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ANALYSIS OF ACCIDENT HOTSPOTS IN KOLLAM

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ABSTRACT

Traffic accident has posed a threat to the safety of human life.So, there is a need for accident location study. The study provides not only a theoretical basis for vehicle safety assistance driving, but also the guidance for collision avoidance. This paper focuses on identifying and analysing the major hotspots within Kollam.

KEYWORDS: hotspot; accident severity index; accident fatality risk; accident fatality rate;accident risk; trend

I. INTRODUCTION :

A hotspot can be defined as a location where accidents occur frequently. Traffic accidents pose a great threat to the safety of human life. The main causes include the location of vehicle, the grade, the road surface condition, the visual condition, the vehicle condition and the driver. The study provides not only a theoretical basis for vehicle safety assistance driving, but also the guidance for collision avoidance. The identification of crash hotspots is the first step of the highway safety management process. Crash hotspot identification results in a list of sites that are prioritized for detailed engineering studies that can identify crash patterns, contributing factors, and potential countermeasures.

II. OBJECTIVES :

The main objectives of the study are as follows:

- Collection of five-year accident data within Kollam (2014 – 2018) from police station
- Identification of top 5 locations based on Accident Severity Index (ASI)
- Performing detailed analysis at these selected hotspots. The analysis includes: measurement of carriageway width, shoulder width, provision of sight distance, presence of traffic signals, etc.
- Trend analysis
- Calculation of Accident Fatality Risk (AFR) and Accident Risk (AR)
- Comparison between the hotspot locations
- Suggestion of remedial measures

III. METHODOLOGY :

The project is performed mainly in three phases namely existing data collection, experimental investigation, analysis of existing data.
First phase included the collection of data from District Crime Records Bureau (DCRB) and police station. The collected data givesinformation regarding the accident severity, cause of accident, type of accident, at what time the accident occurs, vehicle type, place of occurrence etc.

Second phase which is the experimental investigation includes two types of survey and that is field survey and questionnaire survey. Field survey gives more information about the geometry of the roads in accident hotspots. The shoulder width, lane width, drop off, width of footpath etc. are surveyed. Questionnaire survey was conducted in order know the public opinion about the accident. Details regarding when the last accident occurred, exact location where accidents occur more often, time of day, weather conditions, number of victims, fatality of the accidents, cause for the accident and type of vehicle involved in the accident are obtained through questionnaire survey.

Third phase included the analysis of existing data. This is done through various methods such asASI method, Accident Fatality Rate method,AFR method and ARmethod. Also, a trend analysis is performed for the comparison between various locations. This comparison gives an idea about what changes are to be brought at these locations in order to reduce accident chances.

ACCIDENT SEVERITY INDEX (ASI)

The accident severity index measures the seriousness of an accident. It is defined as the number of persons killed per 100 accidents. Table I. shows the calculation of ASI at Paripally. Accident severity index can be calculated by multiplying the parameters such as death, grievous injury, minor injury by corresponding severity weightages which is recommended by the Transport Research Laboratory (TRL). The accident severity weightage for death is 6, for grievous injury it is 3 and that of minor injury, it is 1 (as shown in Table II.).

TABLE I. CALCULATION OF ASI AT PARIPALLY

Year	Death	Grievous Injury	Minor Injury	ASI
2014	0	16	3	51
2015	6	15	2	83
2016	2	11	0	45
2017	4	16	0	73
2018	4	15	6	75

TABLE II. SEVERITY WEIGHTAGES AS PER TRL

Accident Severity	Weightage
Death	6
Grievous	3
Minor	1

ACCIDENT FATALITY RISK (AFR)

The accident fatality risk, defined as the number of accidental deaths per 1,00,000 population. Data includes road accident deaths and estimated mid-year population. Considering the whole of Kollam, AFR value is calculated from 2014 till 2018.

TABLE III. CALCULATION OF AFR IN KOLLAM

Year	Road Accident Deaths	Estimated Population	Accident Fatality Risk (Col.2*1,00,000/ Col.3)
2014	217	26,56,375	8.17
2015	203	26,63,500	7.62
2016	207	26,70,487	7.75
2017	213	26,77,822	7.95
2018	241	26,84,654	8.98

ACCIDENT RISK (AR)

Accident Risk is defined as the number of accidents per 100000 population. Total number of road accidents and estimated yearly population are the required data.

