Study on Catastrophic Factors Involved with Road Accidents in the Southern Capital City of Galle in Sri Lanka

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1. ABSTRACT

Road traffic accidents have become social and economic challenge all over the world. World Health Organization (WHO) reveal that in low- and middle-income countries, vulnerable road users are commonly involved in crashes with severe injuries. This study describes the catastrophic factors involved with road accidents in the southern capital city of Sri Lanka. The analysis includes data from two Police Divisions and the detailed data of each accident was obtained for 2017 and 2018. Most road crash victims were 18-23-year-old motor bikes riders and main reason observed to be the lack of risk perception in drivers with less than 5 years of experience. Majority of the victims of the fatal crashes are pedestrians and the results indicates that 63% of the accidents have taken place on straight roads due to high speed and the impact of the lighting condition is identified as a factor that has a lower impact on the number of accidents. These findings highlight the need of strengthening effective traffic law enforcement.

Keywords: Road Accidents, Accident Characteristics, Blackspots, Risk Perception, Accident Cost

2. INTRODUCTION

Transport demand growth in developing counties in modern era has led to several traffic substances in urban areas, among the most challenging ones are traffic congestion, accidents and vehicular emission. The World Health Organization (WHO) articulates that travel demand growth has great influences and impact on society regarding the crashes, death, injuries from road accidents and it has reached epidemic proportions worldwide. Road traffic accidents were ranked as 11th leading causes of death globally, and WHO has tabled 1.25 million people die each year as a result of traffic fatalities. Also highlights that between 20 and 50 million people suffer from non-fatal injuries, and most of them become disable. Also importantly noted that the traffic accidents would be the fifth leading cause of death by 2030, and 90 per cent of the world's fatalities are recorded in low and middle-income countries, even though these countries have approximately 54 per cent of the world's vehicles. (World Health Organization, 2014). The transportation system is, the most essential element of human civilization and it could become the most destructive element if not properly managed. Importantly the transportation can define as the backbone of the country's economy and it has direct impact on the Gross Domestic Product. Therefore, investigating the economic impact of road accidents by identifying the influence factors for road fatalities become essential for developing countries like Sri Lanka. By identifying the black spots and trends in road

accidents the regulating authorities will have the opportunity to minimise the number and the significance of future accidents on specific areas.

Main mode of transport in Sri Lanka is land transportation and has a well spread road network with a total length of about 112,136km. The road density is 1.8 km of roads per sq. km of land area. The vehicle population recorded as 6.3 million and recorded 86% of growth in vehicle population from 2008-2016 in Sri Lanka, and also statistics indicates a rapid increment trend in road accidents. After the civil war in North and East, which ended in 2009, the road accidents and the influences are seen as a major tragedy in Sri Lanka. (Department of Motor Traffic- Sri Lanka, 2016) Further it is recorded that the highest number of fatalities is caused by accidents involving motorcycles, three-wheelers, Lorries and private buses. Hence, precautions must be taken with proper studies in order to minimize road accidents in Sri Lanka.

Figure 1: Galle Municipal Council Area Selected for Study

The study area for this research is the Galle Municipal Council (GMC) Area, which is the District Centre and administrative capital of the Southern Province of Sri Lanka. Galle, which is located 119km from Colombo, is one of the major primary cities of Sri Lanka. The Galle City is on the southern part of the country surrounded by sea on one side and has approximately 158km of roads within the Galle Municipal Council Area. The selected study area has mixed commercial land use with a number of private and public land use. The main transportation infrastructure facilities of urban setup in Galle consists of railway station, central bus stand, expressway road connection, walkways, parking facilities etc. This research attempts to identify the appalling factors involved with road accidents in the southern capital city of Sri Lanka by analysing the trends in accidents and accident data against the climate conditions, time of the day and other external factors.

2

3. LITERATURE REVIEW

Sri Lanka passed its first traffic act in 1934 and, from 1938 onwards, the Police Department documented the traffic accidents. Still the Police reports remain the main available source for evaluation of road traffic crashes in Sri Lanka. In Sri Lanka, a lack of road safety research on accident safety, influencing factors for road fatalities, causes of accident safety, accident severity crashes, and the limited availability of statistics on road traffic crashes and injuries made it difficult for policy-makers to propose interventions that would prevent road traffic crashes.

Police reports states that a person is killed, and three people are injured every 3 hours by road accidents. The highest number of fatalities is caused by accidents involving motorcycles, three-wheelers, Lorries and private buses. Lack of training to the drivers, poorly designed roads, inadequate safety standards of the vehicles, drunk driving, negligence of road rules by drivers and pedestrians, road infrastructure not on par with the rapid increase in the number of vehicles, incompetent public transport system, lack of infrastructure in road traffic control system and weather conditions are the major causes of the accidents in Sri Lanka (Bhavan, 2019).

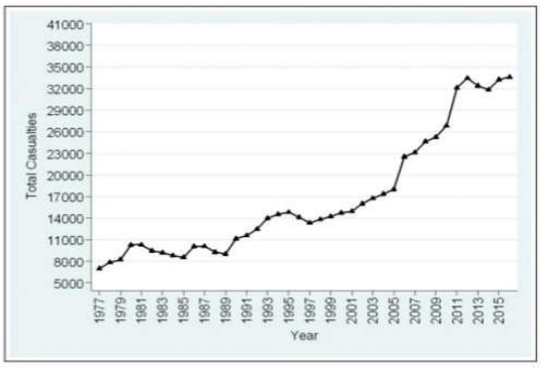

Figure 2: Trend of a number of total casualties from 1977 to 2016 (Bhavan, 2019)

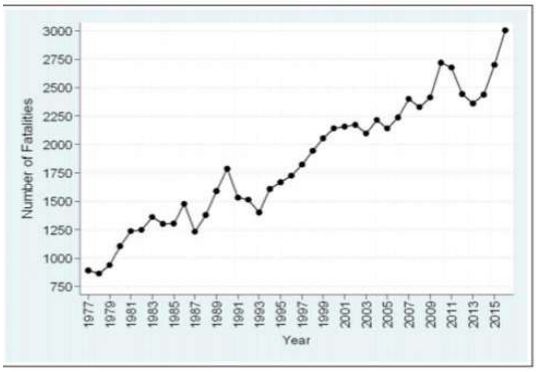

Figure 3: The Trend of Total Fatalities during 1977–2016 in Sri Lanka (Bhavan, 2019)

According to the accident data management system which is managed by Sri Lanka Police, the majority of death reported on riders of motorized two and three wheelers which is 51% and Figure 4 illustrate the death by road user category in 2016. Motorcycle usage has been drastically increased in Sri Lanka over past few years and in 2012, 27% accidents are recorded related to the motorcycles.

