International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 07 | July 2021 www.irjet.net p-ISSN: 2395-0072

RISK MANAGEMENT IN INFRASTRUCTURE PROJECT

Sanatan D. Patel[1], Prof. Ankit S. Patel[2]

[1]*PG Student*
[2]*PG Coordinator*
[3]*U.V. Patel College of Engineering, Ganpat University, Mehsana, Gujarat, India*

---***---

Abstract - *Risk identification and analysis for complex mega infrastructure projects has become one of the main parts of the present-day project management process. In this paper, we discuss few methods of measurement of project risk, such as probabilistic analysis, risk severity analysis and risk matrix method for the complex project such as Ahmedabad metro. The methodology used in this paper are primary data collection, where the major risk activities of metro rail infrastructure project were known through interactions with experts and questionnaire surveys. The identified risks were analyzed for likelihood, impact, severity of a project. This paper aims to compare different results found through the different type of qualitative as well as quantitative analysis methods and to know the common high rated risk factors.*

***Key Words*: Metro Rail, Project risk management, probabilistic analysis, risk severity analysis and risk matrix method.**

1.INTRODUCTION

Risk management is a system that enables you to actively understand and control individual hazardous events and general hazards, optimize success, minimize threats, and maximize opportunities and results.

It is the process of finding that what not goes according to the plan. Acceptable level of uncertainty. Risks can be viewed as positive (potential growth opportunities) or negative (negative factors). A hazard has the ability of a situation or event to interfere with the achievement of certain goals.

1.1 Risk management in Infrastructure project

The construction enterprise sounds to be challenging to the stakeholder connected to any project every time. Various varieties of risks are involved in the construction project specifically in infrastructure projects. If these risks are not known then the contractor is going to face a lot of troubles (Singh, 2020). So, there's a need to study about risk management by the students in order to gain the expertise and to implement on site, because of the various types of dangers involved in the infrastructure project there will be loss of life, cost overruns and delay of the project. Study of risk management analysis has a bigger scope not only in the construction industry but also in human life and business sectors too. In the infrastructure project, there are numerous types of risks involved such as political risk, financial risk, labor risk, client risk, contractual risk, stakeholder risk etc.

In large construction projects, hazard management is an important part of project management. Infrastructure projects can effectively manage risks by inspecting and identifying the sources of risk associated with each project activity. These risks can be evaluated or measured according to their probability of occurrence and impact (Sarkar, 2012).

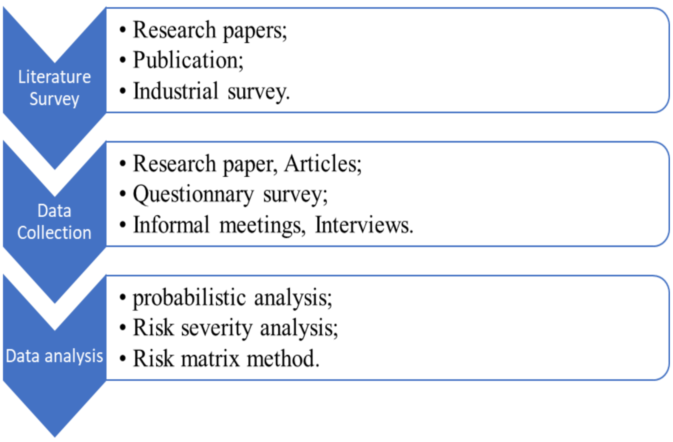
1.2 Objectives:

Primary objectives are to Identify, Evaluate and Compare risk involved in each activity of metro project and to know the severity of different activity involved in metro project. Secondary objective is to suggest executives to the dangers after examining the consequences of various hazards, plan to overcome their impact on the project.

1.3 Need for study

Risk management is essential because it allows a company or an enterprise to control and frequently prevent the political, financial, social and construction related risks. Whatever the danger level is, the enterprise must know the potential effect of the hazard would have on the project. The reason for performing risk management is to become aware of what potential problems can occur on the project. So, the executive plan and evolved as per requirement to achieve the target within given time and cost.

