

## **Risk Analysis and Project Management of Reconstructed Korappuzha bridge using Primavera P6**

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### **Abstract**

There are varieties of risks during the whole phase of bridge construction from start to end. The construction of bridges has higher risk compared with the other engineering construction. The occurrence of risk accidents will lead to great losses to construction enterprises. The risk management of large bridges in construction phase has great significance to prevent the occurrence of construction accidents. Risk analysis is an evaluative process that establishes magnitude of risk on project. Good condition of infrastructure facilities ensures safety and economic well being of society. To find out reasons for failure of bridges, risk analysis were carried out. & the risks were categorized as design risk, construction risk, financial risk. Based on questionnaire survey different risks were ranked. Scheduling is obtained using software Primavera P6 and required scheduling as per site prepared in MSP is collected and then comparisons are made to obtain differences. Through a proper management of bridge project with Primavera P6, we can implement the project within time without any extra losses. This paper aims at using management tool with good management skills can be beneficial to implement site projects more speedy and proper resource distribution.

**Keywords:** Risk Analysis, Primavera P6, Project Management, Scheduling

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### **I. INTRODUCTION**

A “BRIDGE” is a structure built to provide passage over water, valley, or road. Designs of bridges vary depending on the function, nature of the terrain, material & funds. Bridge construction is a complex & systematic work. There are varieties of risks during the whole phase of bridge construction from start to end. The risk management of large bridges in construction phase has great significance to prevent the occurrence of construction accidents. Risk analysis is an evaluative process that establishes magnitude of risk on project. Good condition of infrastructure facilities ensures safety and economic well being of society. To find out reasons for failure of bridges, risk analysis were carried out & the risks were categorized as design risk, construction risk, financial risk, health & safety risk etc. Based on questionnaire survey different risks were ranked & from the data analysed, it is found that design risks & natural risks are the major reasons that lead to reconstruction of bridges. Primavera P6 software is designed to assist project manager in formulation of plan, resources allocation for tasks, tracking the work progress, analyzing the workload and managing the budget. Primavera P6 was used to create WBS, schedules and assign cost to each task. The software helped in evaluating the EVM technique and developing the CPM scheduling of the project. Through a proper management of bridge project with Primavera P6, we can implement the project within time without any extra losses. This paper aims at using management tool with good management skills can be beneficial to implement site projects more speedy and proper resource distribution.

#### **1.2 Objectives**

The main objectives of this project are the following;

- To Identify & Analyse the critical risks affecting performance of Bridges in Calicut.
- To collect major risk factors through a questionnaire survey
- To quantify and rank the risk using statistics
- To find out the reasons behind reconstruction of bridges
- To Develop scheduling and planning using Primavera p6
- To prepare construction sequence for bridge construction

#### **1.3 Scope**

Scope of this study include;

- To find out impact of various risks on bridge

- Strength, weakness, opportunity and threat of projects can be identified
- The progress of the project can be compared with the prepared project schedule.
- Future projects can be completed as per the schedule
- Ensure safety & economic well being of society

## **II. METHODOLOGY**

The project methodology is a way to systematically solve the research problem. It deals with the objective of a research study, the method of defining the research problem, the type of data collected, method used for data collection and analyzing the data etc. the methodology of this project include;

1. Problem statement
2. Literature review
3. Questionnaire design
4. Data collection
5. Data analysis
6. Project Scheduling
7. Results and discussion
8. Conclusion

### **2.1 Questionnaire Design**

The questionnaire design took into consideration the objectives of the study with the aim to answer the research questions. Great effort and brainstorming were done for designing the questionnaire. The questionnaire was prepared which included 7 types of risk factors. Though there were many types of risks which affected the bridge construction projects, those 7 risk factors were considered the most easy to collect all the sub risk factors. Meetings with members from the industry were conducted to identify the right questions required and to present them in a clear and an unambiguous format. Special care also was done for phrasing the questions that is easily understood by respondents. The questionnaire was prepared considering Financial, design, construction, Management, External, Environmental, Human resource risk factors.

