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Impacts of road safety initiatives

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***Abstract*— Road safety is a multi – sectored and multi - dimensional issue. Kerala is one of the leading states in high rate of road accidents and injuries. Road accidents are considered to be the third major cause of death in the state. The state has nearly 3% of the country's population but it has recorded about 10% of the country's road traffic accidents. The main problem existing is that the traffic is not homogeneous but mix mode type with a vast range of vehicles plying in it (i.e., bus, truck, car, rickshaw etc.). Growing business activities in major Central Business District (CBD) areas has attracted more population and bunched up without expansion. As a result, congestion is created. Every year the number of vehicles increases but the road length remains the same. Due to peculiar geographical condition, nature of human settlement and land use pattern, most of our roads remain narrow and congested. Thiruvananthapuram, also known as Trivandrum, is one of the major cities in Kerala State and derives its importance being the capital city of the State. The future prospects of Trivandrum are manifold. The city witnesses severe traffic congestion during major part of the day, resulting in low vehicle speed, air and noise pollution and high accident risk. In this regard, Kerala Government had implemented many road safety initiatives and city improvement plan in major part of the cities during 2013. This study attempts to evaluate, analyze the road safety initiatives up on the non-engineering and engineering aspect using the observation survey alone. This study gathered data like traffic volume, parking, pedestrian movement and accident data within the 1 km stretch at Thiruvananthapuram city (main CBD area). From the analysis it was observed that the number of accidents occurred in the said stretch has decreased by 1.2% when compared with the older data which indicates the effectiveness of the road safety initiatives implemented by the Kerala Government.**

Key words: **Road accident, Road safety, Accident prevention.**

I. INTRODUCTION

Transportation is the backbone and lifeline of any country's economy. For any country road transportation holds a greater percentage of its total transportation network. Road accidents are considered to be as a serious issue of concern in the present era. The increasing vehicle population and inadequate serviceability of the existing roads had resulted in a large number of fatalities in roads. Road traffic crashes are a leading cause of occupational fatalities throughout the world, especially in developing countries, the high cost of accidents incurred to the economy of a nation makes road safety an important consideration and objective of Civil Engineers. Road Safety refers to the methods and measures that are related to reduce risks of injury, death and harm to drivers, passengers and pedestrians. Road Safety is primarily meant about the protection and security of all those who travel on roads. It encapsulates all from pedestrians to animal-drawn vehicles and from two-wheelers to all types of multi-wheel transport. It is a double-sided and complementary exercise and will bear less fruit if it is minus anyone; that is to say, everybody will have to honor other's rights to see his ones respected. Road safety has many facets and pedestrian safety is one very imperative aspect of this subject. Road traffic safety has become a huge concern to many countries across the world. Even though developed countries has become successful in making effective solutions in terms of both engineering (good geometric elements of roads, better pavement surface, visible cross walks, automatic traffic signal system etc.) and non-engineering (enforcement of traffic rules like usage of helmets and seatbelts, conducting awareness classes for the road users etc.) measures to curb this problem, the situation in developing countries like India is still not effective. The main reason for this situation could be the lack of advanced technologies, enforcement of law, and lack of availability of funds. For ensuring safety in roads, the Government of India has taken many initiatives all over the country. One such initiative is the starting of Road Safety Authorities in all states. The Road Safety Authority is being conducting several measures to curb the accidents which include engineering and non – engineering aspects.

II. SCOPE OF THE STUDY

The study area is restricted to road stretches of Thiruvananthapuram district. The stretch which is taken for the study is confined to a small stretch on the MG road between overbridge junction and Attakulangara within the Thiruvananthapuram city. The study stretch is of length 1 km from over bridge to Attakulangara which covers over-bridge

junction, East fort, Vettimuruchankottai, Pazhavangadi and Attakulangara junction. Since, Attakulangara and East fort has the main land mark of Padmanabhaswamy Temple, which is amongst the richest temples in India, this place is regarded as the busiest place with the rush of pilgrims and other pedestrians which may lead to road accidents causing alarming to the public. During 2015, most of the important areas within the Thiruvananthapuram City underwent improvements as part of the city improvement plan. In this regard, our study stretch also falls in the said criteria. The aim of the study is to evaluate the impact of the improvements that were carried out in the said stretch and to assess whether these improvements were helpful to the road users and also contributed in reducing the accidents.