1.4 Research Methodology



2. LITERATURE REVIEW

In their research, researchers mainly focus on various types of hazards related to risk management in infrastructure

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 07 | July 2021 www.irjet.net p-ISSN: 2395-0072

projects. In their work, they used different methods to analyze the risk factors of the project infrastructure. Studying this research will help anyone or any organization understand the uncertainties that may arise during the project. The papers related to the risk management in infrastructure project were taken from different cities of India which includes Ahmedabad, Pune and Cochin were studied.

3. Data collection

3.1 Introduction

The metro of the Ahmedabad city is known as Mass Rapid Transit System (MRTS) which is being underdeveloped and constructed by Gujarat Metro Rail Corporation (GMRC) Limited, and it was previously known as 'Metro-Link Express for Gandhinagar and Ahmedabad' (MEGA), In the future, it will serve Ahmedabad, the largest city in Gujarat and its capital, Gandhinagar.

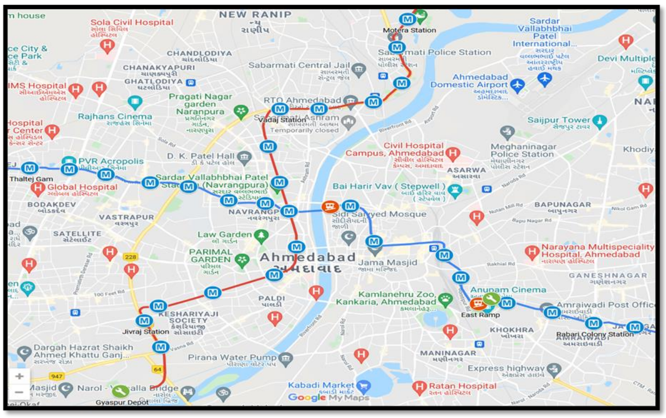


Fig 1: Ahmedabad Metro Map

Google Maps, 2021. Google Maps [online] Available through:<http://map.google.com> [Accessed 3 March 2021]

3.2 Project detail

3.2.1 Phase 1 (under construction)

All out Length: 39.28 km (24.41 mi), North-South passageway: 18.87 km (11.73 mi), East-West passageway: 21.16 km (13.15 mi), Raised: 33.50 km (20.82 mi), Underground: 6.53 km (4.06 mi), Operational: 6 km (Phase 1)

3.2.2 Phase 2 (endorsed)

All out length: 28.254 km (all raised), Motera-Mahatma Mandir passageway: 22.838 km

3.2.3 Construction Methodology:

Raised viaduct comprising prestressed solid "Box" formed Girders on Single dock with heap/open establishments, and underground segment with tunnel Boring and station in underground station cut and spread

3.2.4 Station Types:

A total of 32 stations are planned for the two corridors. These stations are usually elevated stations 5.5 m above the road and can be reached on both sides of the road to better serve the catchment area. You are heading towards such a station. Approximately 6 kilometers of the system in the VZ corridor is underground.

Ashram Road Station is the main subway hub for trade between the North-South Line and the East-West Line. Other commercial railway stations include interconnected transportation hubs such as railway stations, GSRTC terminals, BRTS and AMTS stations.