### **2.2 Questionnaire Structure**

Based on the extensive literature reviews and expert's advice, the questionnaire consist of fifty risks fewer than seven risk factors. Responses on the extent of effect of those attributes on bridge construction were sought on a five-point ordinal scale: "1" referred to "Insignificant," "2" to "Minor," "3" to "Moderate," "4" to "Major," and "5" to "Catastrophic".

## **III. DATA COLLECTION**

Data collection is done by site visit and questionnaire survey. Different risk factors in Bridge construction projects were identified through detailed literature review. 7 major risk factors were identified from the study. Datas were collected from 10 Bridge construction sites. Responses are taken from Project engineer, Assistant engineer, Chief engineer, Project Manager, Contractor, staff respectively. Remedial measures were identified for the risk factors which have more impact on construction sites. Also, questionnaire survey is conducted to find out the impact of these remedial measures. The Financial, design, construction, Management, External, Environmental, Human resource risk factors and the responses from the data collection on the impact of these risk factors are obtained from the data collection. Sufficient datas were also collected from Korappuzha bridge site for the preparation of project schedule using primavera.

## **IV. DATA ANALYSIS**

The datas obtained from questionnaire survey is analysed to find the critical factors and to rank those factors. And also to find suggestions or remedial measures for the risk factors which have major impact on the Bridge construction sites. Ranking is done by using software Ms Excel. The various risks were categorized separately & total percentage of each of them were calculated & tabulated. In order to understand the results in detail Pie diagrams were prepared. After finding out the percentage of each category of risk, the final results were again tabulated in which the different percentage of risk were listed in a chronological order. After analysing the table, the higher percentage of risk related to bridge construction can be find out.

The bridge across Korappuzha on the National Highway, which was almost a century old and constructed by the British, was demolished in December 2018 as it was in a dangerous condition. As a huge sum had to be spent on its maintenance, the authorities decided to build a new bridge and the Kerala Infrastructure Investment Fund Board (KIIFB) released funds for the purpose. The new bridge was built by the Kerala Road Fund Board and the National Highway division of the Public Works Department. It is 12-metre-wide, has a 7.5-metre carriageway, and a 1.5 metre-wide footpath on both sides. There are 150-metre-long approach roads on both the banks of the river. Reconstruction of Korappuzha bridge was done by ULCCS

**4.1 Percentage of Construction Risk Factors**

Table 1 shows the Percentage of Construction Risk Factors & Figure 1 shows its Bar diagram. Average percentage of construction risk is 15.3%

**Table 1 Percentage of Construction Risk Factors**

1. How do you rank construction risks	1	2	3	4	5	Percentage
Lack Of Budget	6	4	3	4	0	12
Inflation	5	6	3	4	0	10.66
Material Price Growth	4	8	3	4	0	12.66
Delays In Financial Payments	7	2	3	4	0	10.66
Financial Failure Of Contractor	7	2	3	4	0	11.33
Economics Losses	6	4	3	4	0	12
Incomplete Cost Estimation	5	6	3	4	0	12
Lack Of Budget	5	6	3	4	0	12.66
Inflation	3	10	3	4	0	23.33
Material Price Growth	1	2	6	16	10	35

