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Categories Wise Analysis of Risk Assessment in Highway Projects using R.P.V. Method

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Abstract— To minimize the adverse effects of highway construction hazards, it becomes imperative to evaluate the risk before planning and manage the risks. From design and planning until the project is completed, risks factors are present everywhere. To improve the effectiveness of a highway construction project, it becomes necessary to reduce the risk factor to a defined assessment for timely, safe, and economical completion. Identifying, classifying, and assessing different hazards in the design of highway a project is the focus of this research. Risks from legal proceedings, such as contract disputes, disputes between the government and other parties, land acquisition, and so on, are assessed, and cases are reported. After that, a site survey will be conducted among professionals to evaluate the likelihood of an event and the risk of impact. Extreme, High, Medium, Low, and Minimum are the five risk classes that must be assigned to risk. Risk factors are also rated according to their severity. In order to reduce the cost of the project, the maximum probability of the event and the maximum impact risk must be minimized. The most significant risk is as follows: Money/Funds, Heritage issues, Concerns around mineral mining, Utilities were not moved in a timely manner, Skilled Labour, Cost of land acquisition is uncertain, Schedule for land acquisition.
Keywords— Risk identification, Risk assessment, Risk Classification, Risk Impact, Risk Probabilities.

I. INTRODUCTION

There is a risk in all aspects, and no exception is the development of road projects. Risks in road projects will lead to failure to accomplish the desired project goals. The negative effect of the risk associated with highway projects includes delays, cost overruns and less access to resources. Risk defined as the potential for loss, damage, disadvantage or destruction as a mix of the chance that the Risk will occur and its repercussions. Risk assessment is a step-by-step technique involving Risk identifying, classifying, analyzing and evaluating risks. Risk evaluation is a quantitative or qualitative risk estimate conclusion.

Several risks are involved in the highway project, and various contracting parties, including designers, contractors, sub-contractors and providers, are involved here. In highway building projects, the most significant cause of Risk is poor performance. The construction of roads involves several risk considerations, from design and planning to project completion. Because of these difficulties, the completion of the project is delayed, and significant funds are affected. Inefficient planning, unforeseen terrestrial services, design quality and integrity and approvals delays are the most critical risks [4].

The answer to the decision-making problem on budget allocation can be achieved through integrated fuzzy, AHP and MCDM methods, providing money to worthy and concurrent organizations [8]. The significant risk variables affecting the road construction project include delays in decision making and land procurement. The usage of adequate risk management must therefore be deployed [10]. The cost and quality of the project and the scheduled completion of the project are therefore subject to risk assessment, which consists of risk identification, risk categorization and risk analysis or appraisal. [12].

A risk assessment is carried out for a road construction project to prevent harmful effects during the design or planning stages, prioritize risks and control methods, preserves the projects' cost and quality, and prepare for the project's planned completion. This study includes identifying, classifying, analyzing or evaluating and ranking risks using the Risk Potential Value.

II. OBJECTIVES

The objectives of this study are listed below:

A. Identify the risks in various Phases of the Project.
B. Determine the probability of occurrence and impact of risk.
C. Divide the risks into various categories like high Medium and Low based on the probability of occurrence and impact of risk.
D. Determine the actions to be taken for that risk.
E. Determine the cost of reducing the impact of risk.
F. Determine the Optimum cost of Construction.

III. RISKS IDENTIFICATION PROCESS

The goals of risk identification are to

- Define and categorize potential project risks and
- Document these risks.

A collection of threats is the product of risk identification. The risk assessment process should not stop short of evaluating or reviewing risks to prevent "minor" risks from being identified. The method should encourage innovative thinking while still using team experience and expertise. However, in practice, risk identification and risk assessment are often conducted in a single phase, referred to as a risk assessment process. Consider the case where danger is discovered when questioning an expert. In that case, it makes sense to look at the likelihood of it happening, the consequences/impacts, the time frame associated with the danger (i.e., when it could happen), and potential solutions. Although the above activities are part of risk assessment, they often begin with risk detection. However, for the sake of transparency, the two tasks of risk identification and evaluation will be treated separately in these documents.

IV. RISK CLASSIFICATION

Many researchers use various criteria and assumptions to describe risk into various categories. A classification system is used, as shown below,

A. Technical Risk

Technical risk can be described as the events that occur while implementing critical technology, and the subsystem relies on them, causing the project to fail to meet its objectives. Some of the causes of technological risk in the project are preliminary plans, a lack of risk control, and project complexity.

