Chapter 2: Literature Review

2.1 Introduction

This chapter presents the theoretical basis of this study through the examination of extant literature and also by obtaining a practitioner insight into the underlying issues of risk management in logistics infrastructure development projects. This literature survey covers various theoretical and practical dimensions of Project Risk Management. This chapter presents the essential tenets of the constructs employed in this research. This chapter first introduces the risk management in infrastructure development projects for conceptual understanding, importance of risk management in infrastructure projects and various risk management practices followed in the industry.

This chapter is structured into 5 sections including introduction, the second section 2.2 provides foundation of project and project risks, Public-Private Partnership (PPP) projects; the third section, i.e. Section 2.3, provides understanding on Project Risk Management (PRM); Section 2.4 integrates the previous two sections and provides foundations of the risk management in logistics infrastructure projects. This section introduces industry practices, risk awareness, PRM frameworks and further sub-sections present extant literature review on important constructs of PRM concerning logistics infrastructure industry, discussing the important constructs like risk sources and their identification, risk drivers, enablers, barriers in PRM, tools and techniques for assessing risks and various strategies used by managers in the logistics infrastructure development industry to mitigate risks. The final section, i.e. section 2.5, identifies research gaps from a critical review of available literature in risk management in logistics infrastructure development.

2.2 Risk Management in Infrastructure Projects

Risk management is very critical for the success of any infrastructure development project. Despite large investments in infrastructure development projects including energy, power, rail, roads, airports, etc. worldwide, very limited knowledge is available related to the performance of these investments in terms of actual value and risks (Flyvbjerg et al., 2003). This section details the outcome of studies conducted in the field of risk management in infrastructure projects.

2.2.1 Conceptual perspective – Projects and Project Risks

A project in terms of project management can be defined as a endeavor to accomplish objectives to create a unique product or service (PMI PMBOK, 2013). Different stakeholders may view project success in different manner. To some, it may be completing the project within timelines to others it may be completing project within certain cost while compromising on the risk of time and quality (Tavares et al., 1998). This view is also as per the Project Management Institute (PMI), which defines successful project which are accomplished within planned time, cost and desired quality. The uncertainty in a project, which leads to variation to meet these objectives leads to project risk (García-Quevedo et al., 2018). These three project objectives are also known as 'Triple Constraints' or the 'Iron Triangle' (Pollack, 2018).

Mega infrastructure projects involve huge investment and are subject to risks which may result in monetary losses due to delayed development or lack of resources (Renuka et al., 2014). Risk is a concept which is the product of likelihood that an event will occur and the impact it may have if it happens (Proag and Proag, 2014). Risk assessment involves the identification of risk through checklists and assigning subjective ratings to individual risk factors (Yildiz et al., 2014). Project success focused organizations not only are concerned on successful project implementation but also on how they execute and manage the projects (Purnus & Bodea, 2014). It is seen that land development communities across the world experience diminished infrastructure performance and increased costs, both operating and capital resulting from unmanaged development (Linthicum & Lambert, 2010). Cost overrun happens in roughly in 90% of the cases where final project costs may be higher in range of 28% as compared to their estimated costs (Annemiek et al., 2013). For instance, large multi-phased transportation infrastructure highway project in the United Arab Emirates (UAE) with an initial budget approved approximately US $100 million was completed at a cost nearly 4 times of estimated cost with significant time delays and contractual issues (Nahyan et al., 2014).

The mega projects require high focus on project completion time, cost management and quality control while strong coordination between the project entities (Kardes et al., 2013). The issue of overshooting the cost of project is a global phenomenon where as project characteristics of reasons can be local region specific (Huo et al., 2018). It therefore becomes very important that all these features and indicators are closely evaluated and monitored (Savita & Pradeep, 2014). Risk environment may change with project specific conditions, management techniques and construction management (Tamosaitiene et al., 2013).

The risks in infrastructure projects would change depending upon the country, industry, regulatory framework, economic conditions, project enterprise environment, management and organization (Marques & Berg, 2010). For example, Project environment and conditions in the US, Canada will differ from India as an individual country would have a different regulatory environment, Corporate governance and project conditions (Kardes et al., 2013). Hence, learning from one country cannot be directly applied to another project in a different country unless all the factors are specifically studied and analyzed. The project cost management is, however, fragmented and may lack global recognition (Smith, 2014). A crucial skill for project managers in construction projects is to manage the project critical activities and relevant stakeholders (Vinten, 2010). Failure to address these expectations can result into project failures (Lim & Lee, 2005; Cleland, 1995) primarily because construction stakeholders tend to have the capability to influence construction projects (Zwikael et al., 2005). In other words, they have a significant impact on project outcomes relating to time, cost, performance and stakeholder satisfaction (Moza et al., 2014). The interplay between many sub-systems wherein lies the complexities of elements of risks, uncertainty, path dependency, irreversibility and other lock-in effects (Ramjerdi & Fearnley, 2014).

Complex interfaces, less prior experience, along with varieties of stakeholders, can add more difficulties in managing risks on these projects (Elkington & Smallman, 2002). Risk management involves a large number of stakeholders like the public sector, construction company, management company, suppliers and many others (Irimia-Diéguez et al., 2014). It is also very important to properly understand the risk management capability of construction organizations instead of the high-risk nature of construction business and integration between the expectations of various stakeholders (Mu et al., 2014). Each risk is required to be analyzed and then distributed as feasible to various stakeholders and partnerships, which is the key to effective risk management (Mu et al., 2014). Assessing risk management capability of contractors and suppliers before their selection for a project also contribute significantly to the success of the project delivery (Salawu & Abdullah, 2015).

