INVESTIGATION OF CAUSES OF ROAD TRAFFIC ACCIDENTS

(A Case Study of Zalambesa – Adigrat-Mekelle Road Traffic Line and Its Tributaries)

[1]Tsgab Tesfay Hagos

, [2]Mehari Gidena Tsegay

[1]Lecturer, [1]Civil Engineering Department,

[2]Lecturer, [2]Electrical and computer Engineering Department,

[1]Civil Engineering Department,
[1]Adigrat University, Adigrat, Ethiopia.

Abstract: The overall purpose of the study was to investigate the root causes of road traffic accidents on study areas which include the whole Eastern Zone of Tigray and May-Mekden to Lachi road traffic line found in South East Zone of Tigray and to create a comprehensive model which is crucial to reduce road traffic accidents in this area. The study area was selected systematically as per the preliminary survey results generated from the road traffic accident records in the traffic police office of Eastern Zone and South East Zone of Tigray. A mixed research method i.e. qualitative and quantitative research approach was used to carry out the research analysis and interpretation over the primary and secondary data collected from the study area.
The findings generated from the research analysis made known that within four years from 2007E.C onwards 422 accidents have occurred in which 228 people was dead, 568 people was injured and 26,592,265.53birr worth property was damaged. The major cause of road traffic accident was driving at high speed i.e. beyond 80 KM/hour at towns and 120 KM/hour at rural areas (in the context of Ethiopia) where over 85% of the drivers traced in the survey was not clear about recommended range of driving speed in town and rural areas. Lack of giving priority to pedestrian, driving left direction (in the context of Ethiopia right is for vehicle) and lack of appropriate distance while driving sequentially were ranked as root causes of road traffic accidents next to high speed driving. From the total accidents 86.97% and 65.4% of the accidents were occurred at good weather condition and straight road alignment respectively. 57 % of pedestrians at the study areas were not aware about road utilization i.e. they did not know the left direction against of vehicle motion and left and right direction of road was used interchangeably. Vehicle inspection was not carried regularly and to the standard due to lack of machineries and experts. As a result 87% of drivers included in the survey were not using preventive maintenance rather used breakdown maintenance.
This study has confirmed the major causes of road traffic accident in the study area were primary driving at high speed and next lack of giving priority to pedestrians. A hexagonal road traffic accident reduction model was developed which fully considers the analysis results and takes in to account all the causes determined in the survey

Index Terms **- Traffic accident, speed, Vehicle motion and Pedestrian approach.**

I. INTRODUCTION

In our country Ethiopia road traffic accident (RTA) is the major socio-economic problem in the society. Our government has approved policies and strategies to mitigate road traffic accidents. But on ground the road traffic accident rate is increasing from time to time as the number of vehicle and human population is also increasing. The policies and strategies by themselves are not enough to reduce road traffic accidents. It is better to identify the root problems causing road traffic accidents and to provide proper and comprehensive solutions as road traffic accident is producing a high loss in millions of dollars and killing life of thousands of people. Road traffic accidents are highly dependent on the attributes such as lack of proper training for drivers, vehicle maintenance quality and scheme, road quality, skill of driving and knowledge of road traffic rules (dynamics rules) as it was already investigated by many researchers.

In Tigray region as one of the states in the country road traffic accident is one of the major socio-economic troubles. So far the causes of road traffic accidents in Tigray region Eastern zone and South East zone (Maymekden- lachi road traffic line) were not well studied but a number of road traffic accident records are found in police traffic stations and Road Transport Bureau. The records show that some of the reasons for road traffic accidents were lack of proper training, pedestrians' road utilization mistakes and high speed driving due to lack of knowledge about road traffic rules (dynamics rules). So that to identify the root causes of road traffic accidents on Eastern zone and South East zone (Maymekden- lachi road traffic line) on ground investigation was mandatory. After the investigation an integrated road traffic accident reduction model was developed taking in to account the parameters drivers' quality of training, pedestrian road utilization approach, vehicle maintenance scheme and road traffic control system to support the government policies and strategies in reducing road traffic accidents.

II. BACKGROUND AND JUSTIFICATION

Road traffic accidents (RTAs), here defined as "An accident that occurred on a way or street open to public traffic; resulted in one or more persons being killed or injured, and at least one moving vehicle was involved. Thus, RTA is collisions between vehicles; between vehicles and pedestrians; between vehicles and animals; or between vehicles and fixed obstacles", is a major global socio-economic challenge.

