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ADDIS ABABA UNIVERSITY
COLLEGE OF SOCIAL SCIENCES
DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

**GIS BASED IDENTIFICATION OF ROAD TRAFFIC FATALITY
ACCIDENT HOTSPOTS AND HAZARDOUS TRAIN STATIONS IN YEKA
SUB-CITY, ADDIS ABABA ETHIOPIA**

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ADDISS ABABA, ETHIOPIA
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ACCIDENT HOTSPOTS AND HAZARDOUS TRAIN STATIONS IN YEKA
SUB-CITY, ADDIS ABABA ETHIOPIA**

**By
Tesfaldet Sisay**

**A THESIS SUBMITTED TO
THE DEPARTMENT OF GEOGRAPHY AND ENVIROMENTAL STUDIES**

**Advisor
Teferi Mekonnen (PhD)**

**Addis Ababa, Ethiopia
June, 2023**

Declaration

I, the undersigned, hereby declare that the study entitled “GIS Based Identification of Road Traffic Fatality Accidents Hotspots and Hazardous Train Stations in Yeka Sub-City, Addis Ababa Ethiopia” has been carried out by me under the guidance of Dr. Teferi Mekonnen and has not been presented as thesis for a degree in any other university.

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Approval Sheet

This is to certify that the thesis presented by **Tesfaldet Sisay Beyene**, entitled “GIS Based Identification of Road Traffic Fatality Accidents Hotspots and Hazardous Train Stations in *Yeka* Sub-City, Addis Ababa Ethiopia” and submitted in partial fulfillment of the requirement for the Degree of Master of Arts in GIS, Remote Sensing and Digital Cartography complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Approved by the Examining Committee:

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| _____ Advisor | _____ Signature | _____ Date |
| _____ Internal Examiner | _____ Signature | _____ Date |
| _____ External Examiner | _____ Signature | _____ Date |

Chair of Department or Graduate Program Coordinator

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List of Acronyms and Abbreviations

| | |
|--------|--|
| AACRA | Addis Ababa City Road Authority |
| AATPMO | Addis Ababa Transport Programs Management Office |
| CSA | Central Statics Agency |
| GPS | Global Positioning Satellite |
| GNP | Gross National Product |
| GRSP | Global Road Safety Project |
| GIS | Geographic Information System |
| HTSA | Hazardous Train Station Accident |
| ICMR | Indian Council of Medical Research |
| IDW | Inverse Distance Method |
| RTA | Road Traffic Accident |
| RTFA | Road Traffic Fatality Accident |
| RTI | Road Traffic Hurts |
| SD | Sustainable Development |
| WHO | World Health Organization |

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Abstract

Road traffic fatality accidents are single and major universal contemporary problems and problems of critical concern in Ethiopia as well owing to the increasing vehicular traffic that lead to loss of life and disruption of material goods. The main objective of this study was to explore the road traffic fatality accidents hotspots and hazardous train stations in Yeka Sub-city of Addis Ababa. This paper is used both quantitative and qualitative data and longitudinal study. The qualitative data approaches are associated with field methods such as observations of the research area to determine venerable area. The quantitative approaches are related with data of traffic accidents occurrence gathered from Addis Ababa city police stations, such as the location of traffic accidents collected by using GPS, Google Earth Pro and where quantitative data were analyzed statistically. The Spatial investigation tools, especially IDW (Inverse Distance Weight) were used to predict road traffic fatality accidents and hazardous train station accidents lengthwise the whole road set-up of Yeka sub-city. All GIS based system were employed for pinpointing, mapping and forecasting hotspots based on spatial dispersal of road traffic fatality and hazardous train station accidents. The result showed that Megenagna, Kotebe Kara and Gurd Shola Road Segment are the most risky section accidents occurrences place. Finally, IDW investigation forecast the road traffic fatalities and hazardous train station accidents sideways the whole road network of Yeka sub-city. The study was recommends that police organization should prepare different types of trainings to members on how to gather the spatial location of traffic accidents using different methods of spatial data collection like GPS and different geospatial applications available in smart phone, and Google earth pro to acquire efficient data about road traffic fatality accidents for appropriate intervention. This makes the analysis easy and more accurate.

Key words: *Road traffic fatality, hazardous train station, GIS, accident hotspot, cold spot, spatial analysis and IDW*

CHAPTER ONE

INTRODUCTION

1.1. Background of Study

Transport is vital thing for the people to move from one place to other places. There are many types of transport like water, air and land transport. From these types of transport the cheapest and the most available in one country is land transport, it is the most vulnerable to traffic accident than any other mode of transport (Berhane , 2015).