Public-Private Partnership (PPP) Projects

Public-Private Partnership (PPP) is a contractual agreement structure, which is very keenly progressed as a model for infrastructure growth and is used to finance infrastructure projects in both developed and developing countries (Ramjerdi & Fearnley, 2014). While PPP model has been very effectively used in various countries globally to source private equity in recent years, there is varied outcome in terms of success of these projects (Chou & Pramudawardhani, 2015). PPP procurement processes are complex by nature, with longer time frames and wider scope of contracted services (Zou et al., 2014). Private sector has been seen to control the risks as compared to public sector to get it implemented through their stakeholders and partners (Satya-Lekh & Virendra, 2014). The existing problems in PPP model and its intrinsic characteristics can be addressed with enhanced control over the partners making apart with high level of diligence (Grimsey & Lewis, 2002). Strong Governance in project management and control plays a critical role in project success (Pitsis et al., 2014). This, governance, risk and compliance can bring enormous benefits to an organization when used and implemented correctly in projects (Hunt, 2014).

The risk of failing large infrastructure projects is due to a decrease in risk management at different stages of the project life cycle (Briscoe, 1999). Companies' sophistication in risk management practice determines the level of maturity of their risk management on projects (Akiraju et al., 2010). International Cost Engineering Council, African Association of Quantity Surveyors, International Project Management Association, Pacific Association of Quantity Surveyors, China Engineering Cost Association, Association for the Advancement of Cost Engineering and the Royal Institution of Chartered Institutes. Work together on recommendations and strategies for joint energy and project cost management (Smith, 2014). The overall organizational factor such as optimism level, complexity, open culture, and effective communication in project organizations strongly influences early risk warning (Haji-Kazmi et al., 2015).

The planning framework can support looking into the risks, openness or flexibility in the planning process (Ramjerdi & Fearnley, 2014). Improper bidding pricing is one of the critical cause of cost deficiencies One of the major cause of difficulties during project implementation is unsustainable biding prices (Purnus & Bodea, 2014). Contract conditions are interpreted by contracting parties to enhance project aspects especially related to time and quality with diminishing pre-expected obstacles aimed towards reducing arising difficulties or claims (Bakr et al., 2012). Project risk assessment is an important aspect in project management and the project team should ensure that risk management is properly ensured and adopted in project planning and execution (Peixoto & Tereso, 2014). There are multiple causes for the project to fail such as gap in project objectives linkages between the project organization priorities and developer alignment to the same. There needs to be agreed measures of success with intermediate milestones. Project priorities should have proper integration with programme. Training and education of project team and managers play an important role to support risk management practices execution on ground (Papadaki et al., 2014).

Although there has been quite an extensive literature available on risk management, there is a lack of studies and research having an integrated approach and framework in risk management (Kardes et al., 2013). A related topic for future research is to investigate how the length of these phases correlate with the cost overruns in their respective phases and to explore whether projects have highest cost enhancement in the pre-construction phase or whether this is normally a specific feature of projects in specific countries (Cantarelli et al., 2012).

2.2.2 Importance of Risk Management in Infrastructure Projects

Importance of risk management

Risk management analogy can be drawn from software projects where the risk management practices are relatively more stable. According to the Chaos report 2015 released by the Standish Group, only 33% i.e. less than one out of three projects are only successful, as shown in Table 2.1. There are different level of risks posed in different phases of the project development life cycle (SDLC). Companies are required to take risk in innovation and launch of new products. It is only the timely identification and management with mitigating measures to keep the impact under control.

Table 2. 1 Share of Successful, Challenged and Failed Projects

	2011	2012	2013	2014	2015
Successful	29%	27%	31%	28%	29%
Challenged	49%	56%	50%	55%	52%
Failed	22%	17%	19%	17%	19%

(Source- CHAOS Report 2015 by Standish group)

Importance of risk management in infrastructure projects

Project management in infrastructure projects becomes challenging when goals are not defined properly (Williams, 1999). Large infrastructure projects development becomes more risky as the capital investment is very high, the payback period is large, multiple stakeholders and the integration becomes a huge challenge. The focus on project success with regards to various agencies are also different (Lee et al., 2007). Also, when there is lack of focus on risk management, the challenges in project success increases and chances of project losing to meet the objective reduces (Krane et al., 2010). Salient characteristics and outcomes from project risk management are summarized below in Table 2.2.

Table 2. 2 Salient project risks characteristics

Author	Risk Characteristics
Boehm, (1991); **Leleur & Salling, (2015)**	• Inadequate time and cost assessment

Author	Risk Characteristics
	• Gold plating of a project • Improper assessment • Quality concerns of resource supplies • Improper outsourcing • Quality and performance issues
Addison & Vallabh, (2002); Kardes et al. 2013	• Lack in defining project scope/ objectives • Improper understanding of requirements • Limited involvement of project owners • Senior management commitment • Improper schedule and budget planning • Change in requirement specifications • Inadequate skills of project team members • Ineffective project management • Gold plating
Boateng, et al. 2015	• Insufficient management commitment to the project • Misunderstand the requirements • Change is not managed properly. • User failure to achieve customer commitment • Ineffective project management skills • Inadequate user participation by the user • Inadequate to maintain stakeholder expectations

