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Feasible Route Proposal by Risk Assessment of a Congested Bypass

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Abstract - *A Bypass is a popular mode of transport in India and is considered to be the best solution to heavy road traffic congestion. Bypass routes are often controversial, as they require the building of a road carrying heavy traffic where no road previously existed. This creates a conflict between those who support a bypass to reduce congestion in a built-up area, and those who oppose the development of (often rural) undeveloped land. From the traffic volume survey conducted at both Amalanagar and Mannuthy, it was clear that the traffic congestion occurs on both junctions. It was about two decades ago that the authorities first mooted the idea of constructing a bypass connecting Amalanagar and Mannuthy to decongest the roads to Thrissur town. But this consists of a no. of blind curves and intersections. The major activities involved in the construction of this Bypass construction were listed out. A no. of new efficient routes was proposed by the project team. Risk assessment and feasibility study will help to point out the key problems in a construction project design. This paper focuses on the risk assessment of route proposed by government authorities and a proposal of efficient, feasible bypass route design from Amalanagar to Mannuthy. Also, a soil investigation is carried out in 5 different locations in between the route proposed by project team at an interval of 2.46 kms for assessing the quality of soil in the route proposed by project team.*

Key Words: **Composite Impact Factor (CIF), Composite Likelihood Factor (CLF), Peak Hour Factor, Risk Assessment, Risk Severity Survey, Spearman's Rank Correlation**

1. INTRODUCTION

Road traffic congestion is a big problem in Kerala. As Kerala is a part of a developing country, road transport is a main factor which affects the social and economic fields. Bypass routes are often controversial, as they require the building of a road carrying heavy traffic where no road previously existed. This creates a conflict between those who support a bypass to reduce congestion in a built up area, and those who oppose the development of (often rural) undeveloped land. However, those of the bypassed city may also oppose the project, as the reduced traffic could damage business. It was about two decades ago that the authorities first mooted the idea of constructing a bypass connecting Amalanagar and Mannuthy to decongest the roads to Thrissur town. However, no plan or proposal was materialized and in-between local governing bodies continued sanctioning new construction projects in the area. By now, hundreds of houses have come up beside the 14.3km road that has about eight to 10 metres of width in most of the portions.

The KSTP has now been entrusted with the preparation of detailed project report for the Mannuthy-Amalanagar bypass. What made the locals furious was that the authorities, who had declared earlier that the bypass would have a width of 22m, have now announced through the tender that the bypass will be of 45m width.

Interestingly, the present Amalanagar-Mannuthy road, proposed to convert into bypass, has dozens of blind corners, a rail-over-bridge constructed as half-circle with just 5.7m width (not ideal to ply heavy vehicles), two government schools, many churches and temples along the stretch. According to the protesters, even the district authorities and a few politicians have secretly admitted that the bypass proposal is unscientific. They now doubt that the 45m wide bypass proposal was mooted only to help land mafia who own acres of land in the area.

The bypass action council has urged the authorities to change the alignment of the road to minimize the number of evacuees. The Kolazhy grama panchayat and Puzhakkal block panchayat also had sent a memorandum to the government with the same request. But authorities have refused to consider these requests, they alleged. The survey will collect information including buildings to be demolished, farmlands to be reclaimed, canals to be constructed, trees to be felled, electric poles to be shifted and other development works. So, it is necessary to find a feasible route for this bypass.

Alignment proposed for this bypass road by authorities having several intersections and bends. The return trips will have to cross the same hurdles. This is the relevance of this study.

1.1 Objectives

•To identify and analyze the risks with each construction activity of the Bypass construction from Amalanagar to Mannuthy.

•To analyse the Risk severity.

•To analyse the correlation between different parties involved in the construction of a Bypass, like Engineers, Contractors, Land owners etc.

•To propose a feasible route for the same by considering different social, geographical and economic factors.

2. METHODOLOGY

A traffic volume survey was conducted at both Amalanagar and Mannuthy for evaluating the traffic congestion on both junctions. The major activities involved in the first phase of Bypass construction are listed out. A detailed questionnaire consisting of all the identified risks has been framed and survey was conducted between the parties involved in the construction team. For qualitative analysis, the probability and impact of each risk was assessed and composite likelihood factor and composite impact factor was calculated. Risk severity for each activity was then calculated. Again these surveys were repeated in the case of the route proposed. Then a soil investigation was carried out in 5 different locations in between the route proposed at an interval of 2.46 kms.