Every year about 1.2 million people are killed and more than 20 million are injured or disabled globally. About 85% of annual road-traffic related deaths and 90% of annual disability are because of RTAs occur in low- and middle income countries despite the fact that they only have about 32% of the global motor vehicles. These countries have shown an increase in deaths and disabilities from RTAs since the 1980s, high income countries on the other hand, recognized the magnitude of the problem in the 1970s, and have since been working towards promoting road safety and raising awareness among road users. Hence, these countries reduced fatalities from RTAs by more than 25% during 1968 -1998, at the same time they increased by 340% in Africa, 200% in Asia and the Middle East, and 30% in Latin America. If the present trends continue, the annual deaths and disabilities from RTAs will drop another 30% in high income countries, while it will rise considerably in low middle income countries by 2020.

The World Bank and United Nations Economic Commission for Africa (UNECA) scoping study "Urban mobility in three cities", confirms the statistics that have been quoted in various studies, i.e. Ethiopia has one of the highest fatality rates per vehicle in the world. It is in excess of 100 fatalities per 10,000 vehicles. This should be compared with Kenya and United Kingdom, where the figure is about 19 and 2 per 10 000 vehicles, respectively. (1)

It is obvious that road transport contributes a lot to develop a nation both economically and socially. In Tigray region, since the service of the road transport is extreme, this sector is a means of transport for 99% of those who use modern transport service and for 100% of cargoes.

When we see traffic accidents in Tigray region, even if no information was obtained from well-studied and well analyzed data, different records show that around 230 people died and over 600 individuals faced light and serious injury and over 10 million birr worth property has been destroyed. It was also indicated that the number of vehicles increased from 8 –10% every year and the number of traffic accidents has also grown from 13–15 %. (2)

In the road transport office, some new activities like new ways of implementation, rules and regulations such as vehicles' safety check up (safety and maintenance of vehicles) , evaluating training standards , examining drivers impairment , skill of driving, knowledge of road traffic rules and giving driving license are underway by controlling their qualities and by ensuring their implementation. If the regulation tasks are done based on the already introduced new traffic accident prevention mechanisms and if the issue is given an appropriate attention and cooperation both by the government and by the society at large, it is possible to mitigate the existing traffic accident record.(2)

As a result this research study was proposed to determine the root causes of road traffic accidents in Tigray region Eastern Zone and South East Zone (Maymekden-lachi road traffic line) since 2007 E.C and the gap to be studied reside on the attributes like drivers' mode of training, road traffic control system, pedestrians road utilization approach and vehicle maintenance scheme. The aim of this research study was to create an integrated road traffic accident reduction model based on the parameters i.e. drivers' quality of training, pedestrians' road utilization approach, maintenance scheme and road traffic control system.

III. OBJECTIVES

3.1.1. General objective

The general objective of this research was to investigate the root causes of road traffic accidents in Eastern zone and South East zone (maymekden - Lachi road traffic line) of Tigray region and to create an integrated road traffic accident reduction model which is crucial to reduce road traffic accidents in this area.

3.1.2. Specific objectives

The specific objectives of this research were:

a. To investigate the level of quality of training given to drivers within training centres in

b. Adigrat and Mekelle towns
c. To investigate the road traffic control system in the study areas
d. To understand the skill of driving and knowledge of drivers about road traffic rules
e. To investigate the current vehicle maintenance scheme
f. To understand pedestrians' road utilization approach
g. To determine the economic loss in terms of material damage and level of human injury and death
h. To create an integrated road traffic accident reduction model

3.2. Description of Study Area

The research was conducted in Eastern zone and South East Zone (May mekden-lachi road traffic line) of Tigray regional state as per the preliminary assessment made was clear indicator for the existence of high rate of road traffic accidents in this area. Since the geographical location of this are naturally consists of a lot of curved and sloppy paths which are the expected challenges for road traffic flow definitely it was the researchers' area of interest.

3.3. Research Methods

3.4. Research Design

Qualitative and quantitative approach was used as research method as this method was so helpful to get detail of data from many participants and to apply document review method to validate and determine facts.

3.5. Sources of Data

The primary data source was collected from traffic police office, transport bureau, pedestrians, drivers' training centers, garages, drivers and trainees whereas secondary data source of this study was gathered from the recorded documents in traffic police office, transport bureau, drivers' training centers and garages based on the parameters i.e. drivers' quality of training, skill of driving and knowledge of drivers about road traffic rules, vehicles maintenance scheme, road traffic control system and pedestrians' road utilization approach for the investigation of the road traffic accident in the study area.

3.6. The Samples and Sampling Techniques

In this research purposive sampling was used as a sampling technique in order to get a representative and validated data at full picture. Since the research considers different participant groups i.e. sample was selected based on characteristics of population and objective of study the sample size taken from each group is summarized in the table below as per the standard sample size range is from 10%-40% of the total population.

