas, etc. The mega infrastructure development involves high investments in which the gestation period is very high. Logistics infrastructure involves roads, aviation, rail and sea. Infrastructure development involves very high investment; the development projects have to be completed within the designated time, cost and with desired quality which are the three prime objectives of any project. There are many risks involved in the development of these projects, and the assessment of these risks and timely mitigation is very critical.

The purpose of this research is to comprehensively identify and evaluate the risk factors involved in the development of logistics infrastructure projects, assess the priorities of risk factors in logistics infrastructure projects development sector, investigate financial risks faced by professionals in managing risks in the sector, investigate the risk enabling factors and develop a normative risk management framework for logistics infrastructure projects development. The research was conceived based on the need of practitioners to have a robust Logistics Infrastructure Projects Risk Management (LIPRM) framework, which can be deployed to minimize the involved risks.

This research explores various questions like: (i) what the various risk sources are? (ii) what are the various risk drivers? (iii) what are risk mitigation strategies used? Moreover, (iv) what tools/techniques are used to identify and assess risks? Further, in logistics infrastructure development, what is the role of risk enabling factors? In this research, risk management practices are explored in Indian airports, and highway development and a normative strategic risk management framework has been developed for logistics infrastructure projects which will help managers in managing risks in their projects to meet the three objectives, i.e. time, cost and quality.

Literature in the area of risk management in infrastructure projects with a focus on logistics infrastructure brings forward important constructs which are critical in the understanding of risks in such projects. These constructs are risk

sources, risk drivers, risk mitigation strategies, risk assessment tools/techniques, risk management enablers in infrastructure development projects. The primary purpose of the research is to address all these constructs in detail and develop a validated Logistics Infrastructure Project Risk Management (LIPRM) framework empirically for Indian logistics infrastructure industry. The prime objective of this research is to investigate risk management practices related to all these constructs and develop a normative framework for logistics infrastructure projects.

Mixed research method (consisting of both qualitative and quantitative research design) was undertaken to address the above research objectives. Under mixed research design, in-depth survey research method was used to explore the risk management practices in logistics infrastructure projects, as it is a useful method in the exploration of field data. For conducting an in-depth survey with experts, an exhaustive questionnaire was developed. Data were collected from professionals working in various mega logistics infrastructure development industries through the designed questionnaire followed by a detailed interview with these professionals. The researcher gave a brief presentation to each professional stating significance of various attributes of the questionnaire along with the purpose of this research study. Detailed directions were given to fill up the questionnaire. The questions were framed to collect data to detail out the risk sources into three levels viz., risk attributes, risk factors, risk categories followed for risk identification, assessment terms of logistics infrastructure projects. With the limitation of less number of airport development projects, study inputs were extended to highway projects to assess these critical constructs. The interviews covered various aspects of risks in infrastructure development projects including (i) What are the significant risks in logistics infrastructure development projects? (ii) What are the trends, which affect these risks? (iii) What are the current risk mitigation strategies used by infrastructure development professionals? (iv) What are the tools and techniques used by Supply Chain Management (SCM) professionals for identifying and assessing supply chain risks?

Post capturing the data from the experts through means of a questionnaire, interviews, group discussions, structured datasets were created for each

construct. Data throw up 133 risk attributes about logistics infrastructure development projects, which were converged into 29 risk factors and then were classified into 9 risk categories. At each level of data integration, it was revalidated by the experts to ensure that it is on the right track.

The data analysis was conducted at four levels. Initially, the risk factor analysis was conducted using the Probability- Impact (PI) assessment and constructing risk heat maps for each objective (time, cost and quality) on all the 133 risk attributes. Risk heat maps were then drawn for 29 risk factors and 9 risk categories. It was further taken to the next level analysis using Analytic Network Process (ANP) while building interdependencies between the risk categories and arriving on top vital risks affecting the logistics infrastructure projects. Level 3 analysis included financial risk modelling for infrastructure BOT Projects. This analysis provided the factors which impact the financial risk the most and what are the critical aspects which need to be addressed to minimize this type of risk. Risk management practice analysis included critical success factors modelling for infrastructure projects using Bayesian Belief Network (BBN). This working included identifying major critical success factors for risk management and then establishing cause and effect relationships in these factors. The BBN model was developed to assess the relative importance of critical success factors.

The outcome of the multilevel analysis of the expert's inputs provided the strong foundation to develop a normative framework for risk management in logistics infrastructure development projects which was revalidated by the experts. The research outcome has several implications for both practitioners and academicians. The criticality of risk intensity and mitigation changes with the consolidation of risk factors, which is a significant drawback of carrying out risk mitigation exercise at risk's aggregate level. It may give a incorrect indication that there is even no risk in the case assessed at an aggregate level. Further, critical risks in typical logistics infrastructure development have been identified; however, the normative risk mitigation framework will provide improved understanding and alarms on risk factors in these development projects. This framework will help enhance the implementation of risk management in logistics infrastructure projects.