3. DATA COLLECTED

As a part of the study, the following data were collected.

3.1 Traffic Study

The data collected after conducting traffic volume study at Amalanagar junction and Mannuthi is tabulated in Tables 1, 2 & 3.

Table -1: Observations of traffic volume survey with PCU calculations for Amalanagar junction

Start Time	End Time	No. of buses * PCU [PCU = 3.5]	No. of cars * PCU [PCU = 1]	No. Of 3-wheelers * PCU [PCU = 0.8]	No. Of 2-wheeler * PCU [PCU = 0.5]	No. Of trucks * PCU [PCU = 3.5]	No. Of cycles * PCU [PCU = 0.2]	Flow in PCU		
8:00 AM	8.15AM	157.5	58	92.8	70	31.5	1	410.8		
8.15	8.30	143.5	65	71.2	68	31.5	0.6	379.8		
8.30	8.45	203	75	46.4	67	24.5	0.8	416.7		
8.45	9.00	217	84	48.8	81.5	28	0.6	459.9		
9.00	9.15	192.5	115	41.6	108.5	24.5	1	483.1	Total 1983.9	PHF 0.909878921
9.15	9.30	199.5	126	60.8	118.5	38.5	1.8	545.1		
9.30	9.45	157.5	127	76.8	92.5	24.5	0	478.3		
9.45	10.00	175	105	76	96.5	24.5	0.4	477.4		
10.00	10.15	119	118	64	83.5	21	0.8	406.3		
10.15	10.30	129.5	104	100.8	66	17.5	0.2	418		
10.30	10.45	161	86	62.4	42	24.5	0.6	376.5		
10.45	11.00	210	80	48	42.5	17.5	0	398		
0.63	3.15PM	140	108	56.8	49	17.5	0.8	372.1		
3.15	3.30	252	111	52	55	10.5	1.6	482.1		
3.30	3.45	255.5	111	68	66.5	10.5	2.2	513.7		
3.45	4.00	199.5	124	68.8	86.5	21	1	500.8		
4.00	4.15	192.5	125	84.8	117	24.5	2	545.8		
4.15	4.30	238	129	92.8	109	14	1.8	584.6	Total 2370.3	PHF 0.971593704
4.30	4.45	245	139	72	133.5	10.5	0.4	600.4		
4.45	5.00	252	137	80.8	131.5	7	1.6	609.9		
5.00	5.15	220.5	132	92.8	107.5	21	1.6	575.4		
5.15	5.30	206.5	107	73.6	98	28	1.2	514.3		
5.30	5.45	175	103	76	73.5	31.5	0.2	459.2		
5.45	6.00	161	94	74.4	76.5	31.5	0.8	438.2		
TOTAL		2537.5	1420	892.8	1103.5	227.5	15.2	6196.5		

Table -2: Observations of traffic volume survey with PCU calculations for Mannuthi junction

Start Time	End Time	No. Of buses * PCU [PCU = 3.5]	No. Of cars * pcu [PCU = 1]	No. Of 3-wheelers * PCU [PCU = 0.8]	No. Of 2-wheeler * PCU [PCU = 0.5]	No. Of trucks * PCU [PCU = 3.5]	No. Of cycles * pcu [PCU = 0.2]	Flow in PCU		
8	8.15	112	51	64	56	21	1.6	305.6		
8.15	8.3	171.5	57	65.6	55.5	17.5	1	368.1		
8.3	8.45	196	63	72	56.5	17.5	1	406		
8.45	9	203	75	71.2	59.5	17.5	0.6	426.8		
9	9.15	210	109	88	96	28	0.8	531.8	Total 2123.4	PHF 0.951003225
9.15	9.3	206.5	124	72	102.5	35	0.8	540.8		
9.3	9.45	217	119	82.4	111	28	0.8	558.2		
9.45	10	192.5	109	72.8	93	24.5	0.8	492.6		
10	10.15	168	108	76	90	31.5	0.6	474.1		
10.15	10.3	147	95	62.4	76.5	28	0.8	409.7		
10.3	10.45	133	80	63.2	57.5	17.5	0.4	351.6		
10.45	11	119	62	60.8	52	14	0.4	308.2		
Total		2075.5	1052	850.4	906	280	9.6	5173.5		
3	3.15	161	73	64.8	54	31.5	0.4	384.7		
3.15	3.3	147	87	57.6	67	42	0.6	401.2		
3.3	3.45	175	81	46.4	81	21	1	405.4		
3.45	4	182	90	63.2	104	17.5	1.6	458.3		
4	4.15	129.5	110	107.2	81.5	28	0.8	457		
4.15	4.3	189	127	125.6	108.5	31.5	1.2	582.8	Total 2170.8	PHF 0.931194235
4.3	4.45	143.5	137	117.6	124	31.5	0.6	554.2		
4.45	5	168	108	120.8	113.5	21	0.6	531.9		
5	5.15	150.5	115	106.4	94	35	1	501.9		
5.15	5.3	136.5	117	80.8	55.5	17.5	0.4	407.7		
5.3	5.45	168	113	68.8	49	24.5	0.6	423.9		
5.45	6	185.5	92	62.4	46	10.5	0.6	397		
Total		1935.5	1250	1021.6	978	311.5	9.4	5506		