Author	Risk Characteristics
	• Ineffective project management methodology • Vague / unclear scope / goals • Frequent changes in scope / objectives
Alinaitwe et al. (2013), Al-Momani (2000); Funderburg et al. (2010)	• Lack of Project Champion • Lack of commitment of senior management • Project ambiguity • Improper alignment of the system using local methods and process • Political games or conflicts • Lack of required knowledge or expertise • Project team changes • Organizational instability • Resources are not enough
Wang et al., (2016)	• The project requirements are constantly changing • Project requirements are not adequately identified • Lack of effective project management methodology • Insufficient project planning • Inadequate assessment of resource requirements • Lack of use of new technology • The progress of the project is not

Author	Risk Characteristics
	adequately monitored • On corporate politics that negatively impacts the project
Audit Scotland, (2011). Ghosh and Jintanapakanont, (2004). Case: Thailand Underground Rail project	• Consumer resistance to change • Differences between users • Customers with a negative attitude towards the project • Customers are not committed to the project • Lack of cooperation from customers • The requirements are constantly changing • System requirements are not adequately identified • Unspecified system requirements • High project complexity • Use of old technology • Use of technology not used in previous project • Lack of effective project management practices. • The progress of the project is not adequately monitored • Adequate assessment of required resources • Inadequate project planning • Novice project managers

Author	Risk Characteristics
	• Effective communications • Inexperienced team members • Adequately trained development team members • Team members do not have the specific skills required for the project. • Change in company management during the project. • On corporate politics that negatively impacts the project • Unstable institutional environment • The company is subject to reorganization during the project

2.3 Project Risk Management (PRM)

2.3.1 Definition of Risk

Kaplan & Garrick (1981) has defined risk as a "set of triplets". They have further extended it to include uncertainty and completeness. Heckmann et al., (2015) have remarked that risk has now been largely acknowledged and hence there are heterogeneous approaches and concepts of risk management.

Different sources have defined risks indifferently. As per Merrian-Webster online, (2006), the risk is the possibility of occurrence of a loss or injury. Project risk is an uncertain event or condition that, if happens, affects at least one project objective. Known risks can be recognized before they occur, while unknown risks are not foreseen. Risk management involves identifying and assessing these risks to the project and managing them to minimize the impact on the project (PMI PMBOK, 2008).

2.3.2 Risk Sources, Risk Types and Classification

Risk Sources

Although uncertainty and risk are two different concepts, they can all be used in the same way. Uncertainty is the existence of multiple previously unknown events, and risk is a type of uncertainty with unintended consequences (Hubbard, 2009). 80% of managers see only side effects as harmful (March & Shapira, 1987). When uncertainty is measured, there is only one parameter, that is, an additional impact parameter, usually based on the risk and risk of a future situation. From this description it is clear that uncertainty creates risk and that risk leads to loss. This concept is in line with the Software Engineering Institute (SII), which defines Risk as loss (Uhner et al., 1999)

For quantitative measurements, Risk is assessed as

$$\text{Risk} = P_i \times I_i \qquad \text{--- (2.1)}$$

where P_i is the probability of event i and I_i is the impact of the event i.

For quantitative measurements, the probability and effect matrix can be used. Managers prefer qualitative or verbal characteristics rather than risks because they suspect that a single number does not accurately represent a wide range of risks (Bannerman, 2008). In other words, uncertainty cannot be measured in the sense that the likelihood of future conditions is unknown and the risk of future outcomes is unknown (Knight, 1921). Therefore, this definition of risk is not only based on probability, but also on the likelihood and effectiveness of most risk management techniques and tools currently used. Risk can have multiple causes and multiple effects. In other words, one accident leads to another. Therefore, risk inter-relations can be modeled as the strength of the relationship as a network or graph of risk nodes, edges, causal relationships and edge weights. It helps to better understand each risk and re-evaluate risks and risks (Fang & Marley, 2012). As the complexity of the project increases, the network becomes more complex.

Uncertainty and risk can be classified differently in different contexts. For project managers and risk managers, a useful classification of uncertainty is timing (uncertainty about when a particular event will occur), control (inability to influence decisions), and information (inaccurate or inaccurate information in decision making) (Zemmer, 1997). Fig. 2.1 shows the classification developed by SEI for software development risks. Table 2.5 lists the risk categories offered by different authors.

Table 2. 3 Risk Categories

Author	Risk Categories
Winston, 2006	Internal, External, Project, Technical
DCITA, 2003 Baccarini & Melville, 2011	Project Management, Health & Safety, Project Outcomes, Operational Management, Natural Disaster, Financial, Commercial, Personnel
Lee et al., 2007	Market, Social, Policy, Technology, Legal, Moral