Road traffic Accidents (RTAs) are the greatest thoughtful harms at universal level that outcome in loss of life and economic damage (Temesgen et al, 2019). According to Indian council of medical research (ICMR), road traffic hurts (RTHs) are the prominent cause of human losses in the globe and principal contributor to the load of disease world-wide (Srivastava, 2009). The economic progression and enlargement of country hang on transportation set-up and network structures, like road, railway, and airborne dispersals and link. Transport types are very significant to persons to travel from one place to alternative place and also to join the urban and rural road for the economy values of the countries (Ghosh et al, 2004).

According to (WHO, 2021), in the realm, a road traffic flow accident has been increased; nearly 1.35 million persons pass away each year on the world's roads. Road traffic accidents are the prominent cause of loss of life for teenagers and early adults aged 5-29 years. As of a young age, males are supplementary likely to be elaborate in road traffic flow fatalities than females. Around (73%) of totally road traffic flow losses occur surrounded by early males under the age of 25 years who are nearly 3 times as possible to be destroyed in a road traffic flow crash as than early females (WHO, 2020).

Almost half of persons pass away on the realm's roads are "exposed road users": walkers (pedestrian), cyclists, and motor riders. 93% of the realm's loss of life due to roads traffic fatalities occurs in low-and middle-income nations, whereas these nations have nearly 63% of the world's vehicles. In 2016, low and middle-income nations had greater road traffic passing away rates per 100,000 inhabitants (27.5 and 19.2, correspondingly) matched to high-income countries (8.3) (WHO, 2020).

In Africa, road traffic accidents were increasing throughout every time and also the fatality rate from road traffic accident is the extreme in the realm. The greatest exaggerated groups of persons are walkers (pedestrian), passengers, cyclists, and motor rider.

Road traffic accidents were contributes great proportion of road accidents because of these influences such as insufficient road plan; too greatly alcohol drinking; fast-moving, under-utilization of seat belts; risky truck design; poor repairs of trucks and roads; scarce preparation of truck users, absence of consciousness and an absence of application of road care monitors (Samuel, 2020).

Pooled guesstimate proportion for road traffic damage was 65.2 per 100,000 people and the loss of life rate was 16.6 per 100,000 people. Road traffic damage proportions enlarged from 40.7 per 100,000 people in the 1990's to 92.9 per 100,000 people between 2010 and 2015, however loss of life rates declined from 19.9 per 100,000 inhabitants in the 1990s to 9.3 per 100,000 people between 2010 and 2015. Road traffic flow hurts build core healthiness and increase badly-behaved in the African Region. Happening 2016 the African section taken the uppermost road traffic flow loss of life rate, at 26.6 per 100,000 people, however the European section taken the lowermost rate, at 9.3 per 100,000 people. Happening in the recent study (2018) the rate might be nearer to 65 deaths per 100,000 inhabitants (Road Safety, 2020). Peoples stayed pass away each day in road calamities throughout Africa, from this people the men were more pass away than women (WHO, 2018).

In Ethiopia, a road traffic accident is increasing and the country is facing several road safety disasters. Of the 123 causalities, 28 stayed mortal, creating the proportion per 100,000 populations. Surrounded by RTC causations, 19.0% stayed car driver, 25.0% stayed passenger truck inhabitants and 26.0% stayed exposed road consumers including: motor rider 17.0%, walkers (pedestrians) 10.1% and cyclists 2.9%. Nearly partial (47.1%) of causations were between 15–29 ages and 15.3% stayed either one minors younger than 15 years or elders older than 64 years of age. Almost 2/3 (65.0%) of damages occurred on males (Abegaz, 2019)

Since 2000 Ethio millennium the amount of road traffic accidents in Ethiopia stayed in worrying state. In earlier eleven years the amount of road traffic accidents were estimates around 291,577. From those traffic accidents 36,796, 54,731, 58,987 and 141,063 road traffic accidents were fatality, serious injuries, light injuries and property damage respectively (Debela , 2019)

The road set-up expansion and mechanical trucks also were increasable in the past eleven year. Even though; government makes road and other setup the rigorousness of traffic flow accidents in the nation still in worrying stage. Previous eleven year, the Ethiopia administrator builds around 912,956 km road link in the nation to drop road traffic flow accident in the nation for having mobile and available road for the user. According to Ethiopia federal police commission well ahead Ethiopia millennium were informed show that in average round 9.16% growth of road traffic accidents were record in the nation yearly (*Debela* , 2019).