III. OBJECTIVE OF THE STUDY

The study on the impact of road safety initiatives which focuses on checking how effectively the road safety initiatives have been implemented in the particular road stretch and what changes it has brought to the traffic conditions prevailed in the stretch.

To evaluate, analyze and categorize the road safety initiatives implemented in terms of Non-engineering & Engineering aspects with the past data of road & road users in terms of accidents;

IV. LITERATURE REVIEW

Rajiv Ganguly.et.al (2010) studied about 50km stretch from Solan to Shimla. They collected accidental details from NHAI and local police stations like Kandaghat, Solan, Shimla. They carried out various tests over the aggregates like Impact test, Los Angeles abrasion test, Flakiness test. After the thorough study they suggested to erect sign boards on turns in blind spots, to use fluorescent sign board ahead curves, to install convex mirror on the curves for good visibility and to provide retaining walls at the line spots and sharp curves.

Manish D Katiyari (2014) studied about a particular road stretch in Nagpur city at Wardha road from Morris College Square to Airport Intersection. The study included checking the condition of surface and carriage way markings, medians and also checked if the traffic islands provided there are adequate for the users, and also the necessity of more crossing facilities for pedestrians. They collected accidental data like Type of accidents and injuries, number of accidents prior to the year, traffic counts in selected regions within the road stretch. The results suggested the increase in width of the carriage way by 2m which could reduce the crash rate and also reduce the long term cost associated with the road scheme.

V. SEQUENCE OF TASK IN THE STUDY

A. Selection of Study Area

The stretch of 1 km was chosen within the city of Thiruvananthapuram for the study i.e. from Over bridge to Attakulangara Junction.

B. Collection of Secondary Data

From SCRB (State Crime Records Bureau) past data like accidental data were collected and from the previous studies of NATPAC link volume data, pedestrian movement data, vehicle parking data and the road inventory for the selected stretch were gathered for the year 2012. The present procedure for the collection of primary data was followed as per the procedure practiced in the year 2012.

C. Study of the Past Condition

After going through the secondary data past conditions like carriage way width, footpath width, presence of bus bays, type of drainage works, provision of carriage way medians such conditions of the road were studied.

D. Collection of Primary Data

Collection of primary data includes the following survey:

- Traffic volume survey
- Parking survey
- Pedestrian survey
- Road inventory survey

E. Data analysis

Data from the surveys like traffic volume survey, parking survey, pedestrian survey, road inventory survey and year wise accident data were tabulated and aligned for the purpose of analyzing. After the findings from the analysis of the collected data, the study shall be concluded with the suitable suggestions.

VI. DATA COLLECTION & ANALYSIS

Past road data like pedestrian movements, link volume and also past accident data for the year 2011-2015 which has to be compared were collected are given below:

Collection of Primary Data

After the successful collection of the secondary data, primary data were collected by conducting surveys like link volume survey, pedestrian survey, parking survey and road inventory survey. These surveys were conducted on three working days from Wednesday to Friday.

1) Parking Survey

The parking survey was conducted on a week day i.e., Wednesday. In the Parking survey, the counting of parked vehicles at the parking area as well as in the non-parking area was done. The survey started in the morning from 8 am to evening 6 pm with every 15 minutes interval.

Table no 1 Equivalent car spacing value

VEHICLE	ECS
CAR	1
2 WHEELER	0.2
CYCLE	0.1
AUTO	1
BUS	2.25
TRUCK	2.3
MINI BUS	1.6
MINI TRUCK	1.6
GOODS AUTO	1

Table no 2 parking survey data

Peak parking accumulation at different road sections of the study area													
Sl. No.	Road section	Peak parking time	Types of vehicles with their ECS value										
			Bus	Mini Bus	Car	Pass auto	Two-Wheeler	Truck	Mini Truck	Goods auto	Total (No of Vehicles)	Total (ECS)
1	Overbridge	11.30-11.45		1	26	2	103			1	133	51
2	Pazhavangadi	11.15-11:30			3	4	96		2		29	29
3	Gandhi Park	11.45-12.00			52	20	128			1	201	99
4	Vettimurichakotta	11.45-12.00			7	17	116				140	47
5	Attakulangara	11.45-12.00			1	3	18				22	8
6	Overbridge	16:00 - 16:15		1	20	1	83			1	106	40
7	Pazhavangadi	16:15 - 16:30			1	4	54				59	16
8	Gandhi Park	16:45 - 17:00			32	19	78			1	130	68
9	Vettimurichakotta	16:15 - 16:30			10	12	40			1	63	31
10	Attankulangara	16:45 - 17:00			4	2	16				22	9

2) Link Volume Survey

This survey was conducted on the weekdays i.e., Thursday. The link volume survey refers to the counting of moving vehicle on the road. Link volume survey was initiated in the morning from 8 am to evening 6 pm, with every 15 minutes interval. In this survey, counting started from a fixed point and the number of vehicles passing through the fixed point were noted down every for 15 minutes. Thus, the readings were taken for the 'To and Fro' direction of the selected fixed point.