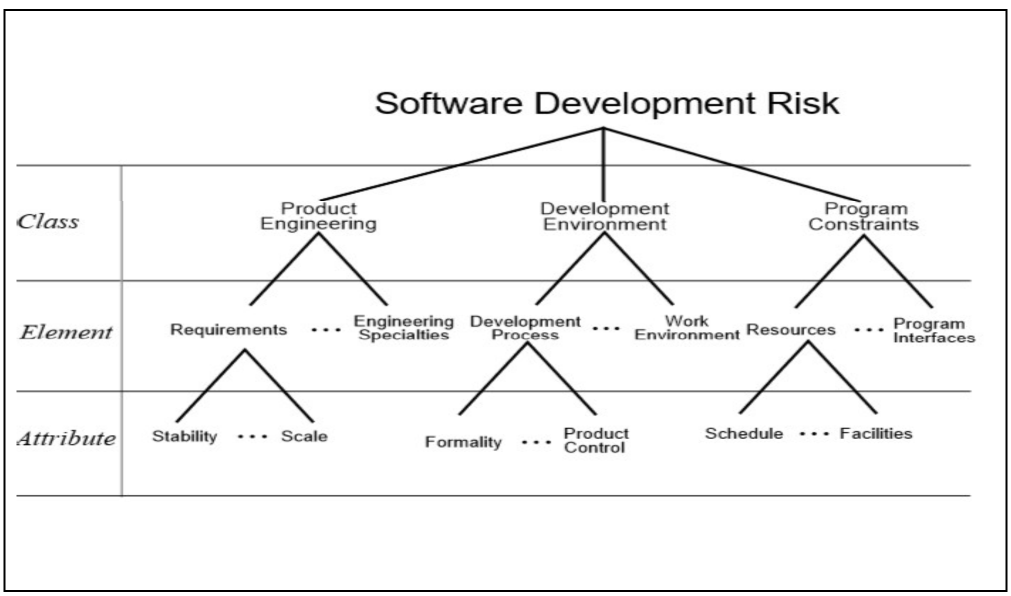

Fig. 2. 1 Software Development Project Risk

Types of Risks in Infrastructure Projects

It is important to evaluate these risks in detail at various stages of the project life cycle. While performing the risk analysis for any infrastructure project, there can be combinations of various risk as described under various classification approaches. The key risks to be evaluated under various approached studied above are:

Macroeconomic risks—These risks are related to the macroeconomic environment of a country and also related to the global macro environment. These are related to external factors which companies cannot control and also includes political factors like civil wars, social unrest, etc. natural disasters or changes in the financial environment such as interest rates, inflation, the overall level of interest, exchange rates etc. (Dailami & Leipziger, 1998).

Commercial Risks - Risks that directly affect the environment in which the project operates and the trade-offs it interacts with (suppliers, associations, customers, local authorities and the environment). They are common project risks and the consequences may be under investor and sponsor control (Ruster, 1996).

Competitive risks associated with competition - risks associated with the market environment and all the forces that affect the market or themselves. Competitive factors and their effects fall into this category (Baloi & Price, 2003).

Competition risks related to the competition - those risks related to the market environment and all the forces that influence or are themselves influenced by the market. Elements of competition and its results fall into this category (Baloi & Price, 2003).

Construction Risk – This risk involves unforeseen consequences during the built-in period, leading to an increase in time and cost or a decrease in the performance parameters of the completed project. High capital intensive and long construction period projects are particularly subject to delays and cost overruns. As a result, construction risks are high in the energy, roads, telecommunications, and urban services sectors (Akintoy & McLeod, 1997).

Construction risk can be reduced by various factors. The reputation and performance of sponsors, engineering, procurement and contractor is an important organization in construction risk assessment. Through engineering, procurement and construction contracts provided for turnkey liability, the contractor may move project sponsors to some extent of construction risk. Such performance guarantees increase project cost (Tahm & Carr, 2000). Construction risk can be reduced to some extent, but this cannot be ruled out, as penalties are limited to those who do not work, and investors must bear the rest. However, lenders are satisfied with risk-sharing, which reduces project risk to the level that equity investors can perceive without risk of repayment of debt (Mustafa & Al Bahar, 1991).

Operating Risk - The technical performance of the project during the project may be lower than what investors expect. As with most power stations and highway projects, operating risk is generally lower for infrastructure projects that rely on tested technology. This is especially true in rapidly changing sectors such as telecommunications where technology is not tested. Operational risks are mitigated by the operation of experimental operations and maintenance contractors/ agencies. There may be some provision for liquidated damages in the contract with such companies. Some risks, including some force majeure risks at the operating stage, are not commercially insurable (Wang & Son, 2012).

One source of significant operating risk in the sector's energy sector is fuel supply risk. Energy projects that disrupt fuel supply are very vulnerable, and independent power producers usually attempt to transfer this risk to a fuel supplier or buyer. Private financing of energy projects depends on their ability to negotiate satisfactory fuel supply agreements and, in the event of non-performance, the fuel supplier will be fined. Fuel distribution issues are handled differently in various private sector projects in India (Day, 2009).

Market Risk - Market risks may not be recognized in determining the feasibility of the project. Failure to meet demand expectations is a clear example of market risk. In some cases, investors expect the monopoly buyer to guarantee the lowest level of purchase, thereby hedging market risk for the investor. This is when the dependent energy producer sells electricity to a monopoly supplier or sells water to a city water supply company. In other projects related to telecommunications, ports and roads, the market risk investor will bear if the private manufacturer interacts directly with the intraindividual users and the consumers are usually faced with competitive options. Investors conduct market studies and satisfy themselves that market demand forecasts reap sufficient returns as soon as possible (Hartman & Myers, 2003).

Interest Risk- Interest rate risks can occur as the interest rate changes over the life cycle of a project. These are critical in infrastructure projects due to high capital intensity and long payout periods. High capital intensity implies that interest expense accounts for a large portion of the total cost; Long return periods mean that financing should be available over a long period of time when interest rates change. One way to deal with interest rate risk is to pass it on to customers, which, during testing, consider the impact of interest rate fluctuations on unit costs to exceed tariffs (Hoy, 1995). The cost-based tariff formula used in many power projects in India, for example, is built on the interest cost tariff. Such an approach is not desirable; However, any arrangement that automatically transfers these costs to the user will reduce the cost savings benefits (Ke et al., 2010).