3.1 Risk Severity Survey

Personally approaching 25 experts having adequate experience in PWD projects questionnaires were circulated to get response with respect to the likelihood of occurrence and the impacts associated with each risk based on their experience. The experts were engineers, people in charge of quality assurance / quality control and safety, etc. The mean of the all responses of respective risk likelihoods and their associated impacts in the related activities were considered. The value of likelihood and impact varies from 0 to 1 and sum of the weightages on local priority basis is 1. The composite likelihood and composite impact factor of each activity was determined. The major activities and common risks identified in the project are given in Table 4. From initial activity of survey works to the finishing works, a lot of risks are coming under each activity which is listed in Table 5.

Table -3: PHF Observations of traffic volume survey

Name of junction	Time duration	Peak hours	PHF	Condition
Amalanagar Junction	08.00 to 11.00 AM	09.00 TO 10.00 AM	0.91	Urban area
Mannuthy Junction	08.00 to 11.00 AM	09.00 TO 10.00 AM	0.95	Congested area
Amalanagar Junction	03.00 to 06.00 PM	04.15 TO 05.15 PM	0.97	Congested area
Mannuthy Junction	03.00 to 06.00 PM	04.15 TO 05.15 PM	0.93	Congested area

3.2 Spearman's rank correlation method

Correlation analysis is used to determine the degree of relationship between contractors, engineers and land owners. As the data are irregular, we can use Spearman's rank correlation coefficient to analyze this. The data collected by government authorities and our group by Spearman's survey is tabulated in Table 10 and Table 11.

Table -4: Major activities identified in the construction of Amalanagar – Mannuthy bypass

Sl No.	Description
1	Survey works
2	Issuance of drawings and other permission from PWD
3	Land acquisition risks
4	Traffic diversion
5	Utility diversion
6	Road widening
7	Barricading board fixing

Table -5: Identification and classification of risks involved in the project

Sl No.	Risk classification nomenclature	Risk description
1	PEPR 1	Pre-execution project risk- risks in survey works
2	PEPR 2	Risks in getting drawings and other permission from PWD
3	PEPR 3	Land acquisition risks
4	PEPR 4	Risks in traffic diversion works
5	PEPR 5	Risks in utility diversion works
6	PEPR 6	Risks in road widening
7	PEPR 7	Risks in barricading board fixing

Project risk (activity) description	CLF	CIF	Severity	
			Quantitative CLF * CIF	Classification
PEPR 1	0.761	0.395	0.300516	High
PEPR 2	0.669	0.765	0.511785	Very High
PEPR 3	0.968	0.808	0.78174	Very High
PEPR 4	0.62	0.827	0.51274	Very High
PEPR 5	0.575	0.7	0.4025	Very High
PEPR 6	0.818	0.789	0.645402	Very High
PEPR 7	0.614	0.676	0.415334	Very High

Table -7: Risk severity analysis of total project proposed by our group

Description of project risk (activity)	CLF	CIF	Severity	
			Quantitative CLF * CIF	Classification
PEPR 1	0.761	0.395	0.300516	High
PEPR 2	0.669	0.765	0.511785	Very High
PEPR 3	0.968	0.808	0.78174	Very High
PEPR 4	0.62	0.827	0.51274	Very High
PEPR 5	0.575	0.7	0.4025	Very High
PEPR 6	0.818	0.789	0.645402	Very High
PEPR 7	0.614	0.676	0.415334	Very High

Table -8: Correlation among participants on Importance of risks determined by Government authorities

	Engineer	Contractor	Land owner
Engineer	1		
Contractor	0.19	1	
Land owner	0.04	0.19	1

Table -9: Correlation among participants on Importance of risks determined by our group