Table 1: sample size versus population considered

S.no	Group	Population / Quantity	Sample size	Remark
1	Drivers' Training centers	28(13 Adigrat +15 Mekelle)	10 training centers (10 x 6 =60)	4 from Adigrat and 6 from Mekelle and 4 technicians and 2 officeholders totally 6 individuals from each training center
2	Drivers	500	100	The total population was taken from the number of cars working in the study areas
3	Trainees	280	100	10 trainees is allowed in one training center. Thus in 28 centers 280 trainees
4	Garages	30	10	7/23 from Mekelle and 3/7 from Adigrat

5	Pedestrian	10,000	2000	Pedestrians living side road in the study areas
6	Police traffic office	90	40	There are 90 road traffic police in the study areas
7	Transport bureau	70	30	A total of 70 transport bureau officers and experts in the study areas

3.7. Instruments and Procedure of Data Collection

Closed and open ended questionnaires, interview, focus group discussion, observation and document review were used as data collection mechanisms. The focused group discussions were used to strengthen the questionnaire and interview responses. The participants of focus group discussion included 50 drivers, 50 trainees and 200 pedestrians where a single group was established with 10 individuals. The whole focused group discussions were recorded by using field notes. Observation was very important to take some field test observations and results about the training quality in selected training centers in Adigrat and Mekelle towns, to observe the road utilization approach by pedestrians and to investigate vehicles maintenance quality and scheme within garages.

3.8.Data Analysis Method

The data collected was analyzed using both qualitative and quantitative method/mixed approach/ of the data analysis technique. Depending on the nature of collected data through questionnaire, interview, observation and focus group discussion different statistical techniques were employed in this study. These data were coded, organized, analyzed and interpreted both qualitatively and quantitatively.

To analyze the quantitative data percentage, frequency and mean value was used. These statistical tests were used for the purpose of testing different variables between the respondent groups. Besides of the statistical process on the quantitative data the qualitative data was narrated qualitatively using words, phrases, statements and paragraphs obtained from interviews, open and close ended questions, observation and focus group discussions. Hence the qualitative data was used as the complement of quantitative data.

4. Results and Discussion

4.1.Quality of Training in Driving Training Institutions

Table 2: Driving training system and facility investigated by the survey made over 10 training centers

S.No	Description	Unit	result	Remark
1	As per the survey made over 70 vehicles the maximum and average service year of vehicles used for driving training was respectively	year	14 and 8	
2	Time allocated for practical driving training	day	35	All training centers used the same time allocation
3	Time allocated for theoretical driving training	day	11	“
4	The ratio of driving license given to drivers disaggregated in terms passengers, truck and special type respectively	%	73:25:2	
5	Number of driving training centers with reverse modality of training (practical first and theory next)	%	71.4	But after 15 days they use parallel mode
6	Training efficiency in terms of time management (utilized time)	%	60-65	About 35-40% of the training time was not utilized appropriately

7	In a single term of driving license exam the percentage of trainees who can pass the exam (Theoretical and practical evaluation)	%	45-65	Only 10 trainees allowed for one training center in a single term

4.2. Road Traffic Control System

Table 3: Road traffic control system

S.no	Description	Respondents rate (%)	
1	Whether training given to pedestrians about road utilization approach was periodical and sufficient enough	Training was periodical and sufficient	Training was not periodical and sufficient
		12.5	87.5
2	Whether all roads in the study areas were installed with appropriate and enough road traffic symbols	Installed with appropriate and enough road traffic symbols	Not installed with appropriate and enough road traffic symbols
		7.5	92.5
3	If traffic police are responsible, free from rent seeking and always available in their workplace	They are responsible, free from rent seeking and always available in their workplace	They are notresponsible, free from rent seeking and not always available in their workplace
		28.57	71.43
4	As traffic police your observation about new drivers' competence during their driving time	Qualified	Low driving skill
		27.5	72.5
5	If some drivers own their driving license through rent seeking mechanism	Yes	No
		67.5	32.5
6	If some drivers having forged driving license available	Yes	No
		57.14	42.86
7	If there is a smart system supported by technology which controls vehicle flow	Yes	No
		0	100
8	If vehicle inspection process is done on time using standard equipment	Yes	No
		16.67	83.33
9	If the training standard given by driving training centers is quality and appropriate	Yes	No
		33.33	66.67
10	If transport office's experts are available in their workplace and responsible enough	Yes	No
		26.67	73.33
11	Any survey conducted about drivers' competence issued driving license by the transport office	Yes	No
		0	100
		64.62	35.38
12	If trainees registered for driving license first own full health examination certificate and the transport office assured it	Full health examination	Partial health examination
		34.78	65.22

4.3. Skill and Knowledge of Drivers

Drivers' skill and knowledge in the study areas was constrained due to lack of quality of trainers, shortage of material resource and facility in the training institutions, loose follow up of transport office towards training centers, below standard training time and the rent seeking system in the transport office for providing driving license without taking proper training which promotes other trainees to own full driving license in such fashion.