Foreign Exchange Risk – There are two types of foreign exchange risks which must be identified. First is exchange convertibility, the guarantee that the proceeds of the domestic currency can be converted into foreign currency for making payments abroad. The government must bear this risk by ensuring adequate transition. Another type of risk is exchange rate risk, where exchange rate changes cause a large increase in the internal currency cost of the payment denominated in the foreign currency (Wang et al., 2000).

Exchange rate risk can be managed in different ways. When setting tariffs on foreign currencies or automatically adjusting to reflect the impact of exchange rate fluctuations on foreign currency-valued cost factors, consumers bear the risk of exchange rate risk. However, in most cases, tariffs only refer to domestic inflation, exposing the project to the remaining foreign currency losses. Changing foreign currency risk in such cases is not easy (Dumas & Zolnik, 1995). If long-term swaps between domestic and foreign currencies are readily available, this risk can be saved at cost. Such conversions are not available in most developing countries, however, due to market policy, government policy. Until the foreign exchange markets are tightly regulated, hedging instruments cannot be developed (Brown, 2001).

The only problem is the lack of hedging equipment. The inherent uncertainty about exchange rate movements in developing countries is that although hedging tools are developed, they are very expensive. In this case, the only way to reduce foreign liquidity is to limit the scope of external financing. It depends on the existence of a healthy domestic capital market that can provide adequate internal financing for infrastructure projects (Gray & Irwin, 2003).

Payment Risk - These can be related to the outcome of government actions or associated with power (wars, social unrest, etc.). Infrastructure investors face the risk of not paying for delivery services. The importance of this risk varies by region. This is not particularly important in projects that deal directly with sponsoring customers, such as a telephone company, toll road or port. This is especially important in cases where an independent sector power producer has to supply electricity to a monopoly buyer such as a public sector supplier. As the economic status of public sector utilities in developing countries is very weak, there is no alternative outlet for manufacturer production (NG & Luzmore, 2007).

Regulatory Risk - These risks include changes in the regulation of certain aspects of the business, such as law and tax. Regulatory risk arises when infrastructure project developers have to interface with various government and regulatory bodies like in PPP projects during the life of the project. Into control measures. Extensive regulatory clearances are required at the beginning and during the execution of the project (Alexander et al., 1999). Another source of regulatory risk is that environmental costs and standards become more stringent over the life of the project, which increases operational costs (Freestone & Stevens, 2011).

In general, regulatory risk can be better managed by establishing robust and independent regulatory authorities that work with maximum transparency of policies within the legal framework, providing investors with reliable help against unfair practices. This is not the key to establishing new systems and policies. Systems need to be seen as reliable and some can only happen if sufficient experimentation is achieved on their performance. Until then, there is a risk in pregnancy (Carney & Mue, 2003).

Political Risk - Infrastructure projects have high visibility and always have a strong point of public interest. It harms them to commercial activities that disturb or disturb trade; In extreme cases, this can lead to revocation or nationalization of licenses (Ashley & Bonner, 1987). These risks can be partially mitigated by political risk insurance offered by multinational corporations such as a multilateral investment guarantee agency or bilateral investment protection agreements. Arbitration proceedings can be resolved by incorporating appropriate amounts of compensation into the project contract, subject to international arbitration. The World Bank has also introduced a partial risk guarantee tool, which includes service payments when there is a disruption in the performance of specific government obligations, another new tool that may play a useful role in this context (Feels & Abak, 2000).

Risk Classification

Approaches to Infrastructure Project Risks Classification

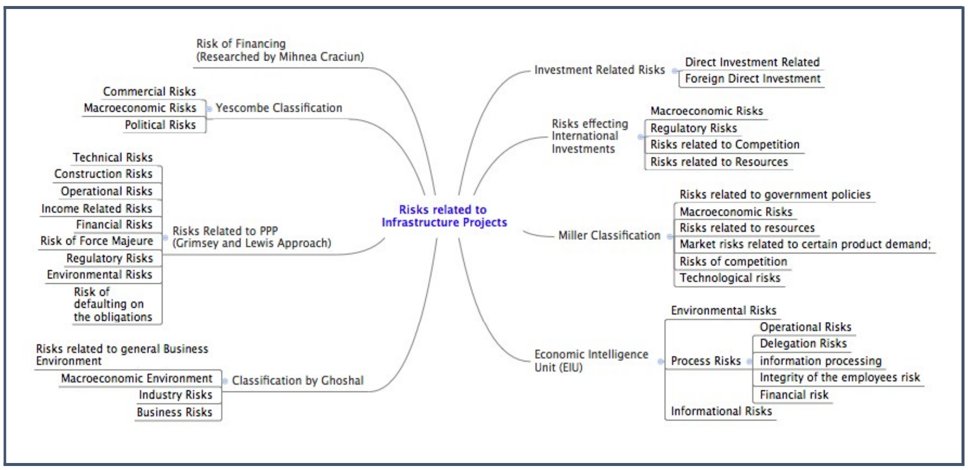

Fig. 2. 2 Salient approaches to risk classification

As indicated in Fig. 2.2, there are various approaches to classify risks in infrastructure projects. This can depend upon the nature of the Infrastructure projects, i.e. mega public projects like transport infrastructure, airports, energy projects or projects development on PPP model, private commercial development projects, etc.