Road accident analysis report in 2003 reviled that in Sri Lanka most accidents appear to occur as head on crashes when travelling in opposite direction. Also, according to the report Western Province shows the highest number of fatalities and southern province shows the highest severity index in the country (Kumarage, Wickramasinghe, & Jayaratne, 2003)

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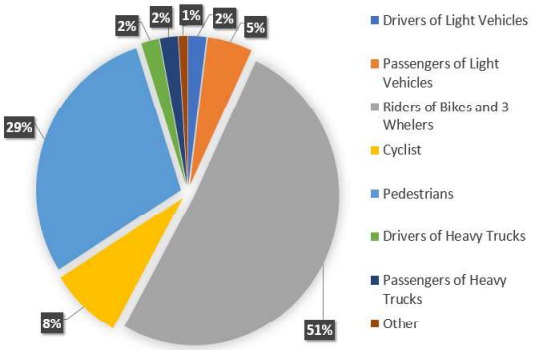

Figure 4: Death by Road User Category (Department of Motor Traffic- Sri Lanka, 2016)

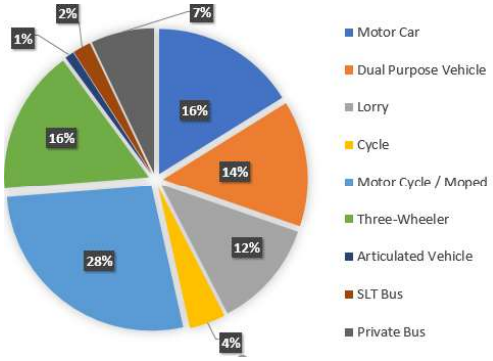

Figure 5: Accidents by different types of vehicles (2012) (Department of Motor Traffic- Sri Lanka, 2016)

3.1. Factors Influenced for Road Traffic Accidents

Road accidents have been an active research topic for the last few years focused on safety conditions, relationship among road conditions, driver characteristic such as drunken driving, driver behaviour, age, gender, etc., weather conditions like precipitation, rain, snow, fog, etc. A research study conducted in California to investigate the impact of traffic volume and lighting conditions on road accidents and the results shown the traffic volume measured prior to the accident has proved a strong relationship between the driving speed and traffic collisions. It is also found out that the severity of accidents has a close connection with high traffic volume than the driving speed (Golob & Recker , 2003;). Another study was conducted in 2005 to investigate the relationship between road accidents and driver's gender the study emphasizes a significantly higher accident rate is associated with male drivers in normal driving conditions and also they highlighted that under the changed weather conditions accident rate variations are adequately reduced between the male and female drivers (Geurts, Thomas, & Wets, 2005).

Chio et al., 2010 studied the contributing factors to crash severity in freeways of Taiwan's rural roads. They consider many variables such as occupation and age of the driver, travel period, travel purpose, location, vehicle type, action of the driver, surface condition, signal control, driver gender, weather, stumbling on road, lighting conditions, collision type, severity, speed limit, road status, marking, *etc*. According to this study the 4 significant factors which leads to determine the severity of accidents are collision type, the purpose of the journey, major cause, and travel period. Also, these factors are necessary for traffic safety evaluation (Y. Chiou & L.Lan)

An accident forecast model was developed in 2011 based on Malaysia on rural roadway (F. Mustakim & M. Fujita). The outcome has shown that rise in speed, absence of traffic light, and the rising number of Annual Average Daily Traffic (AADT) are the substantial contributors to accident rates on multiple rural roads. It was concluded that the vehicle speed, Annual Average daily traffic (AADT), Motorcycle, motor car, the Gap and the total length of the Accident section were significantly contributed to the accidents at four lanes and two-lane undivided rural road. These results further validated in a case study done by using accident data over 5-year duration in Italy (Ismail, 2010). Research conducted in 2010 using accident data in Colombia and Canada, the analysis showed that factors such as traffic flow

4

characteristics, geometry and weather had a statistically significant association with traffic accidents (G. Lovegrove, M. Clarklim, & T. Sayed, 2010)

4. DATA COLLECTION

The study area for this research is the Galle Municipal Council Area (GMC). In Sri Lanka the Department of Police is handling the road traffic accident complains and legal actions. From 2003, motor insurance companies started the scheme of issuing compensation payments at the crash site to the owners of damaged vehicles without police reports, and as such this apparent decrease in road traffic crashes is likely due to under reporting of non-fatal crashes. As there is no requirement to report an accident to the police station, most of the property damage type accidents are not recorded at the police stations. The damage to the property will be borne by the insurance company or the owner of the property or paid by the primary driver who was in fault realized at the accident. Most of the time, only the accidents that need the legal proceedings, are recorded in the Police reports. The accidents are directly recorded to the relevant police station by the driver or the victims of the accidents and the police officers do record a complain after visiting the accident site. There is a separate traffic division in each police station, to handle the road traffic accidents and enforcement of traffic laws. All the traffic divisions of the individual police stations are connected with the Traffic Head Quarters which is located in Colombo, the commercial capital of the country. All the accidents recorded at local police station will be updated to the Traffic Head Quarters monthly using a special summarized data sheet called 'form 297 B'. Those data are transformed to a digital format at the traffic headquarters and they are maintaining a digital database of the road traffic accidents in Sri Lanka.

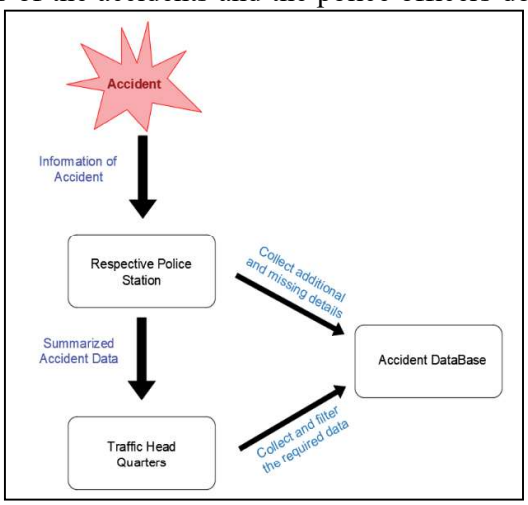

Figure 6: Accident Data Collection Process

The study area is controlled by two police divisions and the detailed data of each accident was obtained for 2017 and 2018 from Galle and Galle Harbour Police Station in electronic formats. The accident distribution in each year is shown in Table 1.

Table 1: No of Accidents recorded in the Study Area

Police Division	2017	2018	Total
Galle	195	168	363
Galle - Harbour	93	38	131
Total			**494**

Total of 494 accidents are recorded within two years period (2017 & 2018) related to 980 vehicles. Majority of the Municipal Council area including the city centre is controlled by the

5

Galle Police station where highest number of accidents are recorded during the study duration.

5. ANALYSIS

Data analysis was performed using data processing spreadsheet package and the data was analysed to identify the significance of each characteristic and external factor recorded at the time of accident.