The theory and practical training time allocated for full driving license driver was found 11 days and 35 days respectively where a single trainee could not train above 4 hours a day. This by itself was a clear indicator for the limited knowledge, skill and attitude of drivers in the study areas.

Vehicles used in driving training centers for training purpose were very old on average eight and above years' service which could not match to most of vehicles found in the workplaces in terms of skill required and similarity of engine system. This challenge was not visible to the transport office because the training focus was not structured and managed through a training syllabus. But it impact on limiting the quality of training mainly the skill and knowledge of drivers was so prominent.

During the interview made for drivers included in the survey all replied that they did not commit any road traffic accident but the Tigray regional state's road traffic accident recorded from September 2014 to November 2017 indicated the number of road traffic accident occurred in the study areas was 422.

Drivers in the study areas did not follow road traffic rules to the desired. As per the observation made most of the drivers were not responsible i.e. always they look for the traffic police officers directly and through phone communication and if the traffic police is absent from workplace they totally abuse the traffic rules by overcrowding the vehicle and allowing to carry over capacity load where the load refers to passengers or dead load and driving at very high speed 120 Km/hour and above in any kind of road alignment. They did not drive at the desired speed as per the traffic flow indicators located in the road side, in urban and rural areas. Even though roads under study areas have limited road traffic flow indicators most of the drivers in these areas did not use the speed limit information rather they use their own observation without giving proper focus to the speed limit indicators

During training time the recommended speed range at rural and urban areas in km/hour is always explained to the learners and the trainers taught them seriously but 70% of the drivers included in this survey were not clear what a recommended speed mean and did not know the range of vehicle speed limit in rural and urban areas.

Even though most drivers keep their place of driving to right direction as it is a rule in the context of Ethiopia 45% of the drivers within the sample did not follow this rule and usually drive at the center where the shift to the right direction if a vehicle is coming in the opposite direction.

Pedestrians in the study areas were suffering from vehicle collision due to the drivers in these areas did allow them a chance to cross road first rather 85% of the drivers interviewed confirmed that due to a competition for getting money they cross first knowingly do not stop their vehicle even for a moment. As a reason even though not acceptable they claimed most drivers do not respect this traffic rule and it creates them a dalliance no to reach their destination before other vehicle could do that.

Drivers included in the survey were not having enough skill and knowledge about vehicle driving, vehicle architecture and organization after finishing their training and own their driving license through certification process. 92% of the drivers were found with limited skill of driving, less confident and limited knowhow about the vehicle's working principle where he/she is working with. 83% of the drivers considered in this survey replied that they have limited knowledge on the internal parts of an engine and vehicle as a whole. From the observation made on 78% of the drivers discipline was a major factor where they lack it at all. They did not respect passengers and the road traffic rules i.e. they do not know their rights and responsibilities clearly. This shows there is a gap in the driving training focus of the learners where discipline was not given the required weight.

It is known that drivers should be more careful than a doctor because life of many passengers is at their hand rather than a single patient to be treated by a doctor. From the observation the researchers made most drivers were found so careless for example when passing a vehicle in a stop condition or in motion moving towards the same direction in a curved path 41% of the drivers tried to pass in an overlapped manner while a third vehicle was coming in the opposite direction. In addition to this all the drivers considered in the survey did not use preventive maintenance to maintain their vehicle looking the signs and symptoms in the dash board and hearing the sound of their vehicle while driving. But the common maintenance approach they were using was breakdown maintenance. Of course the choice of the maintenance scheme was not primarily decided by the drivers but by the vehicle owners. Since they did not have the desired driving and technical competency checking vehicle status whether fault free before starting driving was not a habit except checking water and oil level. The primary factors promoting road traffic accident in the study areas were driving at high speed, poor skill of driving, lack of preventive maintenance and not giving priority to pedestrians while driving. Twenty one drivers were found under age for driving from 18 - 23 as extracted from the road traffic

accident records in the study areas and 608,500 birr worth property was damaged, 11 people died and 31 injured due to being under age for driving and engaged in driving vehicles.

4.4.Pedestrians' Road Utilization Approach

Table 4: Road traffic accidents occurred from September 2014 to November 2017 where victims were pedestrians

location of pedestrians where accident happen	Number of pedestrians injured	Number of pedestrians dead	Number of accident
Moving Along Road Side	51	24	38
Crossing Road	77	65	118
Standing At The Road	16	6	6
Total	144	95	162

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

4.5.Vehicle Maintenance Scheme

Most vehicles which get serviced in the maintenance garages found in the study areas including Mekelle do not use preventive maintenance and rather implemented breakdown maintenance which in turn aggravates road traffic accident. Breakdown maintenance is a kind of maintenance which is used to maintain vehicles and machines after break-down. But while driving a vehicle under fault the probability of occurrence of road traffic accident could increase at alarming rate. As evidence1.19% of the accidents occurred in the study areas since 2014 was due to vehicle technical problem. 87% of the drivers interviewed disclosed that they used breakdown maintenance because the vehicle owners were not voluntary and sensitive enough to note the accident that could be happen due to vehicle technical fault. The drivers themselves were not capable enough to understand the technical faults of their vehicle so that they can inform the vehicle owners and decide to stop driving.