**Construction Risk = 15.3%**

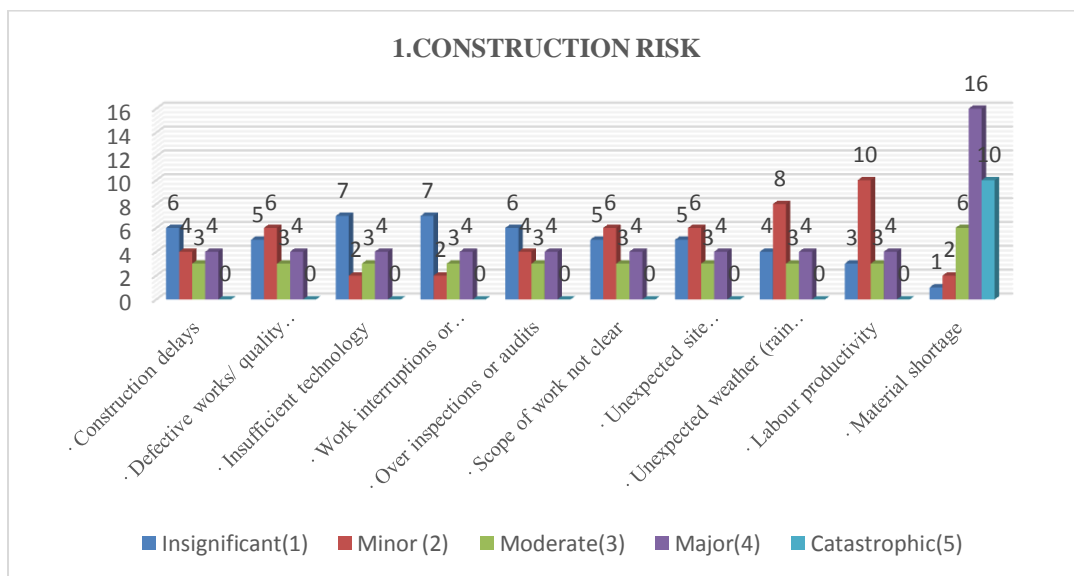


Fig 1 Bar diagram of construction risk

**4.2 Percentage of Design Risk Factors**

Table 2 shows the Percentage of Design Risk Factors & Figure 2 shows its Bar diagram. Average percentage of Design risk is 21.66 %

**Table 2 Percentage of Design Risk Factors**

2. How do you rank Design risks	1	2	3	4	5	Percentage
· Design changes	1	2	18	4	5	20
· Incomplete design	1	2	6	16	10	23.33
· Insufficient inspections on site	2	2	3	4	25	24
· Error in design by planner	2	8	6	16	0	21.33
· Error in drawing or specification	2	8	6	16	0	21.33
· Unclear information about the scope of the work at the time of job description	1	2	18	4	5	20

**Design Risks = 21.667 %**

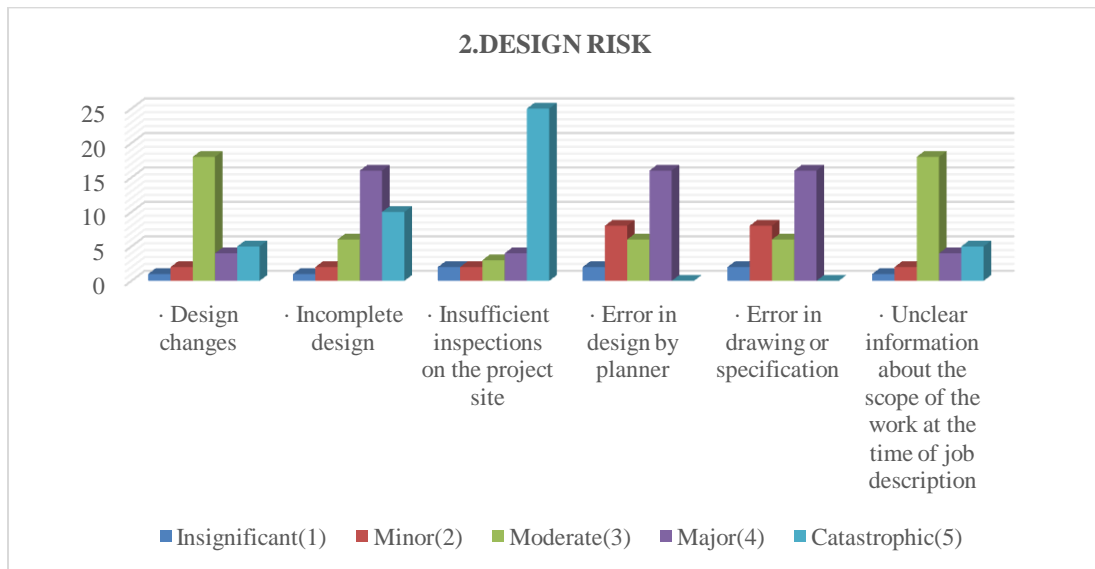


Fig 2 Bar diagram of construction risk

**4.3 Percentage of Health& Safety Risk Factors**

Table 3 shows the Percentage of Health& Safety Risk Factors & Figure 3 shows its Bar diagram. Average percentage of Health& Safety risk is 15.55%