5.1. Hourly Variation of Road Accidents

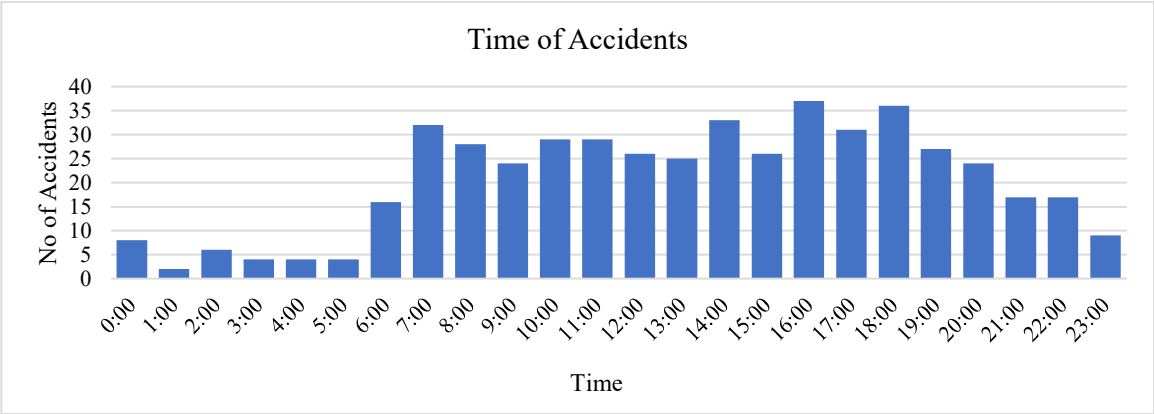

Figure 7: Time Distribution of Accidents Observed within GMC Area

The Figure 7 illustrates the variation of accidents with time of the day. Highest number of accidents has been occurred during peak times (7 AM to 8 AM & 4 PM to 6 PM) rather than off peak durations and comparing the two peaks evening peak has recorded the highest number of accidents. This seems to be exactly matched with the concept of the trends shown as poor driver performance and system demand characteristics with time of the day. Even though the travel speeds during the peak hours are low the trend can be justified as the traffic volume on roads (system demand) during peak durations are high and as the study area confined to urban centre, many junctions are at close proximity to each which will create very high number of turning conflicts (that make poor performance of tired drivers with fatigue) that might lead to many accidents compared to the off peak durations. The possibility of involving in an accident for a driver who is careless, tired, impatient or nervous is more compared with other drivers. All those type of behaviours cannot be observed at the same level in everyday or every hour by a driver. People are in a rush to go their workplaces, schools and to do their personal work which distracted them from driving. Low visibility and tiredness (poor performance) are the main reasons that might have contributed for having high volume of accidents during evening peak hours.

5.2. Daily Variation of Accidents

It was observed that highest number of accidents has occurred on Monday, the day which is known as the busiest day of the week. As Galle City is located along one of the main highways (Colombo – Galle – Wellawaya Road – A002) which is the 3rd longest national

6

highway in the country, a large number of long distance traffic is daily passing through Galle City specially prior and after the weekends. While having high peak of accidents on Monday the number of accidents that have occurred in other days are gradually reducing towards the weekend and again observed to have a high peak on Friday. An average percentage of 12.9% accidents have been recorded per day during the week ends and public holidays when it considered a week total. This is considerably low number of accidents compared to the week days and the Sundays are observed to be recorded lowest number of accident throughout the study period.

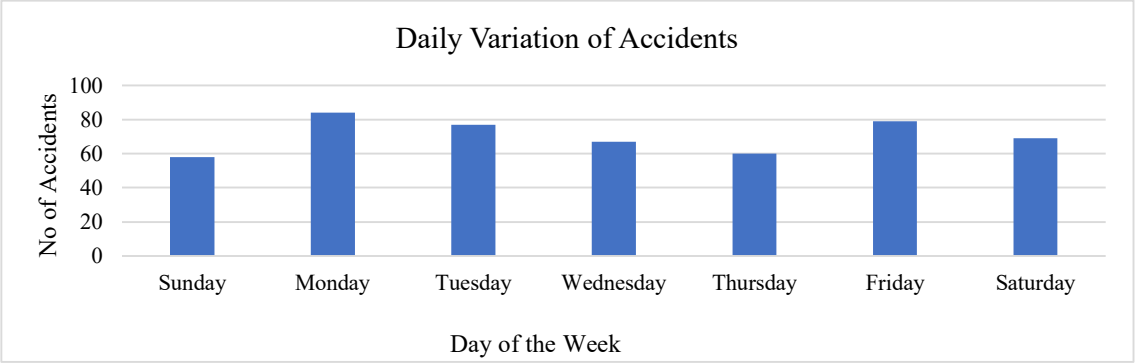

Figure 8: Daily Variation of Accidents in GMC

5.3. Monthly Variation of Road Accidents

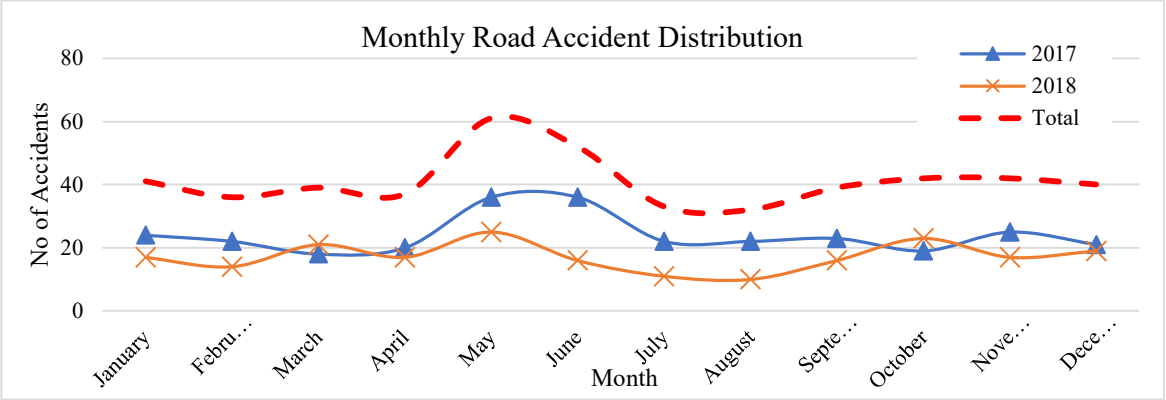

Figure 9: Monthly Variation of Accidents in GMC

The highest number of road crashes are observed in May and June, followed by November and January; and the lowest in March and October. The Figure 9 presents the number of accidents occurred in each month in 2017 and 2018 for the study area. The total number of accidents has been decreased in 2018 (206) compared to 2017 (288). The trends of accidents on 2017 and 2018 looks similar to each other except minor variations on month of October and March. However, number of accidents occurred in March and October have been increased in 2018. In 2017 both May and June have the highest number of accidents in 2017 while only May have the highest number of accidents in 2018. The number of accidents observed on festive seasons such as April and December are not high compared to other months of the year.

7

5.4. Severity of Accidents Recorded within the Study Area

The accidents are classified under four main categories by Sri Lanka Police and the details of the classification are given below.

- Fatal - Accident that has caused death to one or more person
- Grievous - Accident that has cause permeant disabilities for one or more person involved with the accident
- Non Grievous – Accident that has cause temporary disabilities for one or more person involved with the accident
- Property Damage – Accident that has no casualties but property damage.