The auto mechanic technicians and electricians found in the garages within the study areas were not capable enough to maintain a particular vehicle under fault. As per the sample considered 84% the technicians within 80% of the garages were found without any qualification i.e. they were working only due experience but no training has been taken related to the profession. The observation made on 80% of the garages indicated that vehicles were not appropriately maintained i.e. 55% the vehicles maintained for a particular fault returned to the same garage at most within a week for the same fault previously maintained. All the garages included in the survey within the study areas were not having standard and appropriate maintenance machineries.

The transport office in the study areas including Mekelle have not had standard vehicle inspection workshop used to carry out vehicle inspection regularly at the desired time interval. Another problem was lack of capable experts in the transport office to inspect vehicles to identify faults. This limitation was contributing an additive effect to the road traffic accidents occurred in the study areas.

4.6.Material Damage, Humane Injury and Death

This study investigated the material damage, human injury and death happen due to road traffic accident from September 2014 to November 2017 in the area of study where a total of 422 accidents were occurred causing 568 people injured and 228 people dead. 26,592,265.53 birr worth property was also damaged. Wereda Klte-Awlaelo has the highest road traffic accident record within the study areas i.e. 29.62% and Wereda SaesieTsaedaEmba was second where 13.98% of the total accident resides there. Even though it is a single road traffic line 11.85% of the total road traffic accident was occurred in May-Mekden to Lachi where it was ranked third level.

When we see the road traffic accident rate within the three and half years it was found increasing in which the researchers identified the problem aggravating this was lack of monitoring and evaluation in the area of study.

Table 4: Road traffic accident versus its impact

Zone	Wereda	Number of accident	Number of people dead	Number of people Injured	property damaged (Birr)
Eastern	Adigrat	32	25	19	308,700.00
	Atsbiwenberta	28	29	26	790,850.00
	GantaAfeshum	38	32	90	4,188,400.00
	Golomekada	16	9	14	174,500.00
	Hawzen	37	13	29	1,992,550.00
	Klte-awlaelo	125	69	279	7,429,309.53
	SaesieTsaedaEmba	59	30	59	3,266,900.00
	Wukro	33	12	25	950,220.00
	Erob	4	0	3	100,000.00
South East	Maymekden -lachi	50	9	24	7,390,836.00
Total		422	228	568	26,592,265.53

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

Table 5: Road traffic accident versus its impact disaggregated year wise

Zone	Year	Number of accident	Number of people dead	Number of people Injured	property damaged
Eastern zone and Maymekden to Lachi traffic line	2007 E.C/sep.2014/15	113	70	127	7,426,819.53
	2008 E.C/2015/16	134	83	219	7,394,280.00
	2009 E.C/2016/17	144	46	195	10,780,456.00
	2010 E.C (until end of Hidar)/until Nov.2017	31	29	27	990,710.00
	Total	422	228	568	26,592,265.53

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

4.7. Major Causes of Road Traffic Accidents

As shown in the table7 below most of the road traffic accidents were occurred due to high speed driving, lack of giving priority to pedestrians, driving to the left direction and lack of driving at appropriate distance from front vehicle. As evidence from the total of 422 road traffic accidents 46.45% of them were occurred due to high speed driving. 27.25% of the accidents were also taken place due lack of giving priority to pedestrians while driving. Genuinely it can be examined as 73.7% of the road traffic accident was occurred due to high speed of driving and negligence of pedestrians' right pulling them out not to cross the road and use the walk way safely due drivers unlawful act. The third factor causing road traffic accident in the area of study was driving out of the recommended direction i.e. to left direction has a weight of 10.43% out of the total road traffic accident. As 65.4% of the road traffic accident was occurred at a straight line road and 86.97% of the road traffic accidents were also occurred in good weather time and at asphalt road it is clear that other factors role was very minimal. Therefore the major causes of road traffic accident in the study area were high speed driving, lack of giving priority to pedestrians and driving left direction which was accountable for 84.13% of the total accident.