Subsequently, Addis Ababa has a large number of road traffic accidents, particularly happening at *Yeka*, *Bole* and *Guleli* sub-city. From the sub cities, *Yeka* sub-city has the largest death case recorded sub city following to Bole Sub-city (Adddis Ababa Police Commission, 2019). According to Addis Ababa police commission 2019 report an aggregate of 29,448 traffic flow calamities occurred in Addis Ababa, 458 stayed fatal, 1,875 severe hurt, 1,115 slight hurt, and 26,000 material goods cases.

1.2. Statement of the Problems

The city government of Addis Ababa were proclaims that one of the main problems of the city. The rapid traffic accidents increase despite different efforts it is making to address the problem. Broadcastings by way of nationwide and native exposure have been giving out road security Program and movements together with online communicating argument with cell phone community involvement. Implementations of road traffic rules were also occupy you its private role in underestimating the calamity.

Road traffic fatality accidents are occasions that lead to loss of life in millions and make happen damage of the assets foremost to socio-economic disasters all over the realm principally in 3rd world nations (*Robel*, 2020). Subsequently road traffic calamity problem stays get alarming. Around 3,700 people last on the realm's roads every day. These arithmetical displays road traffic calamities were very serious problems. This influence indicates going on human and nationwide enlargement (*WHO*, 2020).

Ethiopia takes the proportion of road traffic flow fatality and hazardous train stations accidents were very countless; for the reason that the road transport was the focal transportation tool beside with unsuccessful road setup, unfortunate application of traffic flow regulations and so on. Addis Ababa city, doubtful the serious road network growth and the boundless amount of truck owner

related to the other sub-Saharan nations, road traffic flow accidents is now grow into the key risk in the city's economic expansion movement particularly at peak hours (Andualem, 2018).

Addis Ababa had high road traffic accidents. In recent times, road traffic accidents are upturn quickly and turn into a challenging problem within the city (Gebresenbet, 2019). Meanwhile the administration has been demanding to recover the security of the road system and road security packages prepared by mass media on nationwide and native stages the problem still destroys several lives. In Ethiopia, according to Federal Police Commission's annual police crash arithmetical report in 2018 nearly resulted is 5,118 people passing. As of those result, Addis Ababa accounts for 12% (456) of deadly crashes. According to Addis Ababa police commission 2018/19 report a total of 29,448 traffic accidents happened in Addis Ababa and from this 458 stayed fatal, 1,875 severe hurt, 1,115 slight hurt, and 26,000 material goods cases. Subsequently this arithmetical were displays growing movement of deadliness from 2017/18 to 2018/19. According to this report, *Yeka* sub-city were the second-largest deadly case recorded sub-city after to *Bole* sub-city which accounts for 68 and 83 fatal cases respectively (Addis Ababa Police commission, 2019).

The absence of pedestrian signals and facilities, risky road setup, insufficient law implementation of traffic, driving further down the effect of alcohol, non- usage of motorcycle head covering, non-use seat - belts, cross walk at train stations, train users crossing the road on congest area to take a train and crossing the road and the railway while talking phone are the risk factors (WHO, 2020). These risky environments were commonly the consequence happening on auto-pedestrian crashes which effect to road traffic fatality accidents. Pinpointing hazardous train stations happening high auto-pedestrian crash locations which give rise to in fatal accidents stayed enormously useful to improve an actual evidence-based intervention.

In Addis Ababa had numerous studies examined on road accidents. Most of the earlier studies created on the report data investigation lacking mapping and detecting the spatial location of the accidents site. Happening the last decadal years, very few studies require functional GIS to realize the situation, and hotspot spaces of road traffic fatality accidents in Addis Ababa, but not at all once well thought-out train stations which were the greatest walker (pedestrian) producer places. Such as, Mahlet (2016), studied road traffic crash in Addis Ababa case of *Kolfe Keranyo* sub-city; Efreem (2019), investigated about GIS-based road traffic accident black spot assessment in Addis Ababa in case of *Kirkos* Sub-city; Dr. Ghosh et al (2004), studied traffic accident analysis for dehradun city using GIS and Dawit (2016), studied about the road traffic accident and safety evaluation in Addis Ababa case of *Bole* Sub City. Nearly all sub-cities are studied by the researchers on the issue of

GIS-based documentation. Nonetheless the consideration was not assumed to detecting hazardous train stations at any sub-city. So this study was satisfying this gap by detecting hazardous train stations in the *Yeka* sub-city.