Table no 3 PCU values of various vehicles

Type of vehicles	PCU
KSRTC bus	3
Private bus	3
Other buses	3
Mini-bus/tempo	2
Car/van/jeep	1
Pass. Auto rickshaw	1
Two-wheeler	1
MAT	5
Truck	3
Mini-truck/tempo	2
Goods auto	1
Bicycle	1
Hand cart	4
Others (Specify)	6

3) Pedestrian Survey

This survey was conducted on the weekdays i.e. Friday. In the Pedestrian survey, the counting of moving people on the carriage way as well as on the foot path was done. Pedestrian survey initiated at morning from 8 am up to evening 6 pm with 15 minutes interval. In this survey, counting started from a fixed point and the number of people passing through the fixed point were noted down for every 15 minutes. Thus the readings were taken for the 'To and Fro' direction of the selected fixed point.

When comparing the lateral pedestrian movement data of the year 2017 with that of year 2012, we came to know that the number of lanes and the length of the road section remained same as it is without any changes whereas width of the foot path got increased 0.2m wide and the peak pedestrian volume got increased certainly. When comparing the cross pedestrian movement data of the year 2017 with that of year 2012, we came to know that the peak hour vehicle volume and the peak hour pedestrian volume got increased certainly.

Table no 4 Peak hour longitudinal movements-2017

Peak Hour Longitudinal Movements - Overbridge to Attakulangara						
Time	Padhmana bhaswamy Temple	East Fort Baba Studio	East Fort Prepaid Auto Stand	East Fort Near Zebra Crossing	Pazhavangadi Temple	Ganapathi Temple Opposite
8.00-8.15	120	180	121	186	112	123
8.15-8.30	186	240	154	231	142	160
8.30-8.45	267	353	220	286	206	231
8.45-9.00	295	297	252	332	354	235
9.00-9.15	288	358	270	387	382	254
9.15-9.30	258	514	357	350	437	226
9.30-9.45	307	383	320	402	404	350
9.45-10.00	272	532	373	379	373	220
16:00-16:15	487	448	368	477	255	237
16:15-16:30	450	422	397	447	295	285
16:30-16:45	398	347	458	392	306	340
16:45-17:00	347	287	421	355	359	295
17:00-17:15	384	347	480	466	420	325
17:15-17:30	361	368	539	389	467	372
17:30-17:45	421	402	499	451	502	402
17:45-18:00	459	383	447	485	481	369
TOTAL	5300	5861	5676	6015	5495	4424

Table no 5 Peak hour cross movements-2017

Peak Hour Cross Movements - Overbridge to Attakulangara					
Time	East Fort Babu Studios	East Fort Prepaid Auto Stand	East Fort Near Zebra Crossing	Pazhavangadi Temple	Ganapathi Temple Opposite
8.00-8.15	102	42	140	170	20
8.15-8.30	125	51	175	194	22
8.30-8.45	185	75	221	307	27
8.45-9.00	237	58	230	314	34
9.00-9.15	200	48	237	325	47
9.15-9.30	258	65	245	299	57
9.30-9.45	309	82	210	274	62
9.45-10.00	358	97	235	263	49
16:00-16:15	400	67	266	97	35
16:15-16:30	351	83	261	82	28
16:30-16:45	298	74	298	105	39
16:45-17:00	350	89	322	117	46
17:00-17:15	270	106	352	132	57
17:15-17:30	321	93	376	147	51
17:30-17:45	381	110	368	162	43
17:45-18:00	356	121	342	153	39
TOTAL	4501	1261	4278	3141	656

4) Road Inventory Survey

This survey was also conducted on the third day of our survey period, that is, on Friday (20.01.2017). Road inventory survey includes the measuring of the geometrical elements like width of the carriage way, width of the median, height of the median, width of the foot path, width of the shoulder and even checking were done for the presence of any sign boards, presence of under-ground drainage facility, number of bus bays etc. Road inventory survey started at 2 pm and ended at 2.45 pm. In this survey, width of the dual carriage way has been measured as 7m with the 2m widened median. The study stretch has been provided with the 2.5m widened footpath on both the sides of the road. And two bus stops were located near Pazhavangadi and East Fort. Comparing to the previous year like 2011 to 2013, in the year 2015 many improvements like Prepaid Auto Stand facility, widened footpath, ITS like traffic signals zebra crossings were provided for the road users.