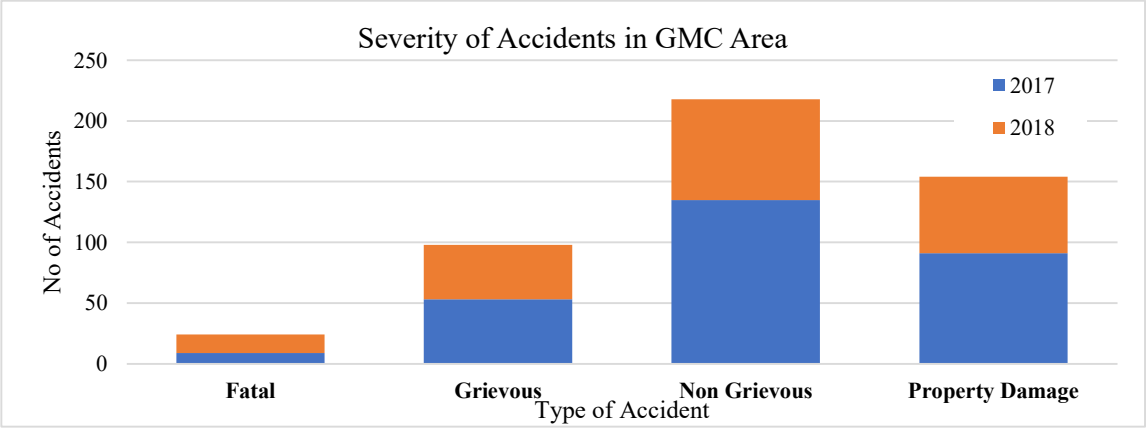

Figure 10: Types of Accidents Observed within the Study Area

The above graph (Figure 10) shows the number of accidents occurred in each category according to the severity in 2017 and 2018. The number of fatal accidents which is the most sever type of accident has least amount (5%) while non grievous accidents hold the highest number of accidents recording 69% of all accidents observed in Galle Municipal Council Area within the study duration. Although the data depicts that the property damage accidents is the second highest type of accidents majority of the minor property damage accidents are not recorded in police stations as it is not a mandatory requirement and the damage will be compensated through the insurance policy and other ways like interventions by the primary source of acident. Although the number of accidents recorded in the year 2018 is less than that of 2017, composition of fatal accidents have increased more than two times that of 2017 recording 7% from the total accidents recorded in 2018. The locations of the accidents occurred in each type is shown in Figure 11.

8

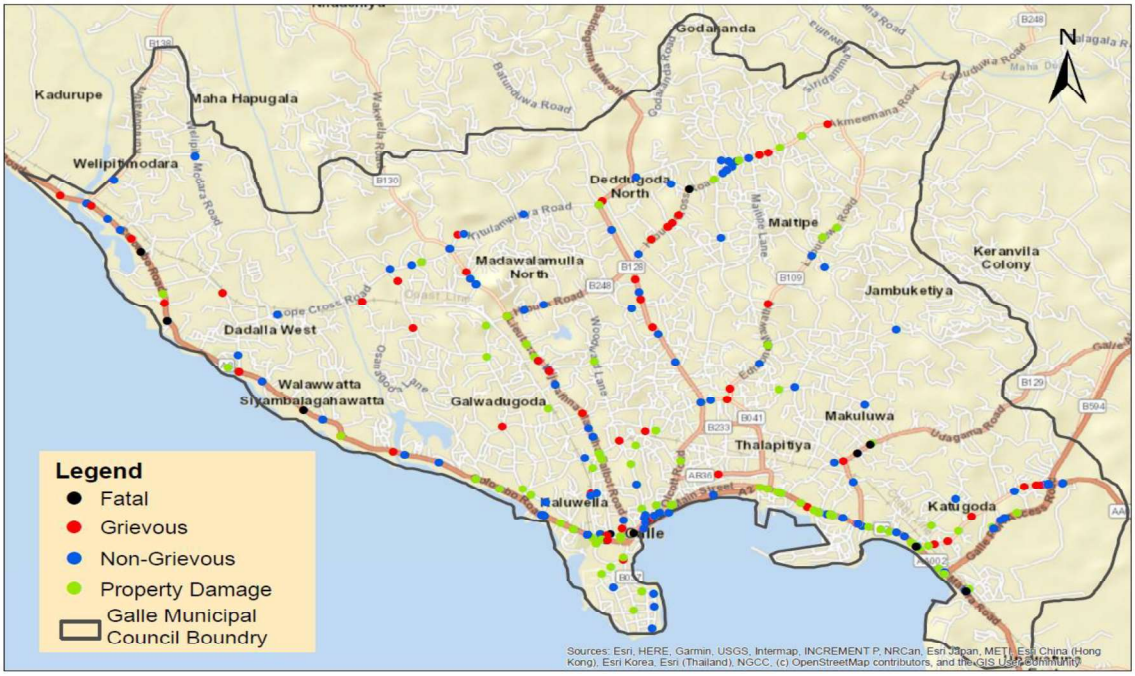

Figure 11: Locations of Study Area Recorded in Study Area

5.5. Vehicle Types Involved with Accidents

Referring to the types of vehicles, motor cycle accidents lie at the top with 38% of the accidents in the category. Motor cycles are inherently unstable and travelling at a high speed further increases the risk, considering the contemporary trends in the country, the younger crowd tend to ride motor bikes the most and in most of the cases these riders has very low experience furthermore riding unfamiliarly increases the probability of crashes which could ultimately end up in severe damages or it could even be fatal accidents. Cars have recorded higher percentage of accidents (21%) compared to its composition (13%). The vehicle composition is calculated based on number of vehicles in each category observed at 31 locations within the GMC Area.

Table 2: Types of Vehicles Involved with Accidents

Type of Vehicle	No of Accidents		Vehicle Composition at Galle City
	#	%	%
Car	177	21%	13%
Dual Purpose	68	8%	4%
Lorry	49	6%	10%
Cycle	19	2%	2%
Motor Cycle	324	38%	49%
Three-Wheeler	142	17%	16%
Bus	77	9%	7%
Total	856		

9

The next categories with a higher number of accidents recorded includes the cars and three-wheelers. The type as well as the condition of the vehicles will have a major impact on possibility of an accident occurring. Some such conditions includes the break systems, stability of the vehicle; three-wheelers and motor cycles are considered to be comparatively less stable. When the composition of accidents was analysed with the vehicle composition of Galle City centre, it was clearly observed that even though the motor cycle accident composition is 38% the its composition along the roads are much higher recording nearly half the amount of total traffic. Although 21% of the total accidents recorded at the two police stations are related to cars their composition of cars at Galle City centre is only 13% of the Total Traffic Flow.