Road traffic accidents were investigated spatially in the GIS situation with their existence of time, type, seasons, hour, day, locations etc. The concentration of this study was GIS-based investigation of road traffic fatality hotspots and hazardous train stations accidents. The study was use 3 years (2018/19-2020/21) of traffic fatality accidents data with accessible built train stations exposure in *Yeka* sub-city.

1.3. Objectives

1.3.1. General Objectives

The general objective of the research was to explore the road traffic fatalities accidents hotspot and hazardous train stations in *Yeka* Sub-city in Addis Ababa.

1.3.2. Specific Objectives

The specific goals of the research are there to:

- Identify causes of road traffic fatality and hazardous train stations accident in *Yeka* Sub-city.
- Explore distribution of road traffic fatality and hazardous train station accidents in *yeka* sub-city.
- To identify the most vulnerable locations of road traffic fatalities and hazardous train station accidents.

1.4. Research Question

1. What does the trends of road traffic fatality and hazardous train stations accidents in *Yeka* sub-city look like?
2. Where does the road traffic fatality and hazardous train station accidents located more in *Yeka* sub-city?
3. What kind of cause is more influencing the road traffic fatality and hazardous train station accidents incident in *Yeka* sub-city?

1.5. Scope of the Study

This research has given intention to analyzing, identifying and mapping on the concern of road traffic fatality and hazardous train station calamities in *Yeka* Sub-city. To conduct this type of research spatial data with its feature was necessary. The study is showed in Addis Ababa city, demarcate to *Yeka* Sub-city admin which is single and leading road traffic fatality and hazardous

train station accidents recorded in Addis Ababa city administration. This research is existed in 3 years' (2018/19-2020/21) road traffic fatality and hazardous train station accidents data.

1.6. Significance of the Study

Road traffic fatality accidents are one of the life-threatening problems that have been increasing through time to time. The Previous studies were limit or no GIS-based studies and undertaken to display road traffic fatality and hazardous train station accidents in the *Yeka* sub-city administration.

This research was support to:

- ✓ To enlarge valuable data and thematic map info about the hotspots or hazardous train stations.
- ✓ Provide reliable information about the reason and influence of road traffic fatality calamities (RTFC) in the sub city.
- ✓ Make mapping of high risk area based on GIS technology.
- ✓ Assist an evidence based intervention and contribution for decision-makers to detecting and giving rank road traffic fatality and hazardous train station calamities.
- ✓ Distribute the awareness.

1.7. Limitation of the Study

The core constraint of this study were relate to accessibility of road traffic fatality and hazardous train station accidents recorded data from Addis Ababa city police commission, which was difficult to accomplish duty because there was no spatial data of road traffic fatality hazardous train stations accidents rather than it was describing in word or manual paper. This limitation was minimized by ordering in Microsoft excels and collecting the location of road traffic fatality and hazardous train stations accidents with the help of police officer, GPS and Google earth pro etc.

1.8. Operational Definition

Accident is an unintentionally make happen event. In furthermost cases, the period is used specially in position to unintentionally-caused undesirable actions (Safeopedia, 2021).

Accidents Hotspot: refers to the place of great on the road traffic fatality and hazardous train station accidents was happened.

Accidents Cold Spot: refers to the place of less on the road traffic fatality and hazardous train station accidents was happened.

Accident Mapping Analysis is the process, by using geographical information with the help of on the road traffic fatalities accidents.

Non-Spatial Data, alternatively, is files only Attributes (SAFE SOFTWARE, 2021).

Traffic Fatalities Accident is demarcated as an accident concerning at smallest quantity one truck on a road exposed to communal traffic in which at least somebody is hurt or killed (Insee, 2007).

Spatial Data, also recognized as geospatial data, is a word used to designate any data interrelated to or having information about a definite position on the Earth's surface.