B. Construction Risk

Contractors and subcontractors are more likely to be the source of most building risks. Experienced contractors should be active in the track development project as early as possible to ensure adequate plans for establishing valid construction programs. Construction-related threats include machinery delays due to rain and other factors, volatile business conditions, contractor productivity problems, time.

C. Design Risk

Problems such as design variations and defective designs may trigger it. Horizontal alignment uncertainty, uncertain indirect costs, and incorrect essential criteria while designing are all design hazards. To avoid bad design, the design team must first thoroughly understand the client's requirements as outlined in the project brief and establish an efficient communication framework among the designers.

D. Political Risk

Clients and contractors seldom complain about "excessive approval processes in administrative government offices" or "bureaucracy in government." These threats are usually beyond the project stakeholders' influence. To encourage investment within their administrative jurisdiction, government agencies should make every effort to establish a welcoming atmosphere in which approval processes are simplified or at least shortened, and bureaucracy is minimized.

E. Organizational Risk

Organizational risks include a lack of qualified labour, a lack of experience in the lead party, and so on. A lack of skilled labour may cause project delays, poor quality, safety, and liability problems.

F. Accidental Risks

Unforeseen damage during construction is an unavoidable danger. On construction sites, any form of accident, such as machinery crashes, overexertion, or accidental falls, may be catastrophic for the project.

G. Uncertain Market Conditions

The global environment influences the market structure, often referred to as "price inflation of building materials." The price of construction materials fluctuates continuously in response to inflation and the supply-demand relationship in the construction materials industry. Since this risk is almost always inevitable, clients should choose the appropriate contract form, and contractors should never use fixed-price contracts to bear the risk.

H. Time/Funds

Since time and expense are inextricably linked, a long timeline would almost certainly derail the project's cost-benefit analysis. A quantitative risk is a correlation between time and expense. In severe cases, time and cost overruns can jeopardize the project's economic viability, rendering a potentially profitable investment unviable.

I. Utilities

Electricity, gas, water, fuel, and other resources play a critical role in completing construction projects; a lack of these utilities will cause problems on the job site. In India, for example, the use of groundwater for highway building projects is forbidden by government agencies.

TABLE I
RISK EXPLANATION

Risk Identity	**Risk Type**	**Explanation**
	CONSTRUCTION	
C1	Machinery-related risk	Construction is a risky business by nature, and much of the risk stems from the use or use of machinery and equipment. Any case in which a construction worker is injured as a result of being hit by objects, machinery, or equipment is referred to as "struck-by accident."
C2	Rain or other unforeseen circumstances trigger a delay.	Schedule for certain activities are to prepare by keeping the weather of the construction site, unexpected rainfall, and a thunderstorm can create delays.
C3	Uncertain construction market condition	Price escalation can affect the cash flow of the project. It will require more working capital to borrow more material required as per the schedule.
C4	A problem with contractor efficiency	The performance of the various contractors and stakeholders is critical to the overall success of the project. If either of them performs poorly, it will affect the project's goals.
C5	Work-related delays	The extra time needed or incurred beyond the stipulated completion date or beyond the date agreed upon by the project stakeholders to complete the highway project can be described as a delay in highway construction.
	DESIGN	
D1	Road analysis is undergoing growth.	A lack of development in the vicinity of highway projects
D2	Horizontal alignment uncertainty	To avoid bad design, the design team must first thoroughly understand the client's requirements as outlined in the project brief and establish an efficient communication framework among the designers.
D3	Uncertainty in the conditions for entry	Problems such as design variations and defective designs may trigger it.
D4	Indirect costs that are	Uncertain indirect costs and incorrect