IV. ANALYSIS :

IDENTIFICATION OF HOTSPOT LOCATIONS

From the past five-year accident data which was collected from Kollam District Crime Records Bureau, the Accident

Sl. No	Location	ASI				
		2014	2015	2016	2017	2018
1	Vavvakkayu	94	94	69	82	73
2	Puthiyakavu	85	92	70	90	61
3	Ayathil	55	65	87	57	94
4	Kottiyam	59	66	52	105	61
5	Paripally	51	83	45	73	75

TABLE II. SEVERITY WEIGHTAGES AS PER TRL

Accident Severity	Weightage
Death	6
Grievous	3
Minor	1

Index (ASI) of each location was calculated.

The total five-year ASI of every location were compared and arranged in descending order. From the list, top 5 locations were chosen for detailed study.

HOTSPOT LOCATION 1 – VAVVAKKAVU

Vavvakkavu comes first with an ASI value of 412. The place is situated at Latitude 9° 6'0.45"N and Longitude 76°31'20.43"E.

Table VI. shows the yearly ASI values at Vavvakkavu obtained based on the accidents that have occurred at the place. Most number of deaths have occurred in 2014.

The ASI trend, fig. 1, is found to be decreasing from 2014 to 2018. Based on the questionnaire survey it was brought to our notice that the introduction of a bus lane in the National Highway during 2016 played a key role in reducing accidents at Vavvakkavu.

Year	Death	Grievous Injury	Minor Injury	ASI
2014	8	14	4	94
2015	6	16	10	94
2016	3	16	3	69
2017	1	25	1	82
2018	5	14	1	73

Fig 1 . ASI Trend at Vavvakkavu

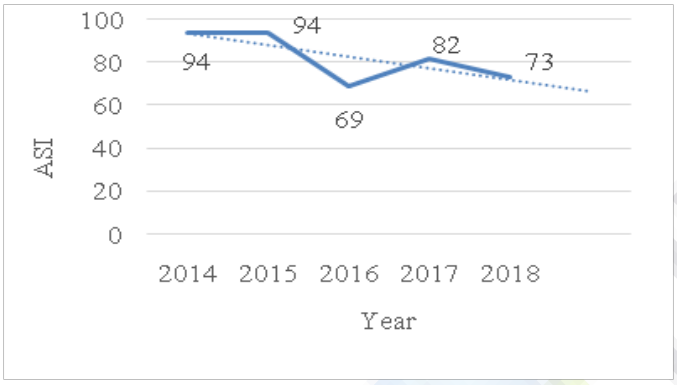
A total of 94 accidents occurred at Vavvakkavu during the period between 2014-2018. Among those, 64 accidents are caused by 2 wheelers, 13 accidents by pedestrians and the remaining 17 by 4 wheelers.

Most of the accidents occurring at Vavvakkavu result in grievous injuries. More than 75% of the accidents end in grievous injury. The number of deaths is found to be more than the number of minor injuries.

Out of National Highway and ODR, it is the National Highway that contribute mostly to accidents. Nearly 90% of the accidents at Vavvakkavu have occurred in the National Highway.

Considering the time of accident occurrence, day time accidents has a big majority overnight time accidents. Nearly 80% of the accidents occur during the day.

HOTSPOT LOCATION 2 - PUTHIYAKAVU



Puthiyakavu comes second with an ASI value of 398. The place is situated at Latitude 9° 4'37.99"N and Longitude 76°31'55.25"E.

FIG 2 . ASI Trend at Puthiyakavu

The ASI trend at Puthiyakavu is decreasing. From the questionnaire survey it was understood that after introduction of traffic signal system at the junction, the number of accidents was found to be decreasing. ASI value is the highest in 2015 and lowest in 2018.

A total of 101 accidents occurred at Puthiyakavu during the period between 2014-2018. Among those, 63 accidents are caused by 2 wheelers, 23 accidents by pedestrians and the remaining 15 by 4 wheelers.

Around 70% of the accidents at Puthiyakavu end in grievous injuries. Here, the number of minor injuries is more compared to the number of deaths. Mostly 2 wheelers and pedestrians create accidents at the junction. That is the reason behind a greater number of minor and grievous injuries compared to deaths.