	Engineer	Contractor	Land owner
Engineer	1		
Contractor	0.70	1	
Land owner	0.55	0.36	1

4. SOLUTION FOR PROBLEM

4.1. Route map proposed by this study

Based on the above studies it was noted that the route proposed by government authorities is absolutely

unscientific and it causes too many land acquisition problems. The proposed Mannuthy – Amalanagar bypass road is passing through Viyyur power house junction towards Amalanagar via Viyyur, Pamboor, Kuttur, Chamakkad and Choorakkattukara. As a bypass is meant to connect two highways or two crowded roads, it should be straight for possible extend. Also the route proposed by government authorities has several junctions, intersections and sharp bends which can lead to traffic blocks in the Shornur road as well as in Kottekkad road. Also this is an issue affecting more than 1600 people residing in about 380 houses, about 285 shops, 2 churches, 4 chapels, 2 temples, 3 schools, 4 cooperative societies, a veterinary clinic and a bank. So there are 3 routes proposed with the help of Google map by this Project team with a sub route which will be a perfect solution for these problems. The route proposed by this project team is connecting Amalanagar, Chamakkad, Kuttur, Attore, Kolazhi, RV puram, Nettissery, Mannuthy, where the empty lands are utilised more for the road other than demolition of buildings.

Table -10: Spearman's survey results and analysis determined by Government authorities

Risks	Engineer		Contractor		Land Owner		Overall	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Poor relationship between parties	3.32	1	1.64	24.5	2.52	17	2.493	1
Inadequate Planning	1.96	8.5	2.08	6	3.76	2	2.6	2
Inappropriate Risk Allocation	2.36	2	1.92	12.5	3.12	10.5	2.467	3.5
Poor Co-Ordination	1.76	16.33	3.68	1	4	1	3.147	3.5
Claims And Disputes	2.08	3.5	1.88	14	3.28	5	2.413	5.5
Insufficient Technologies	1.8	14.5	2.32	2	3.12	10.5	2.413	5.5
Quality Variations	1.6	23.5	1.84	15.33	3.68	3	2.373	7.33
Adequacy Of Insurance	1.76	16.33	1.84	15.33	3.52	4	2.373	7.33
Organizational Interface	2	6.5	1.92	12.5	3.2	7.33	2.373	7.33
Feasibility Of Construction	1.96	8.5	2.04	7	3.08	12.5	2.36	10
Shortage Of Labour, Equipment And Materials	1.88	11	1.76	19	3.08	12.5	2.24	11.5
Delay Of Drawing Supply	2	6.5	2	8.5	3.2	7.33	2.4	11.5
Quality Of Work	1.56	25	1.96	10.5	3.2	7.33	2.24	13
Inadequate Management Methods	1.72	19.33	1.72	20	3.24	6	2.227	14.5
Conflicts In Documents	2.04	5	1.96	10.5	2.68	16	2.227	14.5
Quality Of Material Or Equipment	1.84	12.5	1.68	21.33	2.92	15	2.147	16
Site Access	2.08	3.5	2.28	3	2	20	2.12	17
Safety	1.64	22	1.68	21.33	2.96	14	2.093	18
Changes In Codes And Regulations	1.72	19.33	1.8	18	2.44	18	1.987	19
Failure To Identify Risks	1.8	14.5	2	8.5	2.12	19	1.973	20
Shortage Of Skills/Methods	1.92	10	2.16	4.5	1.8	23.5	1.96	21
Financial	1.76	16.33	1.84	15.33	1.92	21	1.84	22
Unforeseen Site Conditions	1.72	19.33	2.16	4.5	1.8	23.5	1.893	23
Bad Weather Conditions	1.84	12.5	1.64	24.5	1.88	22	1.787	24
Inadequate Or Incorrect Design	1.6	23.5	1.68	21.33	1.52	25	1.6	25