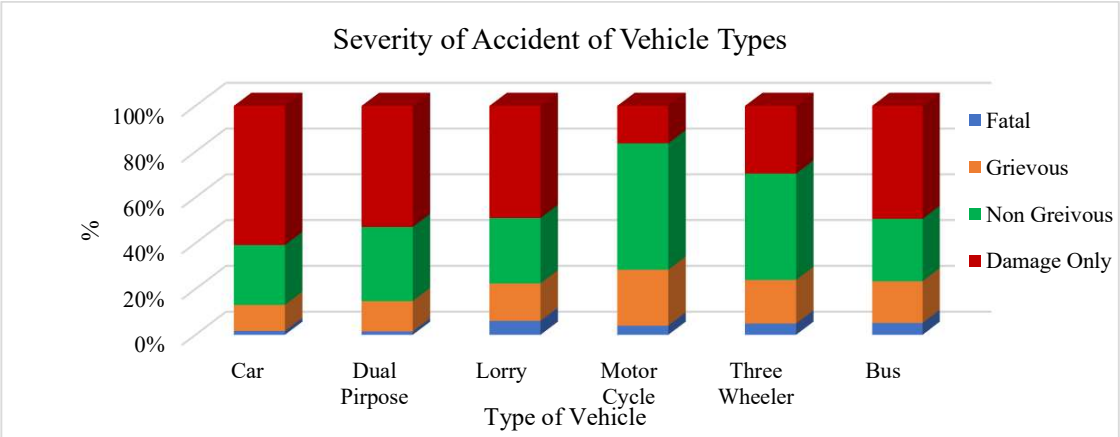

Figure 12: Severity of Accidents of Each Vehicle Types

According to the outcomes of the analysis motor cycles tend to be the type of vehicles that has faced accidents most, either it be fatal, grievous or non-grievous. It is clearly observed that the amount of property damage accidents of three wheelers and motor bikes are significantly low compared to the other vehicle modes. As two wheelers and three wheelers are not stable on the road and probability of causing an injury to the passenger is obvious compared to other closed body vehicles as shown in the above figure. Three-wheelers have met the next fatal accidents along with a considerably high percentage of grievous or non-grievous but only a lesser number of it has survived damages only. This could be due to the instability of the three-wheelers and reckless driving with high negligence. Cars are ranked the third highest category. However, majority of the car accidents experienced damages only as it has a good safety features such as seat belts and air bags compared to other vehicles.

5.6. Lighting Level and Conditions at the Time of Accident

The impact of the lighting level and condition is identified as a factor that has a lower impact on the number of accidents. No of accidents occurred during early morning period has reduced compared to the no of vehicles observed on roads within the GMC Area for the time period and the reason for such reduction may be the freshness of the drivers as it's the start of the day. According to Table 3, total of 68% of the accidents have taken place during the daylight time of the day where 66% of the traffic volume from the days total is observed. Traffic volume split for each time category was calculated based on the 24 hr. traffic survey data at 16 locations on the boundary of the GMC.

10

Table 3: Lighting Conditions at the Time of Accident

Lighting Level	Duration	No of Accidents	Traffic Volume Split
Dawn	2 Hrs. [5:00 - 7:00]	2%	7%
Day	12 Hrs. [7:00 - 19:00]	68%	66%
Night	10 Hrs. [19:00 - 5:00]	30%	27%

The number of accidents during night time period with proper street lighting system is recorded to be 22% of the total accidents. However, 8% of the accidents occurred in an inappropriate lighting conditions; either no street lights or improper street lights. This clearly indicates that the majority of the accidents occur under good lighting condition in day time where vehicle volumes are also high compared to the night time.

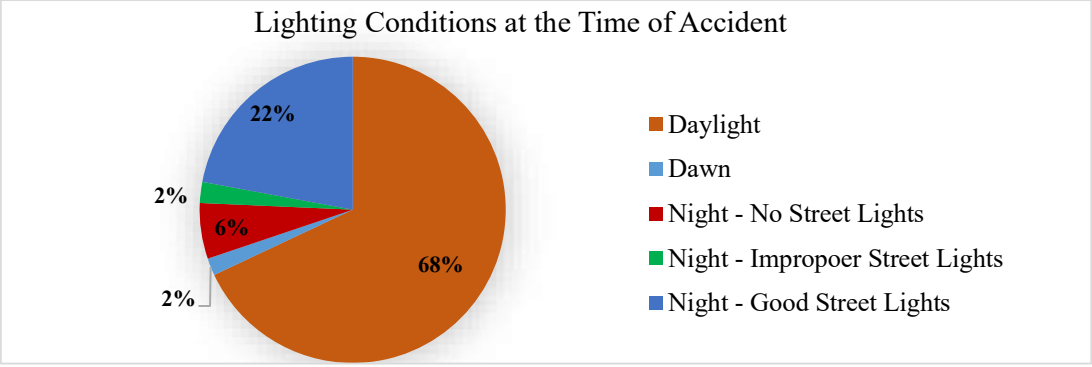

Figure 13: Lighting Conditions at the Time of Accident

5.7. Weather Conditions at the Time of Accident

Road accident severity may be influenced by a number of factors. Prevailing weather at the time of the accident is one key external parameter that will cause accidents. During heavy rain and mist the visibility will be reduced as well as the road surface will become slippery. Galle City which is located at the Southern Coastal area of the country will not experience fog or mist but rain. 97% majority of the road accidents have taken place during clear weather condition while only 3% of accidents are recorded during cloudy or rainy weather (Table 4). The reason for the reduction of the road accidents during rainy weather might be the drivers either taking more care in their driving or canceling their journeys due to adverse weather. As nearly 50% of vehicle composition in the Galle City Center is motor bikes and there will be a significant reduction of traffic volume on the road network at the time of rain and will have resulted in low number of accidents as 38% of the traffic accidents are made by motor bikes as a whole.

Table 4: Weather condition at the time of Accident

Weather Condition	No of Accidents	%
Clear	482	97%
Cloudy	3	1%
Rain	9	2%

11

5.8. Locations of Accidents within the Study Area

The results depicts that the majority (63%) of the accidents have taken place on straight roads. However, a straight road would provide a more clear view to the driver in contrast to the locations with curves and junctions. This could be directly linked with the speed and negligent driving as explained previously as well. There can be other factors such as lesser obstacles on the straight roads encouraging high speeds or more risk taking behavior of the drivers. On the other hand, the T junctions are considered the second potential location that accidents had occurred, accounting to 23% of total accidents that occurred in Galle Municipal Council (GMC) Area within 2017 and 2018. Most of the accidents in 3 legged Junctions are non-grievous and this could be a result of the driver not having a clear view of the vehicles approaching from the other adjacent roads. The other locations with high number of conflicts such as roundabouts witness lesser number of accidents as the drivers are aware of the potential risk of accidents at these locations, hence naturally they tend to be cautious at these locations which leads to mitigation of accidents. Further to above the number of roundabouts in GMC Area is limited to 8 which have resulted in low number of accidents recorded in roundabouts. Out of the all above accidents 11% of the total accidents have occurred at the locations where a police office or regulated traffic signal was in operation. Accidents in areas with no traffic control has contributed to 89% of the total accidents, which also shows the inappropriate road discipline of the drivers.