Year	Death	Grievous Injury	Minor Injury	ASI
2014	4	19	4	85
2015	4	20	8	92
2016	3	16	4	70
2017	4	21	3	90
2018	1	18	1	61

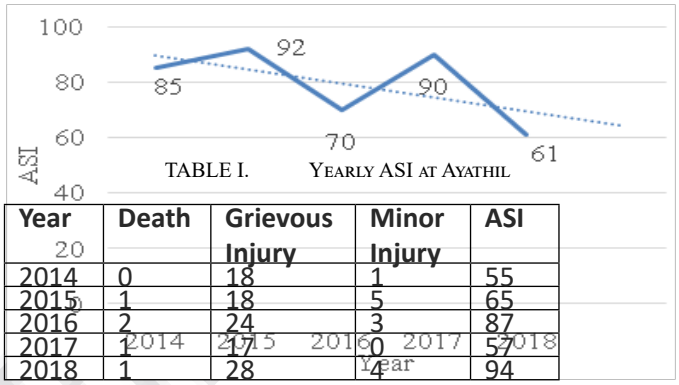


TABLE I. YEARLY ASI AT AYATHIL

Year	Death	Grievous Injury	Minor Injury	ASI
2014	0	18	1	55
2015	1	18	5	65
2016	2	24	3	87
2017	1	17	0	57
2018	1	28	4	94

National Highways contribute to about 90% of the total accidents. Absence of speed breakers in the main reason for this. ODR at Puthiyakavu are poorly maintained and consist of a number of potholes and undulations. The ODR parallel to National Highway joins at a steep slope. This is a major accident location.

Day time accidents occur more at Puthiyakavu compared to night time accidents. Nearly 65% of the accidents occur during the day. Presence of bill boards at junctions block the view of vehicles coming in from the ODR. A series of ODR are present near the junction. Sharp curves are provided at these roads. This contributes mostly to day time accidents.

HOTSPOT LOCATION 3 – AYATHIL

Ayathil comes third with an ASI value of 358. The place is situated at Latitude 8°53'31.87"N and Longitude 76°37'48.08"E.

ASI TREND AT AYATHIL

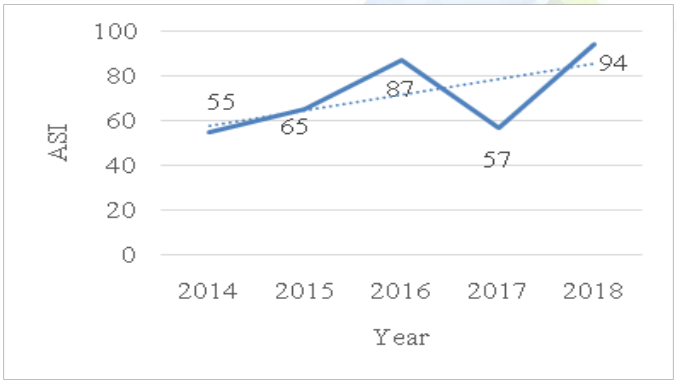
Considering Ayathil, fig. 3 shows the

increasing trend in ASI value. While performing the questionnaire survey, it was brought to our notice that the introduction of new signaling system and changes made to the road geometry has led to rise in accidents at and near the junction. At least one accident occurs per day within the near vicinity of the junction. While moving away from the junction, there are no street lights. So, during night time, the pedestrians and stray dogs are not visible to the drivers and collision occurs. Thus, the introduction of street lighting system at the earliest is a necessity at Ayathil.

A total of 112 accidents occurred at Ayathil during the period between 2014-2018. Among those, 74 accidents are caused by 2 wheelers, 27 accidents by pedestrians and the remaining 11 by 4 wheelers.

TABLE VIII. YEARLY ASI AT AYATHIL

Year	Death	Grievous Injury	Minor Injury	ASI
2014	0	18	1	55
2015	1	18	5	65
2016	2	24	3	87
2017	1	17	0	57
2018	1	28	4	94



out of the total accidents occurring at Ayathil, 90% of them are grievous injuries. Accidents involving 2 wheelers and pedestrians are not very catastrophic. That is why grievous and minor injuries dominate Ayathil junction.

The one specialty for Ayathil junction is that the accidents caused here mostly occur in ODR. While National Highway accidents dominate at all other hotspot locations, considering Ayathil, accidents in ODR is very high. About 95% of the accidents occur here. This is mainly due to the absence of street lighting and steep curve provided at junctions between ODR and NH.

Day time accidents are more at Ayathil compared to night time accidents. About 70% of the accidents occur during the day. Such accidents are mainly between bus and 2 wheelers.