North-South Corridor					
#	Station Name		Status	Connections	Layout
	English	Gujarati			
1	Motera Stadium	મોટેરા સ્ટેડિયમ	Under Construction	None	Elevated
2	Sabarmati	સાબરમતી	Under Construction	None	Elevated
3	AEC	એ ઇ સી	Under Construction	None	Elevated
4	Sabarmati Railway Station	સાબરમતી રેલ્વે સ્ટેશન	Under Construction	None	Elevated
5	Ranip	રાણીપ	Under Construction	None	Elevated
6	Vadaj	વાડજ	Under Construction	None	Elevated
7	Vijay Nagar	વિજય નગર	Under Construction	None	Elevated
8	Usmanpura	ઉસ્માનપુરા	Under Construction	None	Elevated
9	Old High Court	જૂની હાઇ કોર્ટ	Under Construction	East-West Corridor	Elevated
10	Gandhigram	ગાંધીગ્રામ	Under Construction	None	Elevated
11	Paldi	પાલડી	Under Construction	None	Elevated
12	Shreyas	શ્રેયસ	Under Construction	None	Elevated
13	Rajiv Nagar	રાજીવ નગર	Under Construction	None	Elevated
14	Jivraj Park	જીવરાજ પાર્ક	Under Construction	None	Elevated
15	APMC	એ પી એમ સી	Under Construction	None	Elevated

Fig 2: North-south Corridor

East-West Corridor					
#	Station Name		Opened	Connections	Layout
	English	Gujarati			
1	Thaltej Gam	થલતેજ ગામ	Under Construction	None	Elevated
2	Thaltej	થલતેજ	Under Construction	None	Elevated
3	Doordarshan Kendra	દૂરદર્શન કેન્દ્ર	Under Construction	None	Elevated
4	Gurukul Road	ગુરુકુળ રોડ	Under Construction	None	Elevated
5	Gujarat University	ગુજરાત યુનિવર્સિટી	Under Construction	None	Elevated
6	Commerce Six Road	કોમર્સ છ રસ્તા	Under Construction	None	Elevated
7	Stadium (Ahmedabad)	સ્ટેડિયમ	Under Construction	None	Elevated
8	Old High Court	જૂની હાઇ કોર્ટ	Under Construction	North-South Corridor	Elevated
9	Shahpur	શાહપુર	Under Construction	None	Underground
10	Gheekanta	ઘીકાંટા	Under Construction	None	Underground
11	Kalupur Railway Station	કાલુપુર રેલ્વે સ્ટેશન	Under Construction	None	Underground
12	Kankaria East	કાંકરિયા પૂર્વ	Under Construction	None	Underground
13	Apparel Park	એપરલ પાર્ક	March 4, 2019	None	Elevated
14	Amraiwadi	અમરાઈવાડી	March 4, 2019	None	Elevated
15	Rabari Colony	રબારી કોલોની	March 4, 2019	None	Elevated
16	Vastral	વસ્ત્રાલ	March 4, 2019	None	Elevated
17	Nirant Cross Road	નિરાંત ક્રોસ રોડ	March 4, 2019	None	Elevated
18	Vastral Gam	વસ્ત્રાલ ગામ	March 4, 2019	None	Elevated

Fig 3: East-West Corridor

3.2.5 Details of segment (Gurukul station)

1	Project name	Elevated metro rail station box
2	Estimated Cost	40 crores INR
3	Contractor	Tata – CCECC JV

4	Detailed Design Consultant (DDC)	TCPL – Aarvee JV
5	MEPF consultant	Siemens India-Siemens AG, Germany
6	General Consultant (GC) Service	SYSTRA – RITES – Oriental – AECOM JV

3.2.6 Location of segment

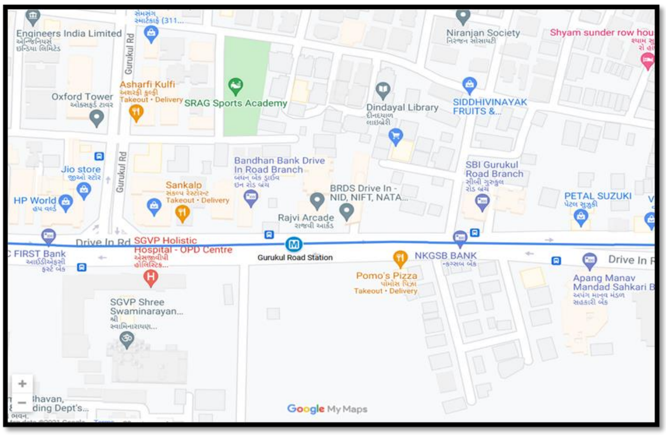


Fig 4: Location of segment

Google Maps, 2021. Google Maps [online] Available through:<http://map.google.com> [Accessed 3 March 2021]

3.3 Questionnaire Design

All major company exercises are further subdivided into various hazards related to specific parts of the well, which must be completed to complete the main exercise.