The broad classification can be based on

Investment-related (Direct Investment or Foreign Direct Investment) - From this perspective, the risks of an investment project in infrastructure are related to risks having effects on any FDI. The risk analysis, however, involves the same tools of analysis.

Miller's Classification (2007) - It classifies risks into six main categories: government policy risks, macroeconomic losses, resource losses, market losses related to certain product needs, competitive risks and technical risks.

Classification based on the Economic Intelligence Unit (EIU) – As per this classification, risks are divided into three categories - *Environmental* (common risks that do not affect the company), *Process* risks (relative risks to the company's objectives, but not the risks) and Informational (risk related to inadequate information). The EIU classification sub-classifies each risk. Process risk involves operational risk related to customer satisfaction, human resource efficiency, efficiency, product cycle and environmental impact. These representative risks are related to management, its performance incentives, or communication, information processing and employee integrity. Financial risk, including risk or currency risk issues, interest rates, liquidity risks and guarantees.

Classification based on approach macro parameters – The approach was put across by Ghoshal (1987) which identifies four types of risks affecting international investments which are *Macroeconomic* Risks, *Regulatory* Risks, *Competition* related and *resource* related risks.

Classification by Yescombe (2002) – A relative simplified classification approach which categories risks into three major areas – commercial, macroeconomic and political risks has been presented.

Risk of Financing – This is the fourth dimension suggested by Craciun Mihnea (2011) in addition to the three above. This is related to risks of financing propped up during the global financial crisis during 2008-10. This risk is determined by events which can lead to loss of project funding opportunities.

2.3.3 Risk Management Process

There are basically five steps in the risk management process -

Risk identification, acquired through brainstorming, may require experience in such projects or consider checklists, which are lists of key risk and success factors developed by researchers using surveys and interviews to gain expert knowledge. The risks identified can be listed on the Risk Register or Risk Documentation form.

Risk assessment involves assessing the risks and impacts of expertise or experienced team members using common methods such as describing responses or using advanced techniques such as analytics, risk analysis, risk matrix and SWOT analysis. Sequence process, complex path method and Monte Carlo simulation.

Risk response planning involves developing plans to mitigate the effects of inadequate rewards and minimize the negative impacts of inevitable risks. This includes plans to transfer risks to a more appropriate agency to handle risks through insurance and contracts.

Risk control and monitoring, periodic risk review, overcoming project costs from budget and project time according to schedule, proper risk reporting through communication and knowledge management.

2.3.4 Tools, Techniques and Risk Assessment Models

While an effective and efficient risk management approach requires systematic methodology, knowledge and experience in project management, previous research results in Chile (Wolbers, 2009) have shown that both, project promoters and developers do not use proper risk management practices, resulting in impact on project performance (Serpella et al., 2014). It is also important that the risk management techniques are applied in any construction project at the initial stage of the project to get the maximum benefit of the techniques (Mahendra et al., 2013). Measurement of risk management processes is the starting point in understanding the risk management capability of organizations (Monetti et al., 2006). Considerable effort has been put into developing various methods, tools, standards and processes for dealing with project risks (Guo et al., 2014). The basic rationale underlying many of different techniques is the integration of risk management into a structured process to solve complexities and uncertainties in a project (Guo et al., 2014). Assessment of Risks can be done either using quantitative or qualitative analysis (Tamošaitienė et al., 2013). Qualitative risk analysis is considered as the most important phase in project management (Sigmund & Radujković, 2014).

Most risks are usually difficult to detect due to inadequate information available or inadequate access (Li & Joo, 2008). Monte Carlo simulations have been used to large-scale the statistical distribution functions of project duration at the end of a project (Acebes et al., 2014). The most commonly accepted methods are to assess the likelihood of risk and its effects on common criteria, e.g. Limits can also be defined numerically from 1 to 5 or more (Climetti, 2006). The Relative Importance Index (RII) method is applied to prioritize project risks based on project-related data (Tylon et al., 2014). The quantity of qualitative criteria can be determined in several ways, one of which is blurring (Pittsis et al., 2014). Simplified methods can also be used for evaluation, such as generalized additive weighting SAW, order for technology, and uniform solution for preference for TOPSIS (Tzeng & Huang, 2011). Risk assessment in fuzzy weather, using TOPSIS-F as a multi-criteria decision aid, provides several powerful resolution tools to solve problems (Tzeng and Huang, 2011). The fuzzy topsis method is most suitable for solving decision problems in a group in a dim environment (Tylon et al., 2014). The quantitative methods used in risk assessment currently include an event (probability) and its consequences or effects (Kauf & Touzak, 2018), sensitivity analysis, and the estimation ranking method of the Monte Carlo simulation (Grimsay & Lewis, 2002), Fuzzy Set, Analytic Hierarchy Process (AHP) (Day & Ogunlana, 2004). Analytic Hierarchy Process (AHP) is an effective technique used to solve a problem in a complex, unpredictable and multi-criteria situation (Nigim et al., 2003). Monte Carlo simulations are commonly used for this analysis to reduce the impact of uncertainties and risks on project budget and schedule (Mahendra et al., 2013).

The three main approaches, which have emerged in recent times as new, powerful, and acceptable approaches, influencing the interpretation of nondeterministic situations are Fuzzy logic, Interval approaches, and Chaos theory (Govindan et al., 2015). Many researchers use sensitive analysis, fault tree analysis, event tree analysis for risk assessment, Monte Carlo simulation for stochastic quantitative modeling analysis and fuzzy set theory for qualitative analysis (Sharma & Goyal, 2014).