**Table 3 Percentage of Health& Safety Risk Factors**

3. How do you rank Health& Safety rank risks	1	2	3	4	5	Percentage
· Accidents	0	4	9	20	0	22
· Equipment And Property Damage	1	6	18	0	0	16.6
· Fatality	8	4	0	0	0	8

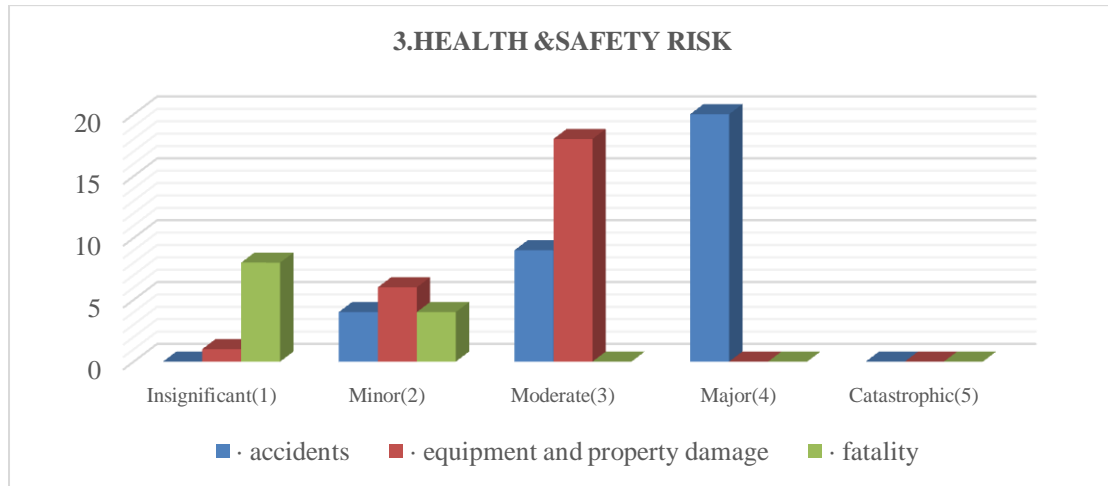


Fig 3 Bar diagram of Health & Safety risk

**4.4 Percentage of Human Resource Risk Factors**

Table 3 shows the Percentage of Human Resource Risk Factors & Figure 3 shows its Bar diagram. Average percentage of Health& Safety risk is 16.66 %

**Table 4 Percentage of Human Resource Risk Factors**

4. How do you rank Human Resource risks	1	2	3	4	5	Percentage
· Less professional	7	6	0	0	0	8.66
· Less labour	9	4	0	0	0	8.66
· Low labour ability	8	6	0	0	0	9.33
· Low labourproductivity	7	6	0	0	0	8.66