These hazards are quantified by probability, impact, and weight. Probability describes the probability of a specific hazard occurring in a specific activity, and impact describes the degree of impact of a specific hazard and weight on a specific activity. Talk about its importance in the company.

The probability of occurrence (16 main risk factors), the influence and weight of each risk factor are used as input to the EVM. The weight of each event is calculated based on the feedback from the questionnaire.

3.4 Sampling:

The example size for the poll study was determined utilizing the accompanying equation (Tripathi and Jha 2018; Sarkar and Singh 2018; Ali et al. 2013)

$n = n'/((1+n^{'}/N))$

$n^{'} = (p*q)/v^2$

Where n = sample size; n'= first check gauge; N = population size; p = penetration degree of the brand in the population, q = 1-p; v = standard error of the test population. Suppose the values of p and q are 0.5 to get the largest sample size. The standard error remains at 4% (the acceptable standard error value is 10%). The overall goal of the respondents is 100, so by substituting these values into the conditions, the population size is N = 100.

$n' = 0.5*0.5/0.042 = 156$

$n = 156\ (1+ 156\ 100) = 60.93$ say 61 nos.

4. Data Analysis

4.1 Introduction

In this paper, 16 main activities involving major risk are analyzed. The activities are (1) Risk in Feasibility (2) Tender and award of contract risk (3) Land acquisition risk (4) Design related risk (5) Risk in traffic diversion works (6) Risk in road widening and barricading (7) Construction of pile foundation (8) Sub structure work to super structure works (9) Construction of precast girder (10) Risk in launching girder (11) Risk in obligatory span (12) Risk in span alignment and bearing (13) Risk in cable tray (14) Risk in expansion joint (15) MEPF works related risk (16) Finishing and handling over

These activities are analyzed by both qualitative as well as quantitative analysis. For qualitative analysis risk matrix method is used and for quantitative analysis risk severity analysis and probabilistic analysis is used. And the results from the different analysis are compared (Singh, 2020).

4.2 Probabilistic Analysis

Probability is the possibility of an event happening, and the consequence of how the project is troubled by the event is the impact of risk.

In this analysis the probability of a hazard will occur is express. Then it has been classifying into the categories that represent their chance or probability. After that the ordering of the risk has been done. The mostly likely to occur is set first that the second is the next most likely.

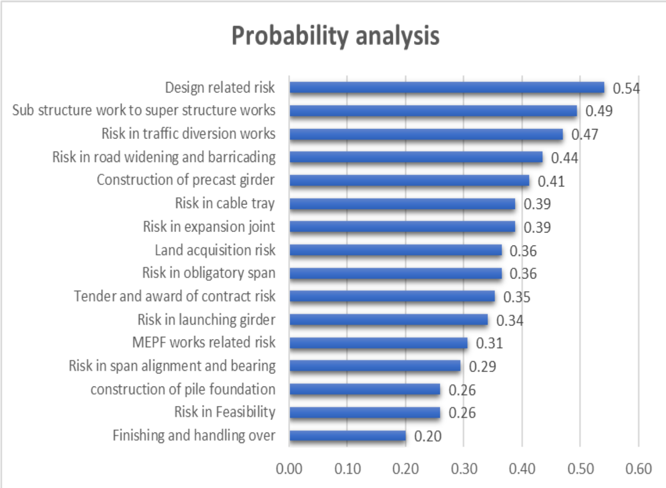


Chart 1: Probability analysis

Chat 1 shows the probability analysis where it has found that the that design related risk has the highest probability to occur and the finishing and hanling over has the lowest probablity to occur.