1.9. Organization of the Paper

This study was present (organized) into five chapters. The 1st chapter is contains introductory portion which is contains of an introduction, statement of the problems, objective of the study, research questions, and scope of the study, significance of the study, limitation of the study, operational definition and organization of the paper. The 2nd chapter was deliberated review of interrelated literature concerning outline of traffic protection in the metropolitan, activities of traffic accidents, the conception of transport and road traffic accidents, importance of transport, modes of transport, global and regional trends of road traffic accidents, summary of road traffic accidents in Ethiopia from 2007/08-2017/18, causes of road traffic accidents, GIS and remote sensing applications to the road traffic accidents, impacts of road traffic accident, spatial dispersals of fatal accidents and bus stops, spatiotemporal dispersals of loss of life of accidents, fatal severity prediction using IDW, conceptual frame work. The 3rd chapter offered roughly data collection method, source of data, data investigation method, research design, and methodology. The 4th chapter evaluated the data argument and presentation part. Finally the 5th chapter encompassed a conclusion and recommendation.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Overview of Traffic Safety

Addis Ababa is the center and capital city of Ethiopia and the bench of the African Union and many global civil services. Hence, the city takes a significant involvement in the cost-effective and communal expansion of the nation. The previous few years, the city is prolonged with a countless size on top of the inhabitants' growths with greater proportion.

According to AACRA yearly report of 2013, above 3,800 kms of roads takes and determined in the city happening the past years. At this time, the city takes a total of 5,915 kms asphalt road through seven-meter width. The growth and development of the road link are substantial for the security and well-being of road consumers. Inappropriately, this expansion moreover can lead to other road transport complications if an achievement is not involved the responsiveness construction and fresh enforceable regulations and assets to appliance them. Such achievement is desirable to counter the estimated growth in average road speediness as a direct significance of well roads and trucks being driven faster that will lead to even supplementary accidents.

2.2. Trends of Traffic Accidents

Ethiopia had number of lorry and traffic growths by way of greater proportion, traffic accidents are rises rapidly. Even if the administration frustrating to restore the road link and scheduled to growth the over-all stretch of road surrounded by the nation from side to side Development and Transformation Plan, the traffic accidents are still growths quickly.

According to (Federal Police Commission, 2019) the effect of crashes that ensued in the nation between 2018 and 2021 is as keep an eye on: 14,194 losses of life, 22,647 serious hurts and 21,159 minor hurts. The drifts indicate that more Ethiopian survives are missing due to road traffic flow damages than to other reasons. Inhabitants pass away (die) on the roads at an average of 4,732 people for every year; or every day, nearly 13 Ethiopians do not return home due to being victims of road traffic crashes. Road traffic injuries in Ethiopia commonly mark passengers, and pedestrians (walkers). In other words, single soul (person) is murdered on the roads every single two hour. It is possible that tangible death data in the nation are greater than those informed by the Ethiopian Federal Police Commission due to influences such as underreporting and misclassification of road traffic flow loss of life. An incorporated crash catalogue is desirable to overcome under recording