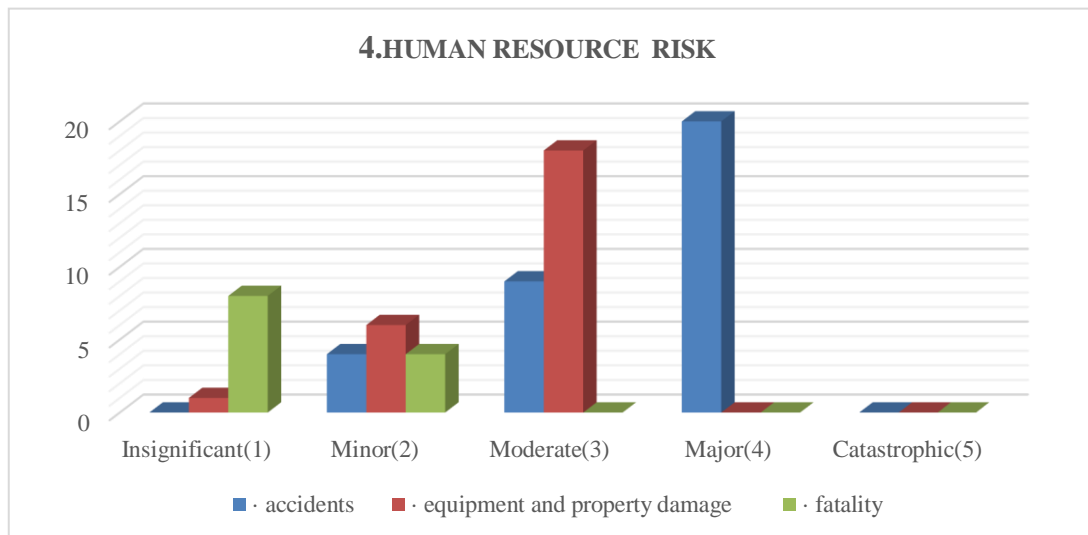


Fig. 4 Bar diagram of Human Resource risk

**4.5 Percentage of Management Risk Factors**

Table 5 shows the Percentage of Management Risk Factors. Average percentage of Management risk is 11.11%

**Table 5 Percentage of Management Risk Factors**

1. How do you rank Management risks	1	2	3	4	5	Percentage
Error in understanding contract document	8	4	0	0	0	8
Document is incomplete	9	2	0	0	0	7.33
Less coordination	4	2	15	0	0	14
Dispute	7	4	3	0	0	9.33
Insufficient engineers and specialists	4	10	3	0	0	11.33
Inadequate project planning	4	6	6	4	0	13.33
strikes and theft	8	4	0	0	0	8
Inadequate project information	9	2	0	0	0	7.33
Error in choosing implementation method	9	2	0	0	0	7.33
Strict project schedule	6	4	3	4	0	11.33
Poor programme scheduling	4	4	6	8	0	14.66
Delay during construction process	1	4	12	12	0	19.33
Many work errors require rework	8	4	0	0	0	8
Poor site management and supervision	5	6	6	0	0	11.33
Subcontractor failure	7	6	0	0	0	8.66

**4.6 Percentage of Financial Risk Factors**

Table 6 shows the Percentage of Financial Risk Factors. Average percentage of Financial risk is 13.42%

**Table 6 Percentage of Financial Risk Factors**

1. How do you rank Financial risks	1	2	3	4	5	Percentage
Lack Of Budget	5	4	6	4	0	12.66
Inflation	4	8	3	4	0	12.66
Material Price Growth	0	8	12	8	0	18.66
Delays In Financial Payments	3	8	9	8	0	18.66
Financial Failure Of Contractor	7	6	3	0	0	10.66
Economics Losses	4	6	6	4	0	13.33
Incomplete Cost Estimation	9	2	0	0	0	7.33

**4.7 Percentage of External Risk Factors**

Table 7 shows the Percentage of External Risk Factors. Average percentage of External risk is 15.86 %

**Table 7 Percentage of External Risk Factors**

7. How do you rank External risks	1	2	3	4	5	Percentage
Delay in approval from regulatory bodies	1	2	24	0	0	18
Political instability	2	2	21	0	0	16.66
Third party delay	2	2	21	0	0	16.66
Unstable government policies	0	2	27	0	0	19.33
Unavailability of fund or right of way (ROW) is not clear	8	2	3	0	0	8.66

**4.8 Percentage of Nature & Environmental Risk Factors**

Table 8 shows the Percentage of Nature & Environmental Risk Factors. Average percentage of Nature & Environmental risk is 22.47 %.

**Table 8 Percentage of Nature & Environmental Risk Factors**

1. How do you rank Nature & Environmental risks	1	2	3	4	5	Percentage
Earthquake	0	0	3	16	25	29.33
Landslide	2	6	15	0	0	15.33
Bad weather	0	0	0	4	45	32.66
Late permissions	0	0	3	8	35	30.66
A less secure project development environment	0	0	3	8	35	30.66
Unstable government policy	7	4	3	0	0	9.33
Excessive government approval procedures	7	4	3	0	0	9.33

**V. PROJECT SCHEDULING**

Scheduling basically means determining the interrelationship of various activities of a project. The activities are listed out and then their duration is estimated on the basis of past experiences. Primavera P6 software is designed to assist project manager in formulation of plan, resources allocation for tasks, tracking the work progress, analyzing the workload and managing the budget. Primavera P6 was used to create WBS, schedules and assign cost to each task. The software helped in evaluating the EVM technique and developing the CPM scheduling of the project. The various activities included in Korappuzha bridge construction is given below as a table in Primavera software. The work is divided as preconstruction work, construction work, drain work & road work. They are categorized under different headings in WBS (work break down structure). By feeding the Work Breakdown Structure, tasks, subtasks, durations, predecessors, resources allocation and leveling for every activity, tracking of the project for every 15 days using earned value technique has been done. Scheduling details of Korappuzha bridge project & Network diagrams prepared based on this data is given below.