Risk Assessment Models

To propose an appropriate framework for risk management in construction projects, various risk management models have been studied. Kangari & Riggs (1989) have studied the models in detail and classified as classical and conceptual models. Some important models provide a common framework while many have a specific purpose like public-private partnerships or decision problems in oil pipeline projects (Dey & Ramcharan, 2008) and application to quarry expansion (Maniar, 2010). Few models tend to rely on certain facts like matrix propagation (Schatteman et al., 2008) and network analysis. Others are based on linguistics and manager's experience. The objective is to propose a comprehensive framework after studying these models and combining and modifying a few of them to overcome their demerits.

Researchers suggest a formalized, structured approach to identifying, measuring and mitigating risk (Frozdik, 1997; Khan & Barnes, 2007). These include the Delphi method, checklists, module decomposition, energy field analysis, control analysis, SWOT analysis, root-cause analysis, process flow charts, impact diagrams, and scenario analysis (Jahangiri et al., 2017). Danny & Rangandan (2008) presented a conceptual model for identifying and predicting risk. The authors suggest that senior planning should be used to actively manage organizational risks. Moreover, there should be no general types of risks, but these should be defined from the context and each sourcing agency has its own unique and unique risks. Scenario analysis and stress testing method Finke & Nagel (2009) predict changes in certain risk factors in the firm's management activities. Although their focus is on high-risk areas, mainly natural disasters and man-made disasters, they do not have any method for frequency estimation, but use severity as a "risk indicator" (Marshall, 1996). Although it is arbitrary in nature, the advantage of situational analysis and stress testing is that it treats situations that are more or less unlikely than the similar advantages of other methods. The main drawback of this method is the lack of aggregation of measurable data. Simulation-based Supply Network Risk Assessment Model (SNRAM) for predicting disruption caused by failures at certain nodes, and their impact on key performance measures that allow companies to undertake risk assessment and identify the most critical scenarios (Sec et al. 2015).

The Fuzzy Logic telephone framework allows not only zeros and values to be values, but any real number between zero and one as opposed to Boolean logic. Many mathematical models based on fuzzy logic are designed to test risk-based scenarios of supplier selection, capacity estimation and appropriate warehouse environmental issues (Mitra et al. 2009; Day et al. 2001; Liu et al. 2010).

The Artificial Neural Networks (ANN) method of combining computer science and biological science is used to create vendor management systems, expertise systems for sales and raw materials, needs to be evaluated based on various factors, most notably the major distributed network bullwhip impact minimization and others (2007). , 2009; Coe et al. 2009). ANN can be used with other assessment tools to assess and mitigate risks. The research of Rath et al. (2017) introduced the Integrated Data Envelopment Analysis (DEA) and ANN method for evaluation and selection of 3PL providers.

Also used to investigate the risks caused by the Monte Carlo approach. Ward (2003) proposed an innovative method for estimating supply networks using a three-stage risk modeling approach, in which they classify distribution risks as threats, high-risk sources and exposure levels; Evaluation of networks in terms of loss and recovery time. They also forecast future risks using Monte Carlo simulations and ways to reduce risk.

Good Denzi & Borgesi (2006) presented the Analytic Hierarchy Process (AHP) method for estimating supply risk to meet supply chain objectives. Wu et al. (2006) developed an AHP-based supplier risk assessment tool to determine the relative weight of individual risk factors. The total risk index is calculated using the weight and probability of each risk. A growing body of literature includes methods for risk assessment, which are used for supplier assessment and selection (Talluri & Narasimhan, 2009). Failure Mode and Effects Analysis (FMEA) can be implemented as a risk management framework for identifying and assessing risks (Ankara, 2011).

The Bayesian network modeling approach (Pai et al., 2003) is the latest model to incorporate quantitative data and the opinions of subjective experts. Locami & McCormack (2012) explored a new methodology using Bayesian networks to determine the overall risk of a supplier and the impact that the supplier has on company cash flows. They conclude that distribution risk profiles can be used to identify and isolate risk events that have a greater impact on the company's cash flow. Mishra et al., (2016) estimated supply chain risk using Bayesian trust network modeling. One of the drawbacks of their model is the presentation of risk variables in binary form and does not include important risk factors in the supply chain.

Although this short literature review covers current issues on resource / distribution risk management, it also highlights the potential for research to model supply risk using financial ratios and standard proxy variables from firms' financial statements (Liksandry, 2016). The relationship between raw material market indices, various liquidity ratios, and quantitative analysis of business and credit risk can be used to arrive at reasonable solutions to a company's supply chain risk. For scalable subjective factors, a solution can be found using the Bayesian network model. The Ex-Anti-Supply Network Risk Assessment Model, based on Orders of Magnitude AHP (OM-AHP), developed by Dong & Cooper (2016), allows the comparison of intangible and intangible factors that affect distribution risk. However, there is no guidance structure on how to pivot using OM-AHP. Mittal et al. (2017) Risk assessment in different product categories using cognitive maps and AHP methodology. Lokami & McCormack (2012) jumps in analyzing supply chains using Bayesian network modeling. There is still the possibility of integrating the methods reviewed above from an industry perspective. Some recent studies have developed the BBN model, but not all of the industry-specific supply chain risk factors are comprehensive. This research provides an empirical model for estimating industry-specific risks by combining the relevant aspects of the various methods mentioned above, including economic, financial, supply chain and natural disasters.