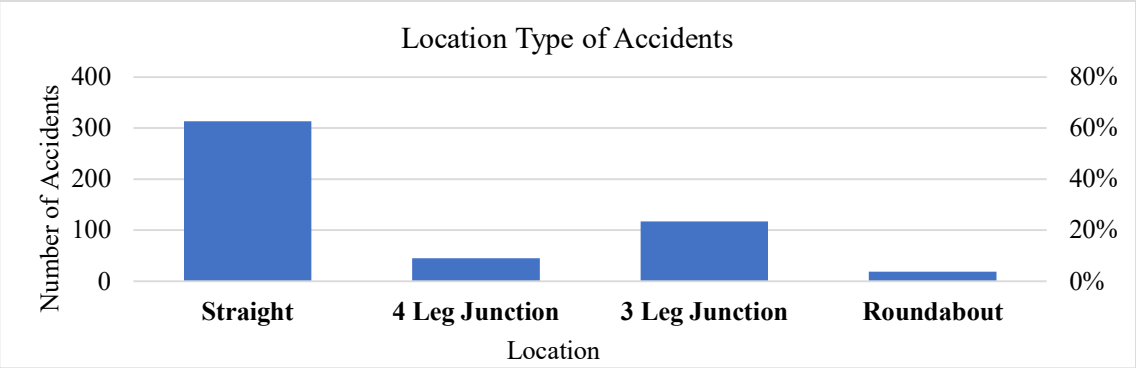

Figure 14: Location Type of Accidents that was observed within the Study Area

5.9. Locations of Accidents related to Pedestrians

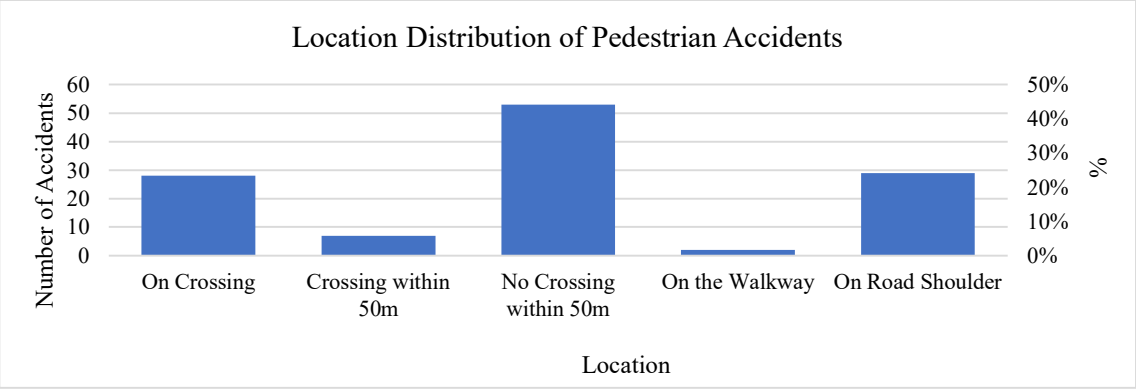

Figure 15: Locations of Pedestrian Related Accidents

12

Compared to the accidents between vehicles, pedestrian related to accidents will obviously make significant damage to the pedestrian as he is directly exposed to the accident and most of the time will end up in a grievous or a fatal accident. The highest number of accidents with regards to the pedestrians has taken place at locations where there were no crossings within 50m of crash site. This high probability could depict the carelessness of the driver as well as the pedestrian due to the fact that the pedestrian would cross the road at an unexpected time. The next event is the pedestrians facing an accident on road shoulders, which was calculated as 24% of the total accidents. On the other hand, a similar number of accidents; 24% of the total accidents have also taken place on the crossings both these emphasizes the recklessness of the driver himself.

5.10. Age Distribution of Drivers Involved with Accidents in GMC

Age is one of the critical factors that influences on the mental and the physical aspects of an individual. The younger generation and the middle aged crowed is perceived to drive vehicles at very high speeds as a result of their impatience, recklessness and risk taking, this is also proved through the analysis results with 70% of the accidents been witnessed through the drivers of age up to 43 years while 15% of the vehicles related to accidents were handled by the young drivers in the age group of 18 to 23. 70% of the accidents faced by the drivers / riders of age group of 18-23 are related to motor bikes which is 10% of the total accidents recorded in the study area and this shows the high probability of young riders to expose for a road accident with motor bikes.

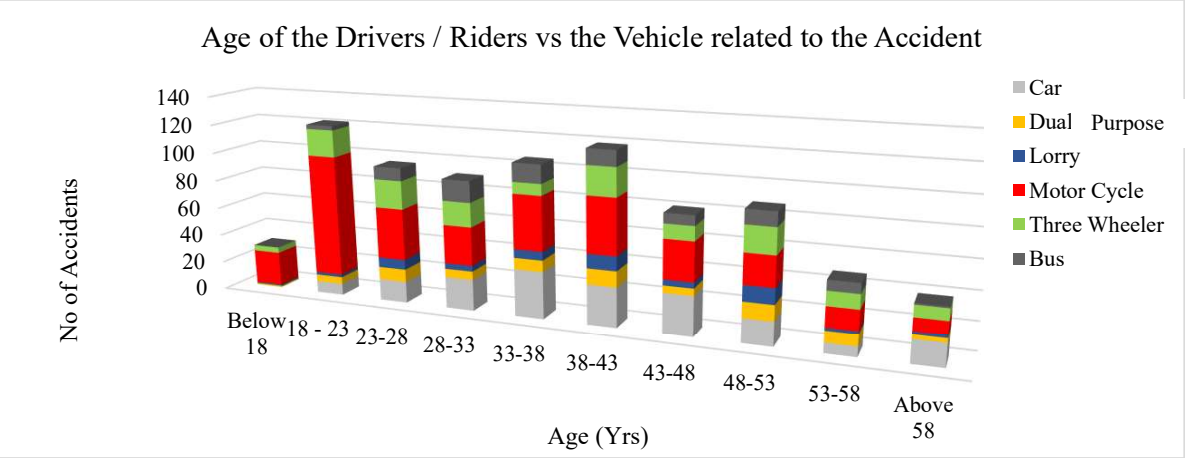

Figure 16: Age of the Drivers / Riders Involved with Accidents

Furthermore, it could also be observed that once an individual reaches maturity and grows older the number of accidents has also decreased gradually. Through this trend it is evident that the experience of the drivers and carefulness while driving is directly proportional. Significantly high number of accidents (41%) out of all accidents observed with the Galle Municipal Council Area during 2017 and 2018 are related with a driver or a rider who has obtained the driving licence within past five years. The drivers with a driving license below 5 years are exposed to higher risk of accidents due to their lack of exposure and experience, and this could be directly related to the age of the drivers as well, as discussed previously. Accordingly, a gradual decrease in the number of accidents or improvements in driving have been observed. Nevertheless, there is a change in this trend in the category of individuals with license been more than 30 years. This category also refers to an elderly crowd week in mental

and physical health who have high potential of decline in cognitive, visual as well as mobility functions which could ultimately lead to accidents. These results will highlight the importance of having proper awareness program and training sessions to educate the new drivers at the time of obtaining the driving licence.