	unknown: design, development, and project management	essential criteria while designing are all design hazards.
D5	Errors and omissions in the design	To avoid poor design, the design team must first fully comprehend the client's requirements as outlined in the project brief, as well as create an effective communication structure among the designers.
D6	Improper specific parameters are taken into account.	The physical, quantitative, and visual details of the project are communicated to the contractor by design. Preliminary design can lead to erroneous design goals.
	TOPOGRAPHY	
T1	In the hilly area, construction is taking place.	Highway project workers in hilly areas face many difficulties such as lack of space during highway construction.
T2	Land-sliding events are fraught with uncertainty.	Landslides are more often in hilly areas.
	POLITICAL	
P1	Problems with securing Railway Permits	Stakeholders, supervisors, and executives may disagree about a document's unclear specification, an unidentified obstruction, or the need for additional construction utilities.
P2	Obtaining Government Permits Issues	Local politicians' interference may occur over water, power, or other public concerns that can erode citizens' confidence in them.
P3	Other political or global issues	Political pressure can force an organisation to borrow material from its source, which can result in poor quality.
P4	Policy changes are occurring.	Policy sudden change.
	LAND ACQUISITION	
LA1	Cost of land acquisition is uncertain.	Changes in tax rates, excise duties, customs duties on materials, and other service.
LA2	Schedule for land acquisition is uncertain.	Changes police and impact the schedule.
LA3	Policy changes are occurring.	According to the strategy, is extremely difficult. It raises problems such as high compensation demands or landowners who are unwilling to give up their properties, and it can also lead to conflicts and project delays.
	ENVIRONMENTAL	
E1	Hills, rivers, and trees are examples of natural boundaries.	Highways are constructed by clearing forest and its major problem in the forest areas, need for forest clearance cause problems by forest departments and also by local citizens.
E2	An EIA is needed.	Interdisciplinary teams performing EIA studies are encouraging integrated thought.

		The ability to concentrate resources on risk-reduction initiatives such as waste minimization, pollution control, and mitigation strategies. Focus on emergency management strategies in the event of collisions and the resulting environmental disruption.
	ORGANIZATIONAL	
OR1	Skilled Labour	Because the execution of work is mainly dependent on them, poor labour productivity causes the project to delay. Unskilled labour leads to execution errors and rework.
OR2	The lead group's level of expertise	It denotes the loss of time in loan approvals due to the late submission of necessary documents, and the lender's lengthy approval process will cause the project to delay.
	ACCIDENTAL	
A	During the construction process, there was unanticipated damage.	Unforeseen damage during construction is an unavoidable danger. On construction sites, any form of accident, such as machinery crashes, overexertion, or accidental falls, may be catastrophic for the project.
	UTILITIES	
U1	Utilities were not moved in a timely manner.	A lack of these utilities will cause problems on the job site.
U2	Fuel availability and cost	Fuel resources play a critical role in completing construction projects
U3	Electrification	Electricity resources play a critical role in completing construction projects; a lack of these utilities will cause problems on the job site.
	MINERALS	
M1	Concerns around mineral mining	Minerals are often not easily found in the surrounding space during highway construction, which has caused problems in highway projects.
M2	Mineral prices	Price increases will have an effect on the project's cash flow. It will take more working capital to borrow the additional material available on time.
	LAW AND ORDER	
L&O	Localized disruptions	Local disturbances are widespread, whether it is due to land acquisition, road blockages, or unnecessary noise, for example.
	CLIMATIC CONDITION	
CC	Unexpected weather conditions	Natural disasters such as landslides, earthquakes, tsunamis, and flooding may affect the project's goals.
	OTHERS	

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O1	Construction and product quality	From a strength and safety standpoint, material quality is critical. If minimum requirements not followed, it can damage the structure only during the construction stage.
O2	Money/Funds	Financial disputes that are not resolved on time may affect the budget available for upcoming activities. Unresolved conflicts lead to the contractor's removal of work or other legal issues, damaging the firm's credibility.
O3	Emotional problems	A contractual relationship is also essential. If the parties do not have a close relationship, even minor disputes can lead to legal issues, and since no companies are involved, the likelihood of a conflict increases.
O4	Heritage issues	Due to the heritage site, there are many problems in getting permission.

V. RESEARCH METHODOLOGY

Information is collected by floating a questionnaire survey form on Google and determining the likelihood of a dangerous event. Should investigate the behaviour with the highest probability and should implement strategies to minimize the probability to reduce the likelihood of occurrence. Contractors, subcontractors, transportation engineers, government officials, and other individuals interested in creating the highway project will be the target audience.

The risks were identified and categorized. A questionnaire was created using a "5-point Liker scale," with points 1 through 5 ranging from low risk to very high risk. A questionnaire survey was used to gather data for a sample size of 200 people. Also, used the Risk Potential Value (R.P.V.) method was to compile and analyze the data. Ranked the evaluated risks were according to the severity of their adverse effects on the highway construction project.

VI. DATA COLLECTION

Information is collected by floating a questionnaire survey form on Google and determining the likelihood of a Risk event. The activity with the highest chance should be analyzed and apply methods to reduce the possibility of a lower probability of occurrence. The target audience would be the contractors, subcontractors, transportation engineers, government officials, and other personals involved in developing the highway project.