Table 6: Major causes of road traffic accidents in the study areas

S.No	Cause of accident	Accident rate (%)
1	Alcohol drinking	0.711
2	Allowing a person to travel on top of a truck	0.711
3	Careless driving (disordered driving)	3.318
4	Door was not locked appropriately	0.237
5	Driving out of right side	10.427
6	Driving without driving license	0.474
7	Vehicle technical problem	1.185
8	High speed driving	46.445

9	Not giving priority to pedestrian	27.251
10	Not giving priority to vehicle	2.370
11	Passing a vehicle in overlapped manner	0.474
12	Turning back	0.237
13	overloading (above capacity load)	0.711
14	Driver sleeping	0.237
15	Lack of appropriate distance while driving	5.213
	Total	100.000

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

Table 7: Road traffic accident rate versus type of accident

S.No	Type of accident	Accident rate (%)
1	Collision with road side obstacle	5.92
2	Vehicle fall down	28.91
3	Collision with pedestrian	38.39
4	Collision with vehicle	23.93
5	Collision with animals	1.90
6	Passenger fall down from truck	0.95
	Total	100

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

Table 8: Road traffic accident rate versus vehicle type

S.No	Vehicle type	Accident rate (%)
1	Automobile	2.84
2	Bajaj	2.13
3	Bicycle	0.24
4	Mini-bus	33.18
5	Bus	11.61
6	truck (long and short)	28.91
7	Station-wagon	4.74
8	pickup	12.80
9	loader	0.24
10	Motor cycle	3.32
	Total	100.00

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

Table 9: Road traffic accident rate versus road type

S.No	Road type	Accident rate (%)
1	Asphalt	86.97
2	gravel road	4.98
3	earth road	8.06
4	Total	100.00

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

Table 10: Road traffic accident rate versus road alignment

S.No	Road alignment	Accident rate (%)
1	Curved path	9.24
2	Inclined down (sloppy)	9.95
3	Inclined up (sloppy)	5.21
4	Zigzag	10.19
5	Straight	65.40
	Total	100.00

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

Table 11: Road traffic accident rate versus weather condition

S.No	Weather condition when accident happens	Accident rate (%)
1	Cloudy weather	1.42
2	Night (dark)	1.18
3	Rainy weather	10.19
4	Windy weather	0.24
5	Good weather	86.97
	Total	100.00

Source: Eastern Zone and South East zone road traffic accident records sep.2014-Nov.2017

4.8.Road Traffic Accident Reduction Model

Road traffic accident was found dependent on quality of driving training, speed of vehicle, pedestrians' road utilization approach, garages' maintenance quality and vehicle maintenance scheme and road traffic control system.

The training in driving training centers included in the survey was not structured and comprehensive. Because the practical and theoretical training given in driving training centers was not curriculum supported and it has not included the required driving skills, vehicle working principles, architecture and organization.

Road traffic control system involves directing vehicular and pedestrian traffic around a construction zone, accident or other road disruption, thus ensuring the safety of emergency response teams, construction workers and the general public. Road traffic control also includes the use of CCTV and other means of monitoring traffic by local or state roadways authorities to manage traffic flows and providing advice concerning traffic congestion.

The investigation carried out found that the road traffic control system established in the study area was not well organized i.e. the road traffic flow was highly constrained by rent seeking problems, lack of adequate traffic symbols, shortage of technological inputs, limited awareness of pedestrians about road utilization approach, shortage of manpower and drivers unlawful act. In the study area the training given to pedestrians about road utilization approach was not periodical and sufficient enough.

The researchers observed that most of pedestrians in the study areas have no unique path direction while traveling in the road side. They flow either right or left direction of the road side and they did not know which direction to flow to save their life from road traffic accident.

Most vehicles which get serviced in the maintenance garages found in the study areas including Mekelle do not use preventive maintenance and rather implemented breakdown maintenance which in turn aggravates road traffic accident. Breakdown maintenance is a kind of maintenance which is used to maintain vehicles and machines after break-down. But while driving a vehicle under fault the probability of occurrence of road traffic accident could increase at alarming rate.

To solve road traffic accident problem in the study areas it is critical to know the cause and effect relationship of these multiple factors as already stated in the discussion part. Therefore an integrated model is necessary to consider all factors and minimize the effect through a closed control system looking for any parameter if creating disturbance where it can instantly adjust the effect by correcting the cause.

An integrated model was developed taking the concept of closed loop control system where it considered pedestrians' road utilization approach, quality of driving training centers, road traffic control system and garages 'maintenance quality and vehicle maintenance scheme to reduce road traffic accident in the areas of study. The model was represented by a hexagonal polygon which allocated equal cause and effect relationship on all the six sides where if one of the parameters lacks appropriateness the system could be totally unstable.