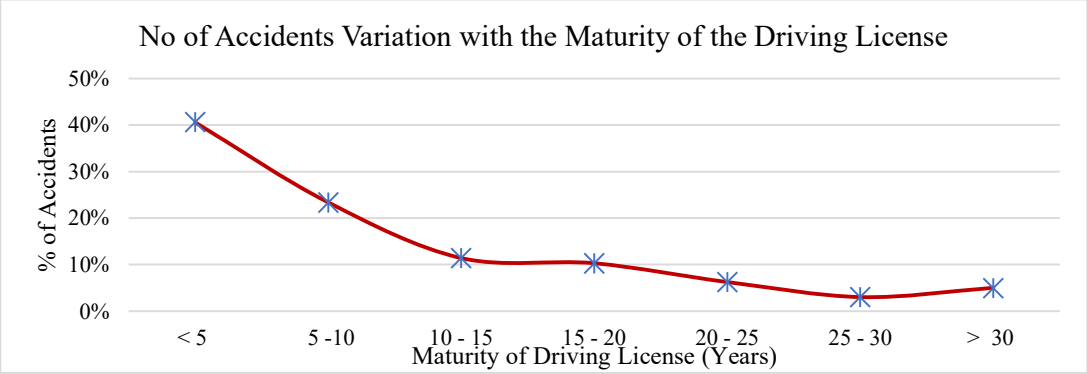

Figure 17: Maturity of the Drivers Involved with Accidents

5.11. Causes for Accidents Recorded in Galle Municipal Council Area

There are mainly two type of causes for accidents that is the human factors and external factors. Most of the time accident occurs at a combination of both external and human factors. This section analyses the causes of accidents in GMC area under 3 categories; High speed (driving exceeding the legal speed limit); Aggressive/ Negligence driving (related to dangerous, and irresponsible vehicle use such as running red lights; frequently changing lanes, reckless driving etc); Influenced by alcohol (accident caused due to the drunk driving). Generally, the majority of car accidents seem to be associated with the human factor. As per the analysis the major cause of accidents is high speed. This amounts to 62% of the total accidents. High speed results in uncontrollability of the vehicle and at the same time the severity and impact of crash is very high at a collision. Aggressiveness or negligence driving is ranked next with 31% accidents which could be justified as the high volume of accidents are related to young drivers of age below 30 years. Thereafter 6% of the accidents are caused due to Alcohol-impaired driving which could also uncontrollable aggressive high-speed driving with delay in decision making which has led to grievous and fatal accidents.

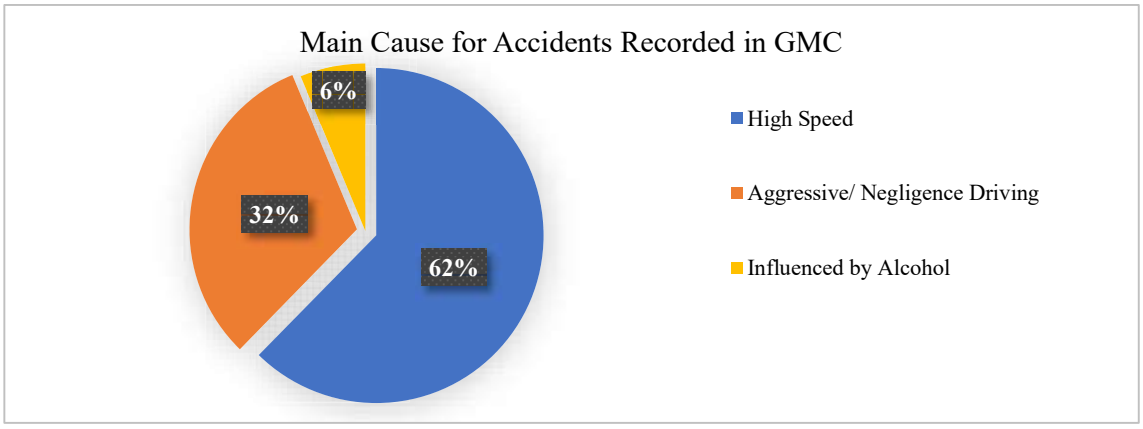

Figure 18: Causes for Accidents Recorded in GMC Area

14

5.12. Causalities Recorded from Accidents Recorded in Galle Municipal Council Area

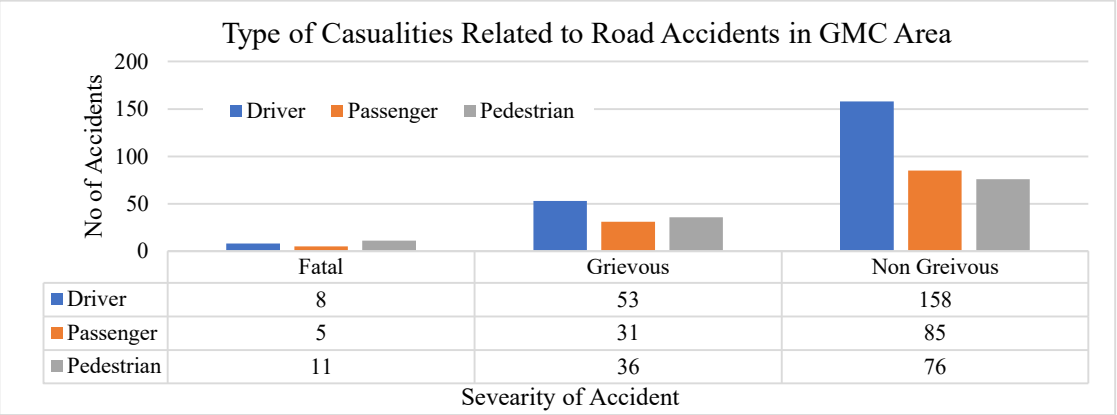

Figure 19: Types of Causalities

This parameter is used to present the degree of severity of the accident and the category of individuals that are affected the most from accidents. Accordingly, drivers are the most vulnerable individuals exposed to accidents when compared to passengers and the pedestrians who had been exposed to accidents in almost equal percentages 26% and 27% respectively. Considering the severity, majority of the accidents; 69% are non-grievous. Fatal accidents are 5% and unfortunately, pedestrians are more exposed to fatal accidents.

5.13. Analysis of High Risk Zones within Galle Municipal Council Area

The selected study area comprises of approximately 160km of Roads. Colombo Galle Wellawaya Road (A002) is the main road link passing through the Galle Municipal Council Area and all other roads are focused towards the Galle City Centre where major trip attractors and public transport terminals are located. In Sri Lanka A and B Class roads are national highways which are having proper highway geometry with wider lanes and standard road markings are owned and maintained by the Road Development Authority (RDA). Even though the quantity of "A" class roads is the lowest, highest amount of accidents are recorded on A Class Roads. There are only two "A" class roads with the GMC Area namely A002 and A017. More than the half the amount of the total accidents is recorded at A Class main highway which carries large traffic volumes through the city. C and D Class roads are connecter roads which connects A and B Cass roads usually with single lane or two-lane capacity. Even though the quantity of C & D Class Roads counts for 78% of all types of roads in GMC only 120 accidents (24%) are recorded during 2017 and 2018. Improved roads encourage people to drive at higher speeds than those to which they are accustomed, because improved roads reduced the perceived risk of accidents and so cause drivers to behave more carelessly, or because improved roads do not incorporate corresponding safety features. For example, improved road geometry may reduce visibility related accidents but increase speed related accidents, unless police enforce speed regulations.

15

Table 5: Accident Classification on Road Types

Road Type	Accidents		Road Length
	No	%	
A Class	255	52%	13.1
B Class	116	24%	21.1
C, D Class & Other Roads	120	24%	124.8

Urban roads commonly have many similar intersections and road sections, as well as varying traffic conditions. As such, there are some road accidents that occur on similar road sections or intersections during a specific period of time and these areas can be called black spots. Though the number of black spots in an urban road network is small, they harm to people's property, lives and to the economy of the country is substantial. Identification of the location of black spots is the most important step in the accident mitigation process.