Traffic Volume Survey Data

Generally every year traffic volume gradually increases from 7 to 8 % in which the share of private vehicles exceeds the share of public transport. Similarly comparing to the year 2012, the traffic volume had increased by 7% in the year 2017 due to the increased number of vehicle users.

Table no 6 Traffic volume survey data-2017

Sl.No.	Type of vehicle	Road stretch			
		Overbridge - Attakulangara		Attakulangara-Overbridge	
		Total no. of vehicles	Link Volume (PCU/hr)	Total no. of vehicles	Link Volume (PCU/hr)
1	KSRTC bus	486	1458	399	1197
2	Private bus	373	1119	314	942
3	Other buses	62	186	70	210
4	Mini-bus/tempo	98	147	72	108
5	Car/van/jeep	10350	10350	8788	8788
6	Pass. Autorickshaw	11515	11515	10100	10100
7	Two-wheeler	17594	8797	17403	8702
8	MAT	0	0	4	18
9	Truck	173	519	163	489
10	Mini-truck/tempo	235	353	208	312
11	Goods autorickshaw	398	398	346	346
12	Bicycle	225	113	127	64
13	Hand cart	0	0	0	0
14	Others (Specify)	3	18	6	36
Total		41512	34972	38000	31311

Accident Data

Accident data was collected from SCRB (State Crime Records Bureau), Thiruvananthapuram. The obtained data consists of accident details of the years from 2011 to 2015. The details of the entire Thiruvananthapuram city was obtained from them and which included the details

Table no 7 Road accident data (2011-2015)

Years	Number of accidents	Number of casualties	Number of fatalities	Number of grievously injured persons	Number of day time accidents	Number of night time accident	Number of accidents with pedestrians involved
2011	27	26	2	21	21	6	5
2012	15	14	1	16	13	2	6
2013	29	27	1	29	19	10	6
2014	33	29	1	31	25	8	5
2015	26	2	3	18	23	3	3

corresponding to each accidents such as crime number, spot, date, type of accident, number of fatalities, grievous and minor injuries, person accused etc. The accidents pertaining to the stretch under consideration is sorted out and analyzed.

During 2011, in the regions between Attakulangara and East - Fort totally 26 accidents took place in which 26 casualties were reported. In these accidents 2 persons died, 20 persons were grievously injured. Among the total accidents reported in the particular stretch, 20 accidents occurred during day time and 6 accidents occurred during night time. Of the total accidents, in 5 accidents pedestrians were involved. At Pazhavangadi one accident was reported to be occurred at day time, no fatalities were reported, but 1 person was reported to be injured grievously.

During 2012, in the regions between Attakulangara, Pazhavangaadi Ganapathi temple, East Fort, a total of 14 accidents took place in which 14 casualties were reported. In these accidents 1 person died and 15 were grievously injured. Among the total accidents reported in the particular stretch, 13 accidents occurred during day time and 1 accident occurred during night time. Of the total accidents, in 6 accidents

pedestrians were involved. At Pazhavangadi, one accident was reported to be occurred at night time, no fatalities were reported, but one person was reported to be injured grievously. In the accident no one got killed but one person got grievously injured.

During 2013, in the regions between Attakulangara, Pazhavangadi Ganapathi temple, East Fort totally 27 accident took place in which 27 casualties were reported. In these accidents 1 person died and 28 persons were grievously injured. Among the total accidents reported in the particular stretch, 17 accidents occurred during day time and 10 accidents occurred during night time. Of the total accidents, in 6 accidents pedestrians were involved. Between over bridge and Pazhavangadi accidents was reported to be occurred at day time, no fatalities were reported, but one person was reported to be injured grievously.