Figure 1: Road traffic accident reduction model representation

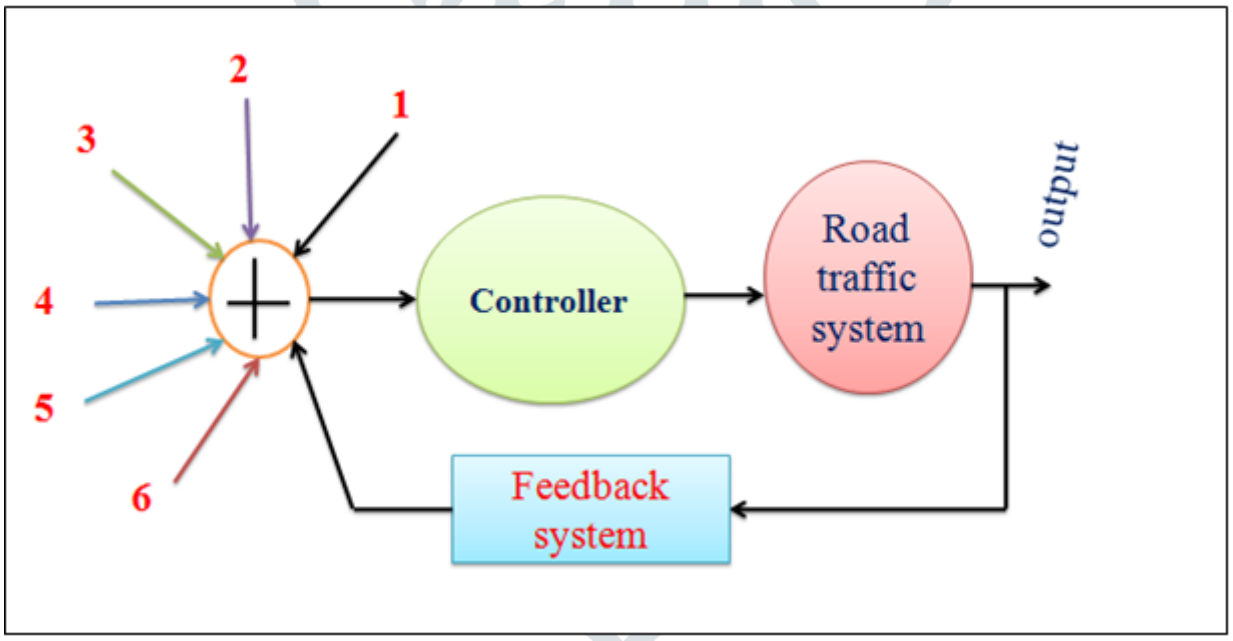

Figure 2: Road traffic accident reduction model

5. Conclusion and Recommendation

5.1. Conclusion

Road traffic is a system where a road is primarily allocated for vehicles but pedestrians have also the right to use it in accordance to a predefined set of road traffic rules. If the motion of vehicles is expected to be appropriate and safe the road should be equipped with road traffic indicators, CCTV cameras, and should be free from obstacles. Road traffic system includes not only vehicles and pedestrians but also the infrastructure set in place and the experts responsible to regulate the road traffic flow within the road. In a road traffic system road traffic safety is the first element that drivers and pedestrians should worry about to reduce road traffic accident so that road transportation could be trustful. As per the investigation made in the study areas road traffic accident was found highly dependent on quality of driving training, speed of vehicle, pedestrians' road utilization approach, garages' maintenance quality and vehicle maintenance scheme and road traffic control system.

Driving training is the process of making drivers competent enough in terms of skill, knowledge and attitude. To attain this goal driving training institutions need to have harmonized syllabus, integrated and appropriate learning infrastructure and

qualified and well experienced experts to train learners to the desired. But this study proved that the training institution in the study area including Mekelle have not established comprehensive auto mechanic and auto electric workshops, simulation oriented computer centers, training fields, libraries with adequate reference books and manuals and they have limited and very old vehicles used for training. The trainers in the driving training institutions were found in adequate in number and less qualified.

Related to the age and health examination cases the training institutions have not had scientific means of checking whether the age is appropriate and the health examination certificate is not forged evidence. Training institutions were using identity card to know age of learners and partial health examinations only focusing on eye vision and urine analysis which did not include mental problems, heart problems, blood pressure and other organs problems as part of the examination.

In the training institutions training time was not efficiently utilized in which all trainees included in the survey replied 35-40% of the training time was not properly used. Fortunately, training time was found too short where the practical and theoretical training was delivered in 46 days that a particular learner gets a chance for one hour in practical session and less than four hours in theoretical session per day.

As revealed by the training centers and informed by the trainees from the training centers the focus given to drivers' discipline was negligible.

Generally, the driving training institutions were found not well organized and structured where their quality of training was deprived due to lack experts, learning infrastructure and facility, limited training time, absence of syllabus and lack of monitoring and evaluation from transport office.