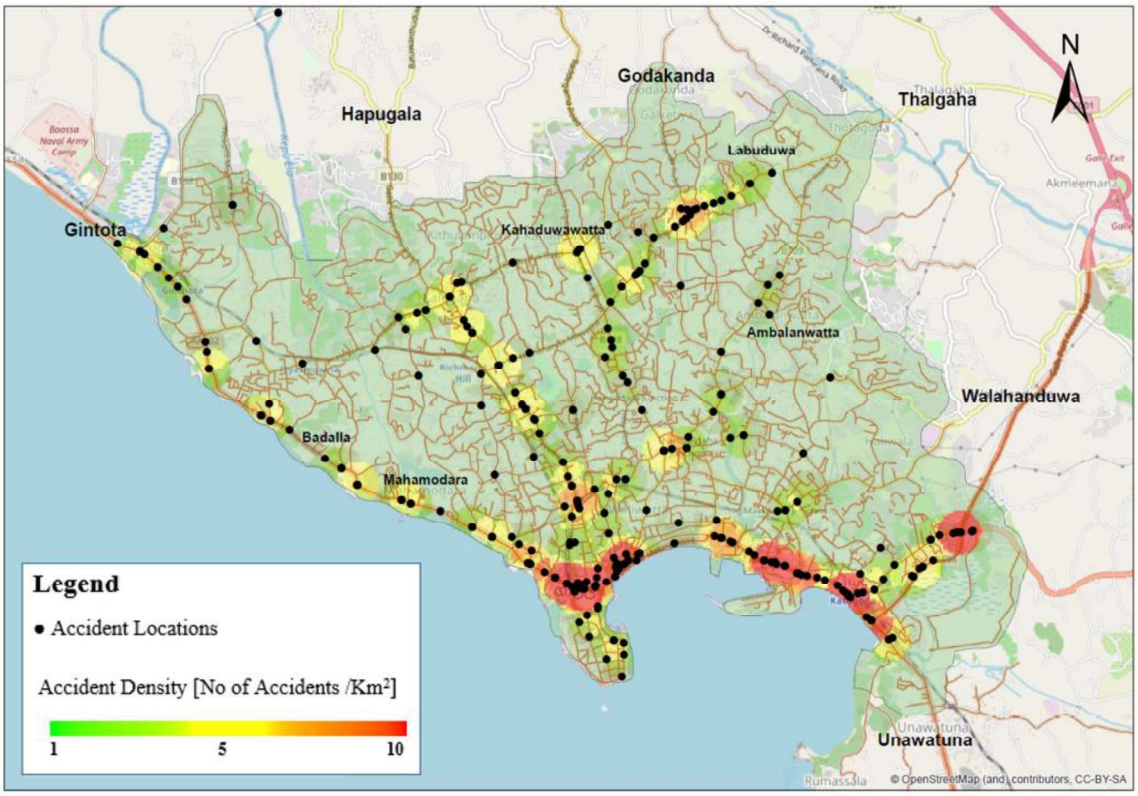

Figure 20: Accident Density in Galle Municipal Council Area

When the study area is considered most of the accidents were observed on the A002 Road along the coastal belt. The accident density is highest at the city centre. Large number of vehicles are conflicting at three roundabouts within 200 m length along the A002 Road. The two main public transport terminals (Bus and Train) are also located on the same stretch discussed above with some other major trip attractions such as three banks, Police Station, Post Office which will create significant amount of pedestrian movements at the city centre. Attention should be focused on identifying the black spots, which could help reduce the frequency of traffic accidents, improve road safety, and promote safe environment for passengers as well as pedestrians.

16

5.14. Cost of Accidents Recorded within GMC Area

The cost has been calculated considering accident-related costs based on type of accidents, fatal or grievous and the average of each per year. The cost related to accidents observed on GMC Area was estimated based on the publication by (Department of National Planning Ministry of Finance & Planning, 1999) of Sri Lanka. The estimations of accident cost were done and forecasted based on the imperial data collected and based on the economic value of each economically engaged personnel of Sri Lanka and the cost of the damage to type of vehicles. It clearly indicates the total cost of each type of accident considering the property damage, medical costs, Police proceedings costs, insurance costs, congestion costs, output loss and the pain and grief for the family and person met with the accident. Although the total cost related to accidents were estimated based on standard norms, savings in accident cost will be a significant factor which cannot be expressed in monitory values as it is related with valuable human lives.

Table 6: Cost Associated with Accidents Recorded in GMC Area

Type of Accident	Average No of Accidents per Year	Accident Cost (LKR)	Accident Cost (USD)	%
Fatal	12	134,018,467	712,864	46%
Grievous	49	54,892,605	291,982	19%
Non-Grievous	109	69,128,761	367,706	24%
Property Damage	77	32,164,017	171,085	11%
Annual Total	**247**	**290,203,850**	**1,543,638**	

The highest accident cost is associated with the fatal accident which is only 5% the number of total accidents recorded within the study area. Above mentioned fatal accidents are accountable for 46% followed by non-grievous accidents recording 24% of total accident cost. The total annual cost of accidents for the national economy per year within the Galle Municipal Council Area is estimated as Rs. 290,203,850 (2020) which is equivalent to 1,543,638 USD Per year.

6. CONCLUSION

This research analysis covers 2 years road traffic crashes, injuries, fatalities in two police divisions in Galle District. Total of 494 accidents were considered for this study. According to police data, in Galle, Sri Lanka most road traffic victims were motor bike riders aged between 18 and 23. Further the results show a causal relationship between the experiences of the drivers, accident risk perception directly proportional. In Galle, the drivers with less experience (below 5 years) exposed to higher risk of accident and also it was noticed that a high number of accidents involved more than 30 years licence holders.

Highest number of accidents have been occurred during evening peak times (4 PM to 6 PM) and the probability of accident occurring on Monday recorded as high while the average percentage of 12.9% accidents have been recorded per day during the weekends and public holidays. It is highlighted that the accident probability on festival seasons (April and December) are not high compared to the other months of the year. The accidents are classified

17

as fatal, grievous, non-grievous and property damage by Sri Lanka police. During 2017-2018, 69% of accidents observed as non-grievous accidents in GMC Area. According to the data fatal accidents has increased more than two times in 2018 than that of 2017.

According to the data the lighting condition that has a lower impact on the accident occurrence since the statistics indicate nearly equal number of vehicles compared to the traffic volume during the day and night time. Several studies confirm that accident severity may be influenced by weather conditions (Satiennam, Satiennam, Triyabutra, & Rujopakarn, 2018). This is also confirming with accident record in Galle, 97% majority of the road accidents have taken place during clear weather condition while only 3% of accidents are recorded during cloudy or rainy weather. It was observed the majority of the accidents took place straight road section mainly because of loss of control due to high speed. T junctions are considered the second potential location that accidents had occurred and police reports stated that the main reason as poor visibility. These results suggest that the most of the accidents are occurred because of poor awareness of traffic laws and act of risk perception. The Galle City centre has numerous crash hot spots for injury for all types of road users. Further analysis at these locations is necessary to recommend specific interventions for each type of road user. The age of the drivers, traffic volume, infrastructure and rain are critical factors for elevated road accidents. The analysis of collision type may also help to uncover accident causes and their risk factor. As developing country policy makes and government need to revisit traffic regulations so that roads can be made safer to use and travel for all

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19