Risk assessment is known as the procedure for measuring the occurrences discovered during the previous identifying stage. Risk management has two facets. The first measurement of the risk probability (risk frequency); dangers are measured to an extraordinarily unusual extent. The second evaluates the possible impact of the risk if it arises (consequence severity)—the impact of the risk on project success in several ways. Risk effects in the form of higher costs or timetables owing to indirect project results are often noticeable. The project involves certain risks because they affect the public, the public climate, and safety issues. The risk might influence projects indirectly by requiring extra planning, assessment, and management supervision. The primary objective of the risk assessment process is to systematically analyze risk episodes, their likelihood of occurrence, and the consequences of such events.

VII. ANALYSIS OF RISK ASSESSMENT

A variety of methodologies and instruments may be used to integrate and evaluate risks quantitatively. The method used would require a compromise between the complication and usability of the study. There are at least five elements to consider when choosing a quantitative risk strategy:

A. The methodology should include the project team members' explicit knowledge of the venue, architecture, political situation, and project approach.
B. Market dynamics, price levels, and contractual risk distribution should all be adjusted quickly using this approach.
C. The approach should be simple to implement and comprehend.

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The probability of a risk occurring is known as risk probability. The effect on project goals if a risk occurs that can have a negative impact on the project an objective is known as risk impact. The probability and outcome of each detected risk must be evaluated individually.

$$Risk\ Probability = \frac{\sum W}{A * N}$$

Where,
An is a constant that represents the weight given to each answer on a scale of 1 to 5,
n is the likelihood of each response,
N is the total number of responses,
And A is the highest weight (i.e. 5 in this case)

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Where,
An is a constant that represents the weight given to each answer on a scale of 1 to 5,
n is the likelihood of each response,
N is the total number of responses,
And A is the highest weight (i.e. 5 in this case) then,

Risk potential value = Risk Probability x Risk Impact

VIII. USING RISK POTENTIAL VALUE AND GIVEN CATEGORY WISE RANKINGS

TABLE III
RISK EXPLANATION RANKING OF CONSTRUCTION RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
C1	Machinery-related risk	0.1722	0.1606	0.02765532	3
C2	Rain or other unforeseen circumstances trigger a delay	0.1628	0.1578	0.02568984	4
C3	Uncertainty in the Market Condition	0.1582	0.1534	0.02426788	5
C4	A problem with contractor efficiency	0.1698	0.1668	0.02832264	2
C5	Work-related delays	0.1732	0.1744	0.03020608	1

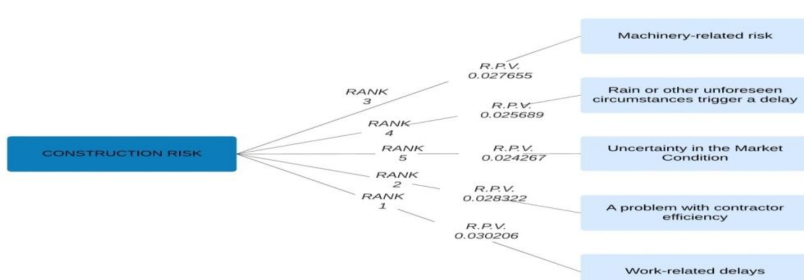

Fig. 1. Flow Chart of Construction Risk Quality Tree

TABLE IIIII
RISK EXPLANATION RANKING OF DESIGN RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
D1	Road analysis is undergoing growth	0.1602	0.1464	0.02345328	5
D2	Horizontal alignment uncertainty	0.1602	0.1464	0.02345328	5
D3	Uncertainty in the conditions for entry	0.1694	0.1594	0.02700236	3
D4	Indirect costs that are unknown: design, development, and project management	0.1726	0.1612	0.02782312	2
D5	Errors and omissions in the design	0.168	0.1658	0.0278544	1
D6	Improper specific parameters are taken into account	0.1606	0.1552	0.02492512	4