The road traffic control system set in place in the study areas was not found encouraging due to limited and irregular monitoring and evaluation activities employed by the traffic police and transport offices. Most of the roads in the study area were not installed with appropriate road traffic symbols and this was a major challenge for drivers not familiar with the road condition. In the study areas lack of CCTV cameras and mounted or hand held vehicle speed measuring devices was another challenge where police traffic officers could not easily control road traffic flow in the areas.

As road traffic accident has a linear relationship to inappropriate pedestrians' road utilization approach it is mandatory to train pedestrians to the desired to follow the right approach while using walkways and crossing roads. In the study areas 94.5% of the pedestrians travel either right or left direction of the road side and 57% of them did not know the left and right direction considering vehicles motion. Even though left direction of the road side is allowed for pedestrians most of them used right and left direction interchangeably due lack of consciousness and understanding.

Garages in the study areas including Mekelle were found less equipped i.e. they lack machineries and their equipments were not adequate. In addition to this the experts employed in the garages were not qualified enough rather most of them owned experience based knowledge and skill where their understanding about vehicles architecture and organization was so limited. As evidence 55% of vehicles maintained for a particular fault returned to the same garage at most within a week for the same fault previously maintained. All vehicle owners and drivers in the study areas were not using preventive maintenance as disclosed by 87% of them where breakdown maintenance was their choice. As evidence 1.19% of the accidents occurred in the study area since 2014 was due to vehicle technical problem.

Transport offices in the study areas did not have vehicle's inspection machinery and they inspected looking the lighting system and sound, forward and backward motion of a vehicle under inspection. This trend by itself was contributing an additive effect on road traffic accident.

This study investigated the material damage, human injury and death happen due to road traffic accident from September 2014 to November 2017 in the area of study where a total of 422 accidents were occurred causing 568 people injured and 228 people dead. 26,592,265.53 birr worth property was also damaged. WeredaKlte-Awlaelo has the highest road traffic accident record within the study areas i.e. 29.62% and Wereda Saesie Tsaeda Emba was second where 13.98% of the total accident resides there. Even though it is a single road traffic line 11.85% of the total road traffic accident was occurred in May-Mekden to Lachi where it was ranked third level.

In the study area most road traffic accidents were occurred due to high speed driving, lack of giving priority to pedestrians, driving to the left direction and lack of driving at appropriate distance from front vehicle. As evidence from a total of 422 road traffic accidents occurred within three and half years from sep 2014 to Nov 2017 G.C 46.45% of them were occurred due to high

speed driving. 27.25% of the accidents were also taken place due lack of giving priority to pedestrians while driving. Genuinely it can be examined as 73.7% of the road traffic accident was occurred due to high speed of driving and negligence of pedestrians' right pulling them out not to cross the road and use the walk way safely due drivers unlawful act. The third factor causing road traffic accident in the area of study was driving out of the recommended direction i.e. to left direction has a weight of 10.43% out of the total road traffic accident. As 65.4% of the road traffic accident was occurred at a straight line road and 86.97% of the road traffic accidents were also occurred in good weather time and at asphalt road it is clear that other factors role was very minimal. Therefore the major causes of road traffic accident in the study area were high speed driving, lack of giving priority to pedestrians and driving left direction which was accountable for 84.13% of the total accident.

5.2.Recommendation

Road traffic accident has naturally many aggravating factors as revealed through the outcome of this study and other researches. The major causes of road traffic accident in the study area were high speed driving, lack of giving priority to pedestrians and driving left direction that indicated drivers' fault taken large share. Depending on the limitations investigated through this research the researchers would like to recommend the following points.

i. It is important to develop harmonized syllabus for training system of driving training institutions to enhance training quality.
ii. Since driving training time in the training institutions was found too short it is better to make it level wise for seven months.
iii. Driving training institutions should set in place the required learning infrastructure and facility
iv. Driving training institutions should recruit qualified experts as trainers
v. Vehicle maintenance garages need have appropriate machineries and equipment's to deliver quality maintenance.
vi. Vehicle maintenance garages need have qualified auto mechanic and auto electric experts
vii. The transport office ought to monitor and evaluate the quality of training in driving training institutions regularly at least in two weeks' time.
viii. The police traffic and transport offices in the study areas need to improve monitoring and evaluation system of road traffic using technology aids like CCTV and mounted or hand held vehicle speed measuring devices.
ix. The transport office should set in place vehicle inspection machineries and recruit qualified experts to provide regular vehicle inspection at least within three months
x. Drivers should drive in their own path and at slow speed as per the road alignment
xi. Drivers should provide priority to pedestrians while driving
xii. Drivers and vehicle owners should make use of preventive maintenance rather than breakdown maintenance
xiii. Police traffic office should provide training to pedestrians about road utilization approach

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