HOTSPOT LOCATION 4 – KOTTIYAM

Kottiyam comes fourth with an ASI value of 343. The place is situated at Latitude8°51'57.37"N and Longitude 76°40'15.28"E.

The shop named Simla Jewelers have created a partition thereby allowing only 2 wheelers to park in front of their shop. This forces the 4 wheelers to park at the nearby bus lane. Thus, traffic congestion is created at the bus lanes.

Vehicles navigating U-turn at the end of the divider is a major source of traffic congestion at Kottiyam junction.

Year	Death	Grievous Injury	Minor Injury	ASI
2014	1	17	2	59
2015	2	17	3	66
2016	1	15	1	52
2017	3	27	6	105
2018	3	14	1	61

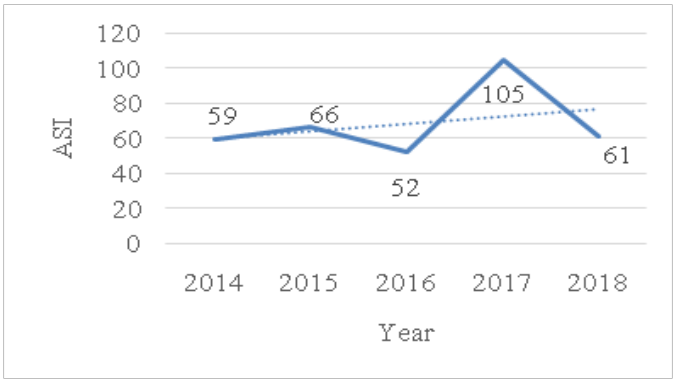


Fig. 4.ASI Trend at Kottiyam

The ASI trend at Kottiyam junction is found to be increasing from 2014 to 2018. This is mainly due

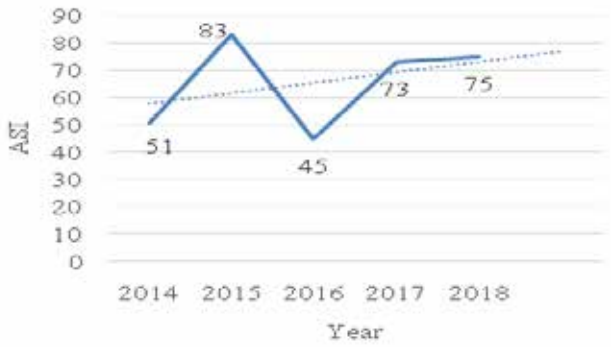
to the traffic congestion caused by road side parking. Also, street vendors occupy the parking spots thereby forcing the vehicles to park onto the road.
2-wheeler accidents dominate at Kottiyam. Road side parking, U-turn navigation and absence of traffic islands are the main source of accidents at Kottiyam junction.

The number of grievous injuries is more at Kottiyam junction compared to deaths and minor injuries. Main location of accidents at Kottiyam is right at the junction. This is mainly due to the absence of traffic islands.

National Highway is the road where most accidents occur. About 80% of the accidents occur in the National Highway compared to Other District Roads. U-turn navigation and road side parking are its main causes.

Day time accidents are more at Kottiyam compared to night. About 70% of the accidents occur during the day. Road side parking is the key factor that leads to such accidents.

Year	Death	Grievous Injury	Minor Injury	ASI
2014	0	16	3	51
2015	6	15	2	83
2016	2	11	0	45
2017	4	16	0	73
2018	4	15	6	75



HOTSPOT LOCATION 5 – PARIPALLY

Paripally comes fifth with an ASI value of 327. The place is situated at Latitude8°48'44.70" and Longitude 76°45'31.53"E.While conducting the questionnaire survey at Paripally junction, it was brought to our notice that accidents occur rarely at Paripally junction. The two main accident locations in Paripally were Mukkada and Thettikuzhi.

Fig 5. ASI Trend at Paripally

The ASI trend at Paripally is found to be increasing. The value topped in 2015. The increase in trend is mainly due to absence of speed breakers at Mukkada and Thettikuzhi. This creates a tendency to drive at a very high speed and collision occurs with the vehicles coming is from the Ordinary District Roads.

The vehicles contributing to accidents at Paripally are nearly equally distributed among 2 wheelers, 4 wheelers and pedestrians. About 45% of the accidents are due to 2 wheelers.