**Table 9 Procedure in primavera**

SL NO	PROCEDURE IN PRIMAVERA
1	Create EPS(Enterprise Project Structure)
2	Create Project
3	Define WBS
4	Creating Calendar
5	Define Activities
6	Durations for every Activity
7	Giving relation for every activity and Perform Scheduling
8	Allocating Resources/Budgeting
9	Leveling of resources
10	Creating Baselines
11	Updating schedule
12	Earned Value Analysis
13	Exporting f Reports

**VI. RESULTS & DISCUSSION**

To find out reasons for failure of bridges, risk analysis were carried out on selected bridges . Therisks were categorized as design risk, construction risk , financial risk, health & safety risk etc. Based on questionnaire survey different risks were ranked. From the data analysed, it is found that design risks & natural risks are more crucial.

- From the collected data analysis were done with the help of bar diagrams & different category of risks were ranked and tabulated un the given table.
- From this table it is clear that nature and environmental risk is ranked as 1 which is about 22.47 % based on results of questionnaire survey.
- Design risk were ranked as 2 which is about 21.66% from the results.
- The major reasons for failure bridges are due to various risk factors under nature & environmental conditions risk & design risk

**Table 10. Ranking of risks**

Type Of Risk	Percentage	Rank
Nature & Environmental Risk	22.47%	1
Design Risk	21.667%	2
External Risk	15.86 %	3
Health & Safety Risk	15.55 %	4
Construction Risk	15.3%	5
Financial Risk	13.42 %	6
Management Risk	11.11%	7
Human Resource Risk	8.3%	8

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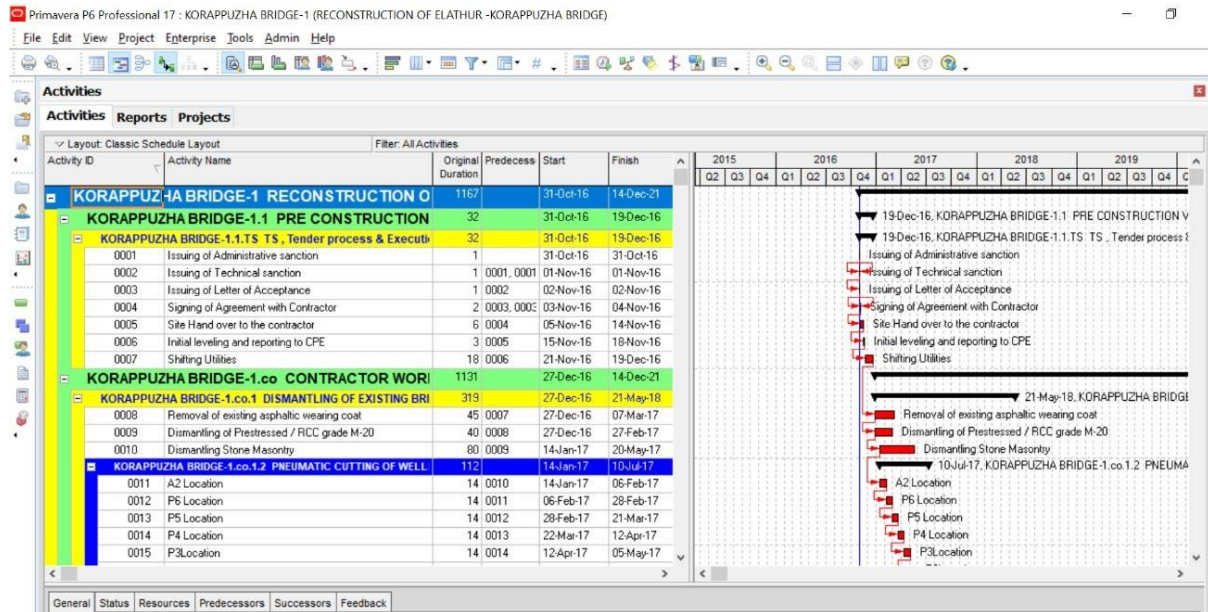