4.3 Risk Severity

To Find Severity of the activity

L: the likelihood of the activity

I: the impact of the activity

W: the weightage of the activity

CLF: the composite likelihood Factor of the activity

CIF: the composite impact Factor of the activity

Likelihood(L): The probability value must be between 0 and 1. The likelihood of failure (L) is determined for the identified risk sources of each type of activity and is determined through a questionnaire; this is the risk probability of the activity.

Impact(I): The impact value must be between 0 through 1. The impact of a risk can be elaborated in such a way that the effect caused by the risk to the time and cost of an activity.

Weightage(W): The weight can be based on the local priority (LP), where all sub-activities of a given activity have a weight of 1. Alternatively, the weight can be based on a global priority (GP), where all project activities have a weight of 1.

Composite Likelihood Factor (CLF): To find CLF we have to multiple the weightages (W) of the risk sources of the activities and their respective likelihoods.

Composite Impact Factor (CIF): To find CIP we have to multiple the weightages (W) of the risk sources of the activities and their respective Impact.

Risk Severity Analysis using the Concept of CLF and CIF

The severity of the risk can be calculated as the product of the probabilities, and the impact of the risk can be regarded as the severity of the risk. This concept can be extended to several risk sources in the work package, and its probability and impact can be expressed in CLF or CIF.

Table 1: Severity Classification

Severity	Classification
0.00 – 0.02	Very Low
0.03 – 0.05	Low
0.06 – 0.15	Mediem
0.16 – 0.20	High
0.21 – 1.00	Very High

Table 1 classifies the severity used in this analysis.

Table 2: Risk Severity

Description	Composite Likelihood Factor (CLF)	Composite Impact Factor (CIF)	Severity (CLF x CIF)
Risk in Feasibility	0.26	0.85	0.22
Tender and award of contract risk	0.35	0.62	0.22
Land acquisition risk	0.36	0.62	0.23
Design related risk	0.54	0.78	0.42
Risk in traffic diversion works	0.47	0.58	0.27
Risk in road widening and barricading	0.44	0.59	0.26
construction of pile foundation	0.26	0.81	0.21
Sub structure work to super structure works	0.49	0.75	0.37
Construction of precast girder	0.41	0.41	0.17
Risk in launching girder	0.34	0.65	0.22
Risk in obligatory span	0.36	0.69	0.25
Risk in span alignment and bearing	0.29	0.58	0.17
Risk in cable tray	0.39	0.40	0.16
Risk in expansion joint	0.39	0.66	0.26
MEPF works related risk	0.31	0.26	0.08
Finishing and handling over	0.20	0.27	0.05

Table 2 shows the Composite Likelihood Factor (CLF), Composite Impact Factor (CIF) and Severity of the selected risks involved in the infrastructure projects.