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FMEA can be implemented as a risk management framework for identifying and assessing supply chain risk (Ankara, 2011).

Here are some qualitative and quantitative tools / techniques often used for project risk management in the literature:

Checklists: Checklists contain questions about risks, risks and risks and are a control tool for assessing against established security levels (Tunzel & Alpan, 2010).

Hazardous Activity: It is used to identify reasons for not meeting the quality and product objectives specified for the process plant (Hamilton, 1996).

What-if Method: It produces a detailed description of the course of events related to a particular risk event, called scenarios (Tseng et al., 2007).

Variance Analysis: It can be undertaken for each function, process, and flow to analyze where the deviation from the normal occurs and its consequences (Tunzel & Alphan, 2010).

Risk Matrix: It involves the production of probabilities and consequences. Obtaining quantitative data is difficult, so it may be the subjective judgment of experts (Murray, 2011).

Risk Mapping: Individuals engaged in various risk areas measure risk in the relevant risk area according to user-defined criteria (Hilson, 2006; Fan et al., 2008).

Delphi-Technique: Expert Panel Anonymously answers many assessment questions. The assessment is repeated. Different professionals can now adjust their expectations. This process is repeated until consensus is reached (Alverbro et al., 2010)

Fault Tree Analysis (FTA): looks at what causes fatal accidents (Alverbro et al., 2010).

Jonson Analysis: Analyzes probabilities and consequences and categorizes them to a certain extent (Hamilton, 1996; Tseng et al., 2007).

Simulation Methods: Methods such as Monte Carlo and Petrie Nets are used to estimate the likelihood of an event and the impact of risk prone events (Tunzel & Alphan, 2010).

Decision trees: Analyzing objectively and subjectively through practices such as expert knowledge (Alverbro et al., 2010).

2.4 Risk Management from logistics infrastructure projects perspective

The general principles of risk reduction are well known. Different risks should be allocated to those who can manage the cost without having to pay for it. Transferring these risks to outside agencies can manage the risk more effectively, thus reducing the risk that the project will take. This process of reversing losses usually involves cost, which is covered by the sponsor's tariff. If risks are effectively transferred to those who can manage them well, the risk management cost is reduced and the tariff is the minimum cost.

Given the nature of the risk and the involvement of many stakeholders, including project sponsors, lenders, government agencies and regulatory authorities, risk mitigation arrangements are usually complex. They include detailed legal and contractual agreements that clarify the liabilities of different partners and penalize those who do not. They protect investors from actions beyond their control. The complexity of these arrangements often delays implementation. Because public-sector infrastructure projects do not use such arrangements, they are often unknown to host governments. For example, PSUs that buy fuel from other PSUs do not have to enter into fuel supply agreements with the harsh penalties sought by the private sector. They do not insist on the same level of protection, such as a commitment to guarantee power purchase agreements, incentive payments and penalties for power purchase. More generally, public sector intermediaries for conflicting obligations are often defined as flexible, without having to enter into strictly defined and legally binding agreements. Investors in the private sector cannot take this approach. Also, expect a high level of enthusiasm when dealing with the private sector.

For these reasons, the development of satisfactory risk mitigation settings is varied and time-consuming but important. Lack of familiarity with such arrangements and lack of adequate requirements from the host governments can lead to delays in the implementation of the project.

Risk Mitigation - The question is whether private sector projects that require risk reduction are unnecessarily expensive compared to public sector projects. The answer depends on whether the public sector undertakes the project and whether the risks represent real risks and the premium paid to reduce the risk is high.

However, in some cases, private sector projects face the risks of not having public sector projects. Private investors, for example, are concerned about the risks of lack of clarity of government policy, lack of a reliable regulatory body and unfair political action. High risk awareness on these statistics leads to high private sector project costs, as many investors are discouraged from exploring investment opportunities, leaving the field for investors willing to live in high uncertainty with high returns. This high income ultimately pays the consumer in the form of higher tariffs (or lower license fees received by the exchequer, where the tariff is constant). However, the higher costs in these situations are not due to risk reduction, but rather to reduce risks and do business against higher returns.

2.5 Research gaps in logistics infrastructure projects risk management

Though quite good research has been conducted on various facets of project risk management, there is limited study in identifying why big infrastructure companies do not follow a framework for risk identification and mitigation. In spite of awareness though limited there is very little focus given on risk management in the logistics infrastructure industry today. Though various risk assessment methods are available and suggested in earlier research, there is a need for in-depth Risk impact assessment and presence of strong risk management framework as a tool, which can be used by the project leaders to identify, analyze, prioritize and address relevant risks on priority in the very beginning of the projects. Irrespective of many tools developed due to complexity and lack of data, project managers lose sight of risk assessment, so there is a need to develop a new assessment framework, which integrates all stakeholder and all the project phases and aligned towards the overall strategy of Infrastructure development. E.g. the risks management framework would integrate both strategic goals and execution of the research because in most of the cases the execution team is not aligned to the overall strategy and purpose of the project thereby the strategic objectives and execution plan remains disintegrated at all levels. Research in this area is quite limited, which lay down proper linkages between stakeholders and risks with possible impacts in logistics infrastructure sector in India. The framework also needs to be tested for its applicability. Hence, the key aim of this research is to come up with areas which remain unresolved and come up with measures which improve the success factors and lay down a framework for risk assessment and management.

Next chapter describes the Research Methodology followed in carrying out this research work.