Fig 5. Scheduling of korappuzha bridge

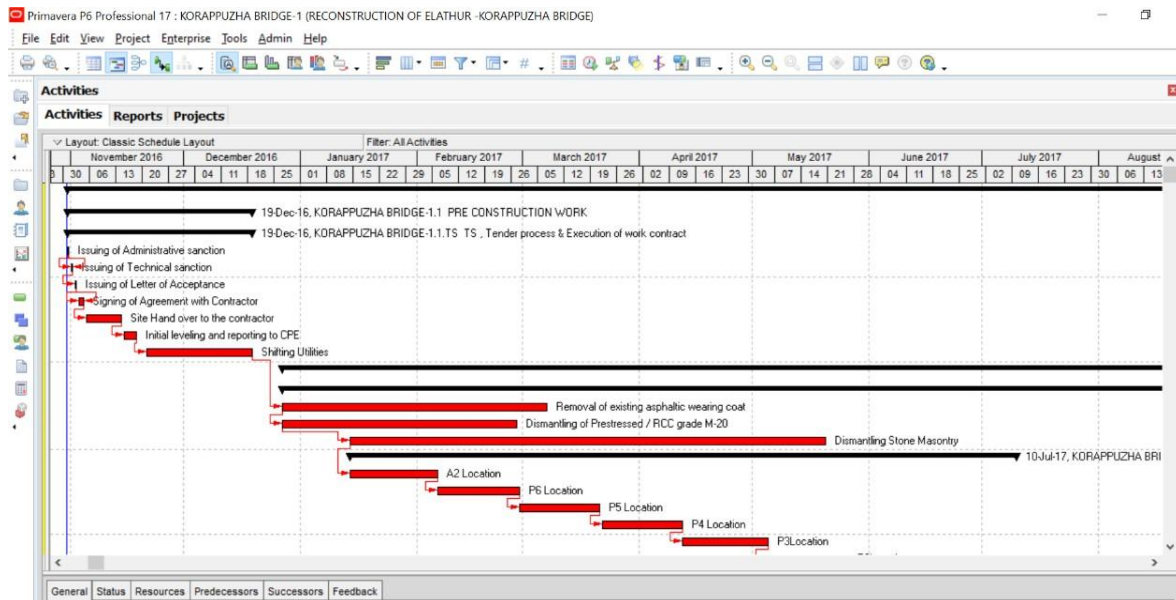


Fig 6. Network Diagram of korappuzha bridge

## VII. CONCLUSION

To find out reasons for failure of bridges, risk analysis were carried out & the risks were categorized as design risk, construction risk, financial risk, health & safety risk etc. Based on questionnaire survey different risks were ranked & from the data analysed, it is found that design risks & natural risks are the major reasons that lead to reconstruction of bridge. Scheduling is obtained using software Primavera P6 and required scheduling as per site prepared in MSP is collected and then comparisons are made to obtain differences. Through a proper management of bridge project with Primavera we can implement the project within time without any extra losses. Here we can conclude that using management tool with good management skills can be beneficial to implement site projects more speedy.

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- Based on questionnaire survey different risks were ranked & from the data analysed, it is found that design risks & natural risks are the major reasons that lead to reconstruction of bridges.
- In this study, Scheduling is obtained using software Primavera P6 and required scheduling as per site prepared in MSP is collected and then comparisons are made to obtain differences
- Through a proper management of bridge project with Primavera P6 we can implement the project

within time without any extra losses

- Here the most important benefit is that we completed the project within given time limit which will minimize the risk of natural calamities.
- Here we can conclude that using management tool with good management skills can be beneficial to implement site projects more speedy and proper resource distribution

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