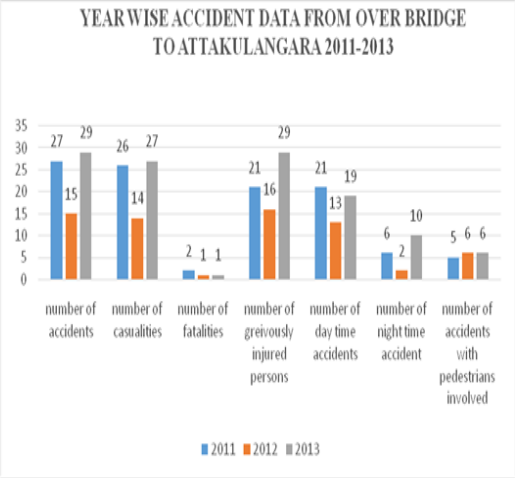

Fig no 1 Year Wise Accident Data from Overbridge to Attakulangara (2011-2013)

During 2014, in the regions between Attakulangara, Pazhavangaadi Ganapathi temple, East - Fort totally 29 accidents took place in which 29 casualties were reported. In these accidents 1 person died, 27 persons were grievously injured. Among the total accidents reported in the particular stretch, 23 accidents occurred during day time and 6 accidents occurred during night time. Of the total accidents, in 5 accidents pedestrians were involved. Between over bridge and Pazhavangadi 2 accidents was reported to be occurred at day time and 2 accidents were at night time, no fatalities were reported, but 4 persons were reported to be injured grievously.

During 2015, in the regions between Attakulangara and East Fort totally 22 accidents took place in which 22 casualties were reported. In these accidents 3 persons died, 15 persons were grievously injured. Among the total accidents reported in the particular stretch, 19 accidents occurred during day time and 3 accidents occurred during night time. Of the total accidents, in 3 accidents pedestrians were involved. Between Over bridge and Pazhavangadi 4 accidents were reported to be occurred at day time, no fatalities were reported, but 3 persons were reported to be injured grievously.

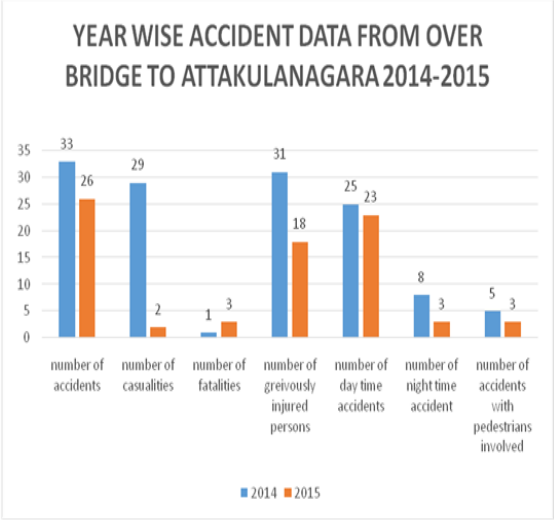

Fig no 2 Year Wise Accident Data from Overbridge to Attakulangara (2014-2015)

VII. CONCLUSION

After the complete analysis of data we found that the road accident rate has been reduced by 1.2% than that of 2015 road accident data, traffic volume has been increased by 7% and pedestrian movement has increased substantially by 80% compared to that of 2012 data.

From our findings we conclude that, in the study stretch the pedestrian's mobility got smoothened due to the widening of foot path and separate provisions for the pedestrians to cross the road (zebra crossing), the delay of the heterogeneous traffic got reduced after the introduction of traffic signals, parking regulations (especially on street parking) and bus bays. Finally, the road accident rate got reduced compared to previous years due to the effectiveness of road safety initiatives considering the road users especially the vulnerable road users. Thus, we suggest for establishing an evaluating body with the check box to monitor the implemented road safety initiatives at the end of every four months. And to conduct an opinion survey that lets us to know about the satisfaction level of the road users over the implemented road safety initiatives and if possible the rectifications should be updated in a separate database which may even help other authorities to be clear with the newly made rectifications and about the measures that shouldn't be practiced.

Due to lack of time, we have completed the observation survey alone like gathering the accident data, link volume data, pedestrian movement data, parking data which comes under the non-engineering aspects and we failed to carry out engineering surveys using Total Station, GPS whereas we partially covered the engineering aspects like road inventory alone for the study stretch.

In future, it is possible to study the same stretch with the detailed data by including inputs from road user's opinion and surveys using Total Station, GPS and such engineering equipments and also evaluating the agency wise impact and cost effectiveness of various road safety initiatives.

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