Grievous injury dominates at Paripally junction. About 75% of the accidents results in grievous injury. The is also considerable number of deaths occurring at the location.

National Highway is the key location where accidents occur frequently. This is due to the absence of speed breakers at both Mukkada and Thettikuzhi. Also, the absence of street lighting at Mukkada causes night time accidents.

Day time accidents are more considering the whole of Paripally. No proper traffic signaling system and absence of speed breakers is the main cause of accidents.

V. INTERPRETATION OF RESULTS :

COMPARION BETWEEN HOTSPOT LOCATIONS

Day time accidents occur more while considering each location separately. While comparing all the locations, accidents occur the most at Ayathil. Even though accidents occur mostly at Ayathil, still the ASI value is most for Vavvakkavu. The reason for this can be understood for the graph below.

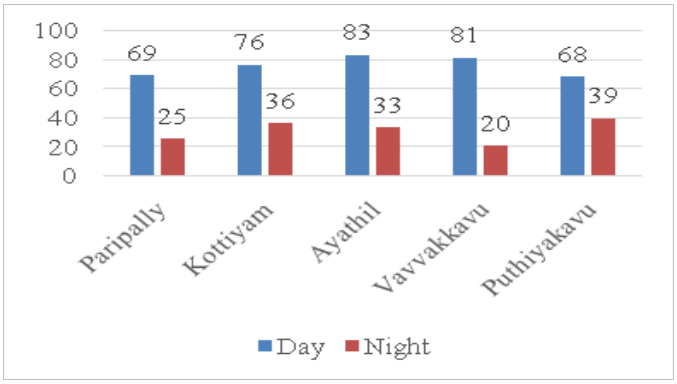
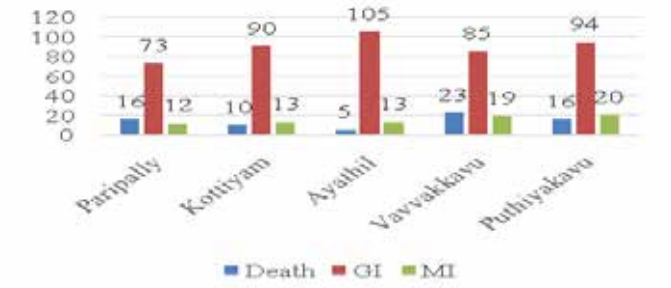


Fig. 6. Time of Occurrence of Accidents

Grievous injuries occur the most at each location. Comparing all the locations, it is clear that the greatest number of grievous injuries occur at Ayathil. Minor injuries occur mostly at Puthiyakavu junction followed by Vavvakkavu. But the ASI value of Vavvakkavu is the most since the number of accidents is more at Vavvakkavu. The weightage applied to death is 6 while calculating ASI values while that for grievous injuries is 3 and for minor injuries is 1. That is the why even though Ayathil and Puthiyakavu dominates while considering number of grievous and minor injuries respectively, still ASI value tops at Vavvakkavu.

FIG 7 . Type of Injury



Considering the type of road, it can be understood that National Highway accidents occur the most at locations except Ayathil.

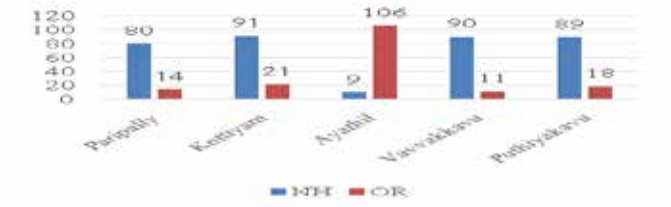


Fig 8 . Type of Road

Least number of NH accidents is at Ayathil and the most occur at Kottiyam. Considering ODR accidents, the most number is found at Ayathil and the least at Vavvakkavu junction.

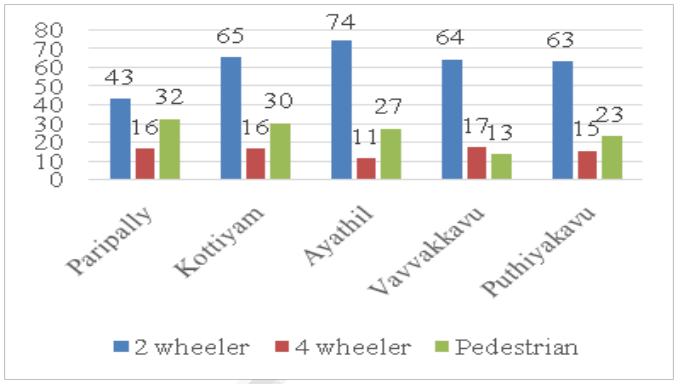


fig 9. Vehicle Type

In all the locations, it is 2 wheelers that contribute mostly to accidents. The most number of 2-wheeler accidents occur at Ayathil and the least at Paripally. Most number of 4-wheeler accidents is at Paripally and Kottiyam while the least is at Ayathil. Considering pedestrian accidents, the greatest number of accidents is at Paripally and the least at Vavvakkavu.