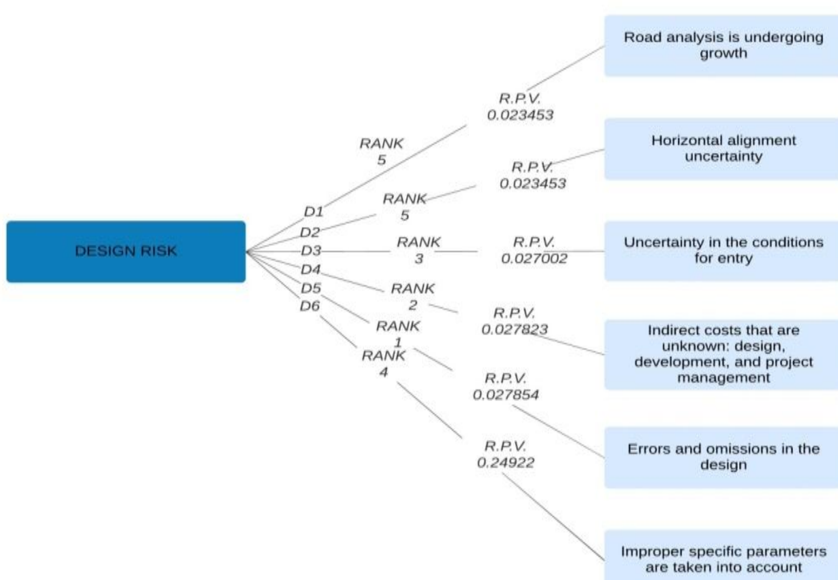

Fig. 2. Flow Chart of Design Risk Quality Tree

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TABLE IVV

RISK EXPLANATION RANKING OF TOPOGRAPHY RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
T1	In the hilly area, construction is taking place	0.1696	0.1696	0.02876416	1
T2	Land-sliding events are fraught with uncertainty.	0.1646	0.16	0.026336	2

TABLE V

RISK EXPLANATION RANKING OF POLITICAL RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
P1	Problems with securing Railway Permits	0.1734	0.1742	0.03020628	1
P2	Obtaining Government Permits Issues	0.1716	0.1684	0.02889744	2
P3	Other political or global issues	0.1662	0.1648	0.02738976	3
P4	Policy changes are occurring	0.1636	0.1584	0.02591424	4

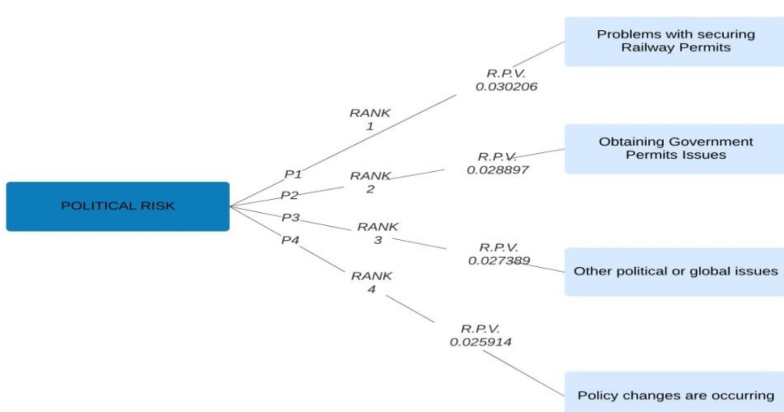

Fig. 3. Flow Chart of Political Risk Quality Tree

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TABLE VV
RISK EXPLANATION RANKING OF LAND ACQUISITION RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
LA1	Cost of land acquisition is uncertain	0.1706	0.1744	0.02975264	1
LA2	Schedule for land acquisition is uncertain	0.168	0.1658	0.0278544	2
LA3	Policy changes are occurring	0.1584	0.1532	0.02426688	3

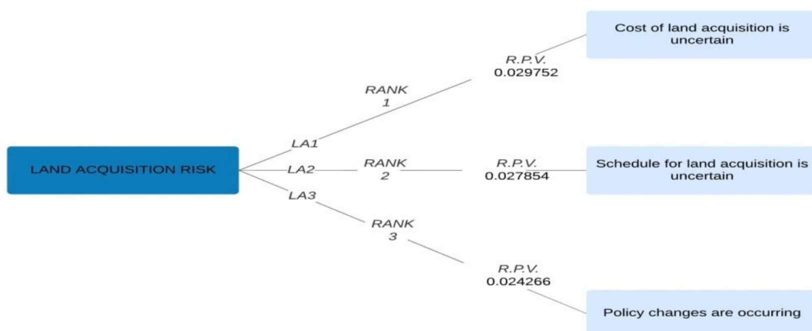

Fig. 4. Flow Chart Of Land Acquisition Risk Quality Tree

TABLE VIVI
RISK EXPLANATION RANKING OF ENVIRONMENTS RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
E1	Hills, rivers, and trees are examples of natural boundaries	0.1602	0.1544	0.02473488	1
E2	An EIA is needed	0.1602	0.1454	0.02329308	2