Table -11: Spearman's survey results and analysis determined by our group

Risks	Engineer		Contractor		Land Owner		Overall	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Delay Of Drawing Supply	3.64	1	3.56	1.5	4.16	7	3.787	1
Quality Variations	3.4	2	3.56	1.5	4.24	5.5	3.733	2
Unforeseen Site Conditions	3.16	3.5	3.32	3.5	4.36	2.5	3.613	3
Site Access	3.16	3.5	2.4	21.5	4.44	1	3.333	4
Safety	2.72	10.5	2.92	8	4.24	5.5	3.293	5
Failure To Identify Risks	3	6	2.96	7	3.88	9	3.28	6
Financial	3.04	5	3	6	3.76	10	3.267	7
Inappropriate Risk Allocation	2.56	15.5	2.76	9.33	4.36	2.5	3.227	8
Inadequate Planning	2.56	15.5	2.72	12	4.28	4	3.187	9
Feasibility Of Construction	2.88	8	2.48	19	4	8	3.12	10
Changes In Codes And Regulations	2.96	7	3.04	5	3.28	15	3.093	11
Inadequate Or Incorrect Design	2.84	9	2.76	9.33	3.52	13	3.04	12
Organizational Interface	2.64	12.33	3.32	3.5	3.08	18	3.013	13
Shortage Of Skills/Methods	2.64	12.33	2.6	14	3.44	14	2.893	14
Inadequate Management Methods	2.64	12.33	2.76	9.33	2.96	21.33	2.787	15
Poor Co-Ordination	2.72	10.5	2.52	15.25	2.96	21.33	2.733	16
Quality Of Work	2.4	18	2.52	15.25	3.2	16	2.707	17.5
Adequacy Of Insurance	2.04	25	2.44	20	3.64	11	2.707	17.5
Shortage Of Labour, Equipment And Materials	2.16	23	2.32	23	3.56	12	2.68	19
Conflicts In Documents	2.28	21	2.52	15.25	3.16	17	2.653	20
Poor Relationship Between Parties	2.36	19.5	2.52	15.25	2.96	21.33	2.613	21
Insufficient Technologies	2.36	19.5	2.68	13	2.68	25	2.573	22
Claims And Disputes	2.44	17	2.4	21.5	2.8	24	2.547	23
Bad Weather Conditions	2.12	24	2.2	24	3	19.5	2.44	24
Quality Of Material Or Equipment	2.24	22	1.88	25	3	19.5	2.373	25

4.2. Traffic study analysis and the need of a bypass through Amalanagar and Mannuthy

As per the traffic volume survey conducted, the traffic conditions at both junctions are of heavy traffic. The peak hour at Amalanagar Junction in the morning is 09.00 to 10.00 AM and in the evening it is 04.15 to 05.15 PM. The peak hours are same at Mannuthy junction also. PHF is of high values that shows congested traffic condition is got from both junctions. So a bypass through another route is necessary to reduce this traffic congestion. There comes the relevance of the Bypass route proposed by this project team.

4.3. Spearman Rank correlation comparison and analysis

Overall, the five most important risks in each route are;

Table -12: Major risks identified in each routes

Major Risks In Gov. Proposed Route	Major Risks In Route Proposed Y Project Team
Poor Relationship Between Parties	Delay Of Drawing Supply
Inadequate planning	Quality variations
Inappropriate risk allocation	Unforeseen site conditions
Poor co-ordination	Site access
Claims and disputes	Safety

From Tables 8 and 9, it is clear that the correlation between different parties is very low in the case of government proposed route. Spearman rank correlation coefficient r between groups show that the risk ranking of engineers have less agreement with contractors (0.19) and land owners (0.04). The correlation between different parties is comparatively very high in the case of route proposed by the project team. The spearman rank correlation coefficient r between groups show that the risk ranking of engineers have significant agreement with contractors (0.70) and land owners (0.55).

4.4. Risk Severity Comparison

From the Tables 6 and 7, it is clear that the route proposed in this study has less risk severity in all the PEPR's compared to government proposed route.

3. CONCLUSION

It is clear from the traffic volume survey conducted that Amalanagar and Mannuthi junctions are of heavy traffic. As a bypass may reduce the congestions in this junction about 35-55 %, the government authorities decided to construct (widen up) a bypass through this route, which will connect the places Amalanagar, Chamakkad, Choorakkattukara, Kottekkad, Kuttur, Pampoor, Viyyur, RV puram, Kuttumukk, Nettisseri, Mannuthy. But this route is an unscientific one and it will affect a lot of land owners and religious centres as is clear from the Spearman's Risk correlation analysis and Risk severity analysis. The route proposed by this project team is connecting Amalanagar, Chamakkad, Kuttur, Attore, Kolazhi, RV puram, Nettissery, Mannuthy, where the empty lands are utilized more for the road other than demolishment of buildings. From the soil investigation result, it is clear that the most of the places in this route doesn't need any special treatments and they are suitable for road construction. So this proposal will be very helpful for the proper designing of Amalanagar – Mannuthy bypass, without causing unscientific land and building acquisitions.

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