CALCULATION OF AFR

The AFR trend at Kollam is found to be increasing from 2014 to 2018. This is due to the increase in number of accident deaths occurring at Kollam. Proper traffic signaling, Street lighting and introduction of speed breakers at all major junctions can help reduce the accidents.

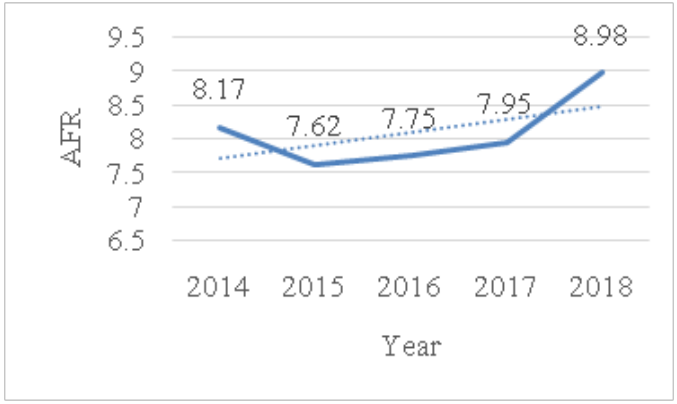


Fig 10 . AFR Trend

CALCULATION OF AR

Accident Risk is defined as the number of accidents per 100000 population. Total number of road accidents and estimated yearly population are the required data.

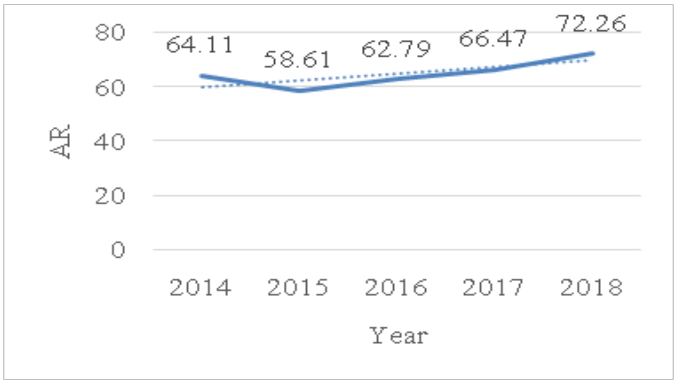


Fig. 11. AR Trend

VI. CONCONCLUSIONS :

The top five hotspot locations were clearly studied and road measurements noted. This was to identify what all measures could be adopted in order to reduce the accident chances at these locations. Some locations required further study to find remedies while others were easier. Identification and proposal of remedies were simple at Puthiyakavu and Paripally compared to Vavvakkavu, Ayathil and Kottiyam.

LOCATION 1 - VAVVAKKAVU

Vavvakkavu junction consist of National Highway and three Other District Roads (ORDs). Two ODR joining NH from the West and the third from East. Various alternatives were proposed such as provision of dividers, provision of speed breakers alone, provision of fly overs etc. Since the road width is limited, dividers cannot be placed. From the alternatives, provision of fly over is selected as the remedy for this location.

TABLE XI. SIGNAL TIMINGS IN BY-PASS AND ODR AT AYATHIL JUNCTION

Road	Orientation	Green Time	Red Time
By-pass	N-S	35	80
	S-N	35	81
ODR	W-E	22	94
	E-W	31	85

LOCATION 2 - PUTHIYAKAVU

Considering Puthiyakavu junction, the main cause of accident is the steep slope provided at the transition between ODR (parallel to the NH) and NH. Since the slope is steep and sharp, it reduces the sight distance as well as there is high chance for the drivers to lose control over their two wheelers.

In order to reduce the chances of accidents at Puthiyakavu, the steep slope should be flattened. Proper re-taring is required to level the elevation at transition. Also bill boards are placed near the ODRs thereby restricting view. It must also be removed so as to mitigate collision occurrence.