TABLE VIIVII
RISK EXPLANATION RANKING OF ORGANIZATIONAL RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
OR1	Skilled Labour	0.1606	0.1448	0.02325488	1
OR2	The lead group's level of expertise	0.157	0.1432	0.0224824	2

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TABLE VIIIX
RISK EXPLANATION RANKING OF ACCIDENTAL RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
A	During the construction process, there was unanticipated damage.	0.171	0.171	0.029241	1

TABLE X
RISK EXPLANATION RANKING OF UTILITIES RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
U1	Utilities were not moved in a timely manner	0.1706	0.1672	0.02852432	1
U2	Fuel availability and cost	0.1602	0.1464	0.02345328	3
U3	Electrification	0.159	0.1532	0.0243588	2

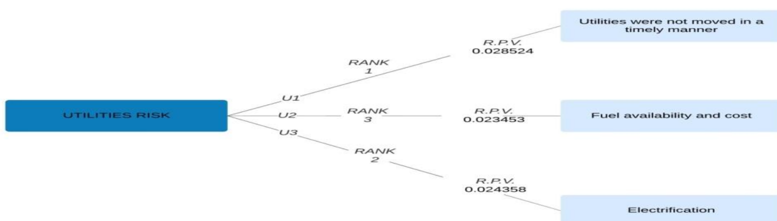

Fig. 5. Flow Chart Of Utilities Risk Quality Tree

TABLE XIX
RISK EXPLANATION RANKING OF MINERALS RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
M1	Concerns around mineral mining	0.1684	0.163	0.0274492	1
M2	Mineral prices	0.1648	0.16	0.026368	2

TABLE XIX
RISK EXPLANATION RANKING OF LAW AND ORDER RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
L&O	Localized disruptions	0.1716	0.1748	0.02999568	1

TABLE XXIII

RISK EXPLANATION RANKING OF CLIMATIC CONDITION RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
CC	Unexpected weather conditions	0.1602	0.1544	0.02473488	1

TABLE XXIV

RISK EXPLANATION RANKING OF OTHERS RISK USING RISK POTENTIAL VALUE

Risk Identity	Risk Name	Risk Impact	Risk Probability	Risk Potential Value	Ranks
O1	Construction and product quality	0.1648	0.1602	0.02640096	3
O2	Money/Funds	0.1738	0.1752	0.03044976	1
O3	Emotional problems	0.1494	0.1566	0.02339604	4
O4	Heritage issues	0.1698	0.171	0.0290358	2

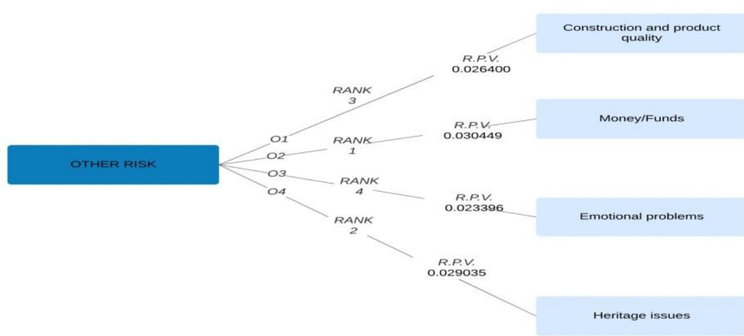

Fig. 6. Flow Chart of Other Risk Quality Tree

IX.CONCLUSION

Since risks can develop at any stage of a roadway project, this study has discovered that a proper risk assessment assesses the quantitative risk assessment. This study offers a complete understanding of how a risk assessment can be performed to evaluate construction risks. Risk management is a helpful tool to enhance decision-making and remedial action in the construction industry. This risk evaluation will improve the risk management and control of any highway construction project. This will also increase the efficiency of highway construction.

Risk identification thorough literature review 36 risk factors identified. The results from the research reveal the 15 most critical factors for the Indian highway construction industry, such as: Money/Funds, Heritage issues, Concerns around mineral mining, Utilities were not moved in a timely manner, Skilled Labour, Hills, rivers, and trees are examples of natural boundaries, Cost of land acquisition is uncertain, Schedule for land acquisition is uncertain, In the hilly area, construction is taking place, Errors and omissions in the design, Indirect costs that are unknown: design, development, and project management, Problems with securing Railway Permits, Obtaining Government Permits Issues, A problem with contractor efficiency and Work-related delays.

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