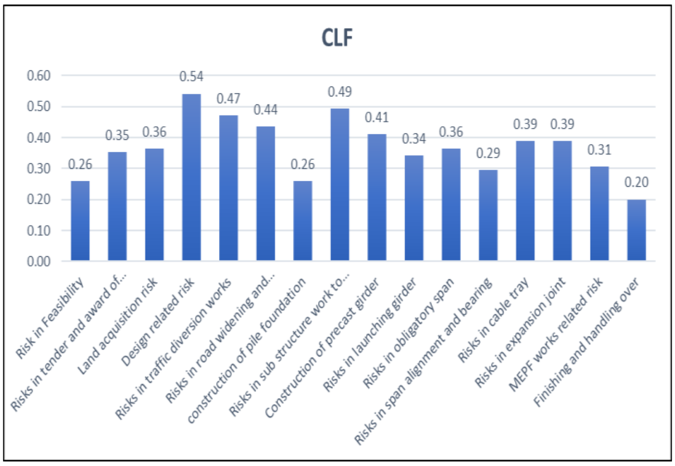


Chart 2: Risk of Composite Likelihood Factor

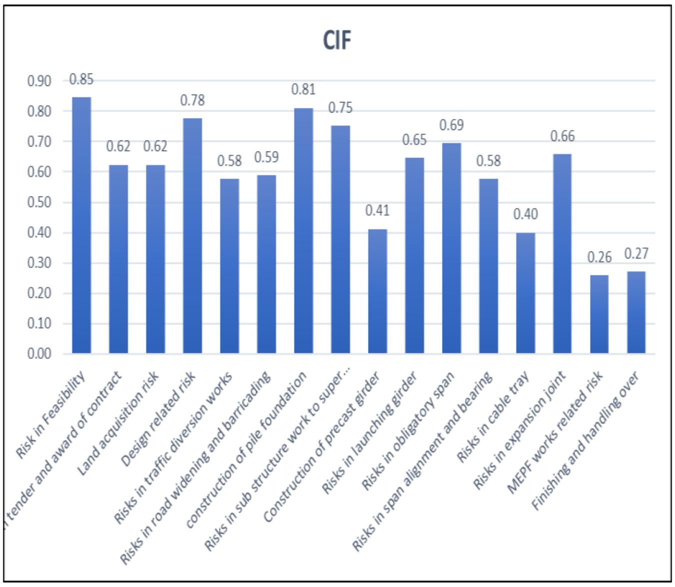


Chart 3: Risk of Composite Impact Factor

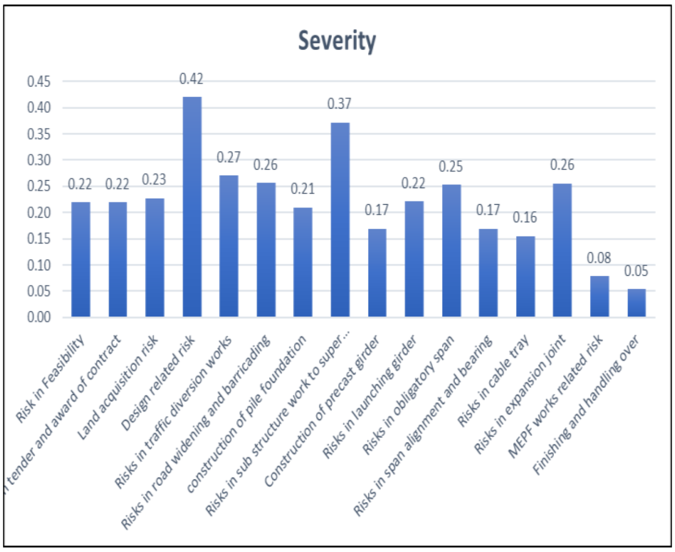


Chart 4: Severity of Risks on Project

In chart 4 it is shown that design related risk has the maximum severity and the finishing and handling over has the minimun severity in an infrastructure project.

Table 3: Result base on Risk Factors

Very High	High	Medium	Low	Very Low
Risk in Feasibility	Construction of precast girder	MEPF works related risk	Finishing and handling over	-
Tender and award of contract	Risk in span alignment and bearing			
Land acquisition risk	Risk in cable tray			

Design related risk				
Risk in traffic diversion works				
Risk in road widening and barricading				
construction of pile foundation				
Sub structure work to super structure works				
Risk in launching girder				
Risk in obligatory span				
Risk in expansion joint				

4.4 Risk matrix method

The risk matrix is used to assess risk and determine the level of risk based on the likelihood or possibility category and the impact of the activity on the severity category. This is a simple mechanism to increase risk transparency and support management in decision making.

Table 4: Risk Matrix

	Insignificant	Minor	Moderate	Major	Catastrophic
Very high					
High					
Medium			Risk in traffic diversion works Risk in road widening and barricading Constru	Design related risk Sub structure work to super structure	

			ction of precast girder	works	
Low		Risk in cable tray MEPF works related risk	Risk in span alignment and bearing	Tender and award of contract risk Land acquisition risk Risk in launching girder Risk in obligatory span Risk in expansion joint	Risk in Feasibility Construction of pile foundation
Very Low		Finishing and handling over			

5. Conclusion

5.1 General conclusion

In our current research, we have used a variety of analysis methods such as probability analysis, risk severity analysis, and risk matrix method. From the analysis, we found that there are several major and minor issues in the process of a project from feasibility study to completion of project. And if it is not handled properly or weakened, the chances of successfully completing the project on time and on budget will be reduced, which has a direct impact on the efficiency and profitability of the project organization.