LOCATION 3 - AYATHIL

Ayathil junction consist of by-pass road and two ODRs. The signal green time is less and the red time is more for the ODRs. Traffic is also found to be more at these two ODRs compared to by-pass road. Also, the road width in ODRs is very less. This causes traffic congestion at ODRs. Table XI. shows the green time red time for all the roads at Ayathil junction.

Based on the above readings, provision of smart traffic signals.

can be proposed. The smart traffic signals work based on the traffic density in each road. In the present traffic signals, green and red timings are predetermined and set into the system. This method neglects the traffic volume. There will be peak flows and normal flows in traffic. So, in order to make the signaling system more efficient and effective, smart traffic lights are to be placed. Sensors are placed at certain distance away from the junction in all the roads. This device notes the number of vehicles moving towards the junction. Based on the number, signaling can be varied. Green time can be provided more for roads with higher traffic volume. This method is to be adopted at the junction to reduce traffic congestion and even accidents.

Moving further away from the junction, there are no street lights. During the night, considerable amount of pedestrian accidents is recorded. Also, due to dumping of waste near the road side, stray dogs can be found near the roads. Since the vehicles travel at very high speeds and absence of street lighting, collision occurs regularly between vehicles and pedestrians and vehicles with stray dogs.

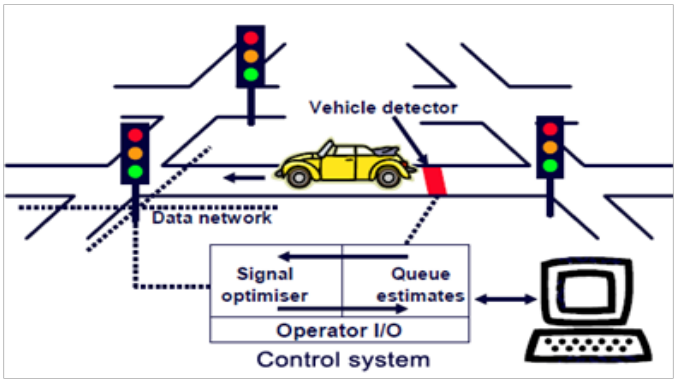


Fig 14 . Smart Signal

Smart LED zebra crossing can be provided at various points throughout the length of road where there are no street lights. These zebra crossings light up when someone approaches it. This will be very helpful in alerting the drivers about the presence of pedestrian. Red color can be provided to the zebra crossing in order to alert the driver and he/she could come to a stop. A threshold light intensity will be set within the system. So, when the surrounding light intensity becomes equal to or less than the threshold value, the LED comes into play. Considering the case of stray dogs, ultrasonic sounds can be produced which would drive away the dogs. Posts are to be placed at either side of the road. Ultrasonic devices are fixed to these posts. Once the devices are turned on, it drives away the stray dogs far away from the road.

LOCATION 4 – KOTTIYAM

The one and only problem within Kottiyam junction which leads to all major accidents is the road parking system. The two wheelers park in front of shops. This forces the four wheelers to park behind these two wheelers while occupying some region of the road. In some case it is found that even though certain shops have underground parking, drivers prefer parking their vehicles near the road. Also, some shop owners allow parking of only two wheelers in front of their shop. This forces the four wheelers coming to that shop to park at nearby bus lanes. Street vendors are also a major source in creating parking problems. It is the responsibility of each individual to understand the need for a proper parking system. The road users should correct themselves by parking at the proper locations. Street vendors should not be allowed to occupy parking spaces and bus lanes. Also, each shop should be demanded to allocate parking spaces for their customers. Oher than this, no other measures can be introduced to reduce traffic congestion at Kottiyam.

LOCATION 5 – PARIPALLY

Mukkada and Thettikuzhi are the major locations where accidents occur while considering the whole of Paripally. Traffic is less at both these regions. The main cause of accidents at both the locations is absence of speed breakers. Also, at Mukkada, there is only one central street light. So, at night, the visibility is very limited.Based on these parameters, various measures that could be adopted are:

- Introduction of speed breakers at both Mukkada and Thettikuzhi.
- Proper street lighting at Mukkada.
- Maintenance of ODR at Thettikuzhi.
- Improving the sight distance of ODR at Mukkada by removing bill boards
- Replacing temporary dividers with permanent ones at Mukkada.

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