5.2 Research specific conclusion

It is concluded that, Design related risk, Sub structure work to super structure works, Risk in traffic diversion works, Risk in road widening and barricading, Construction of precast girder are the top five risks by probabilistic analysis.

For risk severity analysis, Design related risk, Sub structure work to super structure works, Risks in traffic diversion works, Risks in road widening and barricading, Risks in expansion joint are the top five risks.

For Risk matric method, Design related risk, Sub structure work to super structure works, Risk in feasibility, Construction of pile foundation, Risk in traffic diversion works are the top five risks.

It has been seen that there are few risks such as Design related risk, Risks in sub structure work to super structure works, Risks in traffic diversion works are the common high rated risk in all three analyses.

One of the main limitations of the model obtained for the study is that since it is the entire probability model, the test results depend to a large extent on the probability estimates and weights of the identified hazards in the main study which is the data collected from the master poll.

5.3 Future Scope

In view of the booming economy of the study country, there are various proposals for constructing subway projects, which are expected to appear in the next two decades. The research can be used as a preparation for the quantitative as well as qualitative risks faced by these company executives. In addition, the future area of this research work is the development of risk analysis models based on the expected value method. And similar risk analysis models can be developed for other infrastructure projects like Roads, Bus Rapid Transit Systems (BRTS), ports and the like.

REFERENCES

[1] Dale Cooper, S. G. (2005). Managing Risk in Large Projects and Complex Procurements. John Wiley & Sons, Ltd.

[2] Debasis Sarkar, G. D. (2011). A Framework of Project Risk Management for the Underground Corridor Construction of Metro Rail. INDIAN INSTITUTE OF MANAGEMENT.

[3] Dey, P. O. (2002). Risk Assessment in Constrution. Constrution Engineering and Managment, 189-204.

[4] G.Poovizhi, S. D. (2020). Risk Safety Management in Construction of Metro Rail Projects. International Journal of Advanced Science and Technology, 1562-1571.

[5] Hiromitsu Kumamoto, E. J. (1996). Probabilistic Risk Assessment and Management for Engineers and Scientists. New Jersey: IEEE Press.

[6] Jannadi, A. (2003). Risk Assessment in Constrution. Constrution Engineering and Management, 482-500.

[7] Kothari, C. (2004). Research Methodology: Methtos and Techniques. New Age International Publishers.

[8] Mulholland, C. J. (1999). Risk Assessment in Constrution Schedules. Constrution Engineering and managment, 8-15.

[9] Nehru R., V. (2003). Construction Project Management. NICMAR Publication.

[10] R.C.Williams, A. W. (1997). Putting Risk Management into Practice. IEEE Software, 75-81.

[11] S, V. H. (2017). Hazards Identification and Risk Assessment in Metro Railway Line Construction Project

at Hyderabad. International Journal of Engineering Research & Technology (IJERT).

[12] Sarkar, D. (2012). Decision tree analysis for project risk mitigation options for underground metro rail project . Decision Sciences, Risk and Management.

[13] Singh, D. S. (2020). Risk analysis by integrated fuzzy expected value method and fuzzy failure mode and effect analysis for an elevated metro rail project of Ahmedabad. International Journal of Construction Management.

[14] Sinto K A, M. S. (2019). RISK MANAGEMENT ANALYSIS ON COCHIN METRO RAIL PROJECT. International Research Journal of Engineering and Technology (IRJET)

[15] Ward S, C. (2003). Transforming Project Risk Managment into Project Uncertainty Management. International Journal of Project Managment, 97-105.