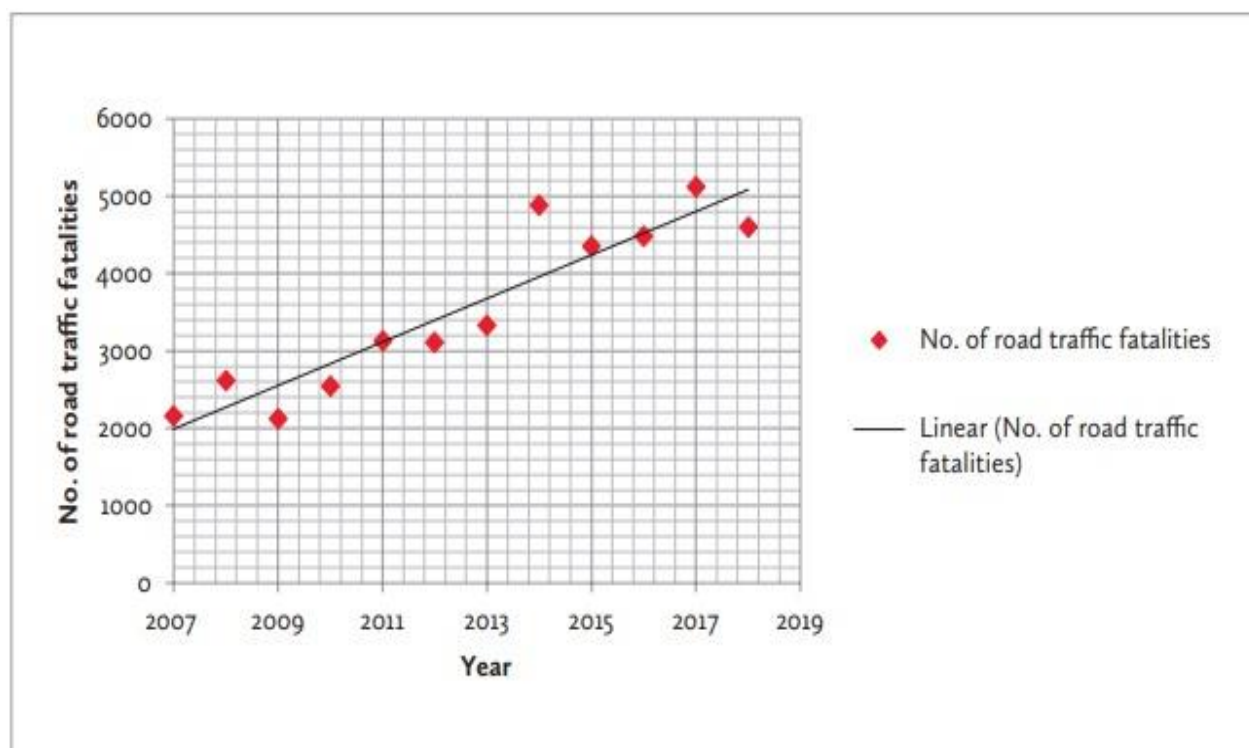


Figure 1: Amount of road traffic flow loss of life in Ethiopia (2007–2018)

Table 1: Road traffic hurt victim distribution in Ethiopia among the Regional States (2016–2018)

| Addis Ababa | 2018 | | | 2017 | | | 2016 | | |
|------------------|--------------|------------------|-----------------|--------------|------------------|-----------------|--------------|------------------|-----------------|
| | Deaths | Serious Injuries | Slight Injuries | Deaths | Serious Injuries | Slight Injuries | Deaths | Serious Injuries | Slight Injuries |
| Tigray | 386 | 854 | 381 | 374 | 858 | 584 | 371 | 664 | 356 |
| Afar | 56 | 73 | 20 | 72 | 49 | 31 | 131 | 164 | 79 |
| Amhara | 1 104 | 1 032 | 1 252 | 1 152 | 1 181 | 1 924 | 1 035 | 1 190 | 1 990 |
| Oromia | 1 478 | 1 448 | 1 386 | 1 882 | 1 710 | 1 586 | 1 541 | 1 459 | 1 485 |
| Somalia | 132 | 127 | 134 | 204 | 533 | 447 | 157 | 408 | 396 |
| Benishangul | 91 | 136 | 266 | 36 | 126 | 215 | 33 | 224 | 395 |
| Southern Nations | 712 | 1152 | 725 | 720 | 1121 | 922 | 634 | 990 | 937 |
| Gambela | 19 | 43 | 81 | 18 | 20 | 48 | 16 | 38 | 101 |
| Hareri | 55 | 203 | 188 | 34 | 224 | 507 | 53 | 123 | 284 |
| Addis Ababa | 528 | 2 210 | 1 274 | 585 | 1 804 | 1 232 | 477 | 2 085 | 1 232 |
| Dire Dawa | 36 | 129 | 242 | 41 | 128 | 279 | 31 | 141 | 180 |
| Total | 4 597 | 7 407 | 5 949 | 5 118 | 7 754 | 7 775 | 4 479 | 7 486 | 7 435 |

2.3. The Concept of Transport and Road Traffic Accidents

Transportation is unique and elementary needs for the opposite operational of humanities as its claim is importantly connected to the movement of persons from one residence to another. Later every movement of human life has its private consequences. Transport is not exclusion to this event (Kindaya, 2014). Road traffic Accident (RTA) is exists on an accident among moving truck/cycle and another truck, pedestrians (walkers), creatures (animals) which occurs on a way to public traffic (Persson, 2008).

2.4. Global and Local Trends of Road Traffic Accidents

According to (WHO, 2004), the expansion of road traffic fatalities were approximately 999, 000 in 1990 to just over 1.1 million in 2002. This number implies mainstream the low-income and middle-income nations. Particularly, the growth of road traffic hurts has continued to enlargement in the world as a whole, time series investigation exposes that road traffic fatalities demonstration pure variances in the arrangement of growing among high-income nations

The movements exist founded on inadequate number of nations designed for which facts stayed presented during the course of the period in addition to the encouragement by means of the biggest nations happening in the local models. Such local developments might cover nationwide movements plus the facts must not be deduced to the nationwide side by side. The local organizations laboring were staying alike as well, nonetheless not precisely the equivalent as persons well-defined by way of The World Health Organization (WHO). Here is remained a generally downhill movement in road traffic losses in high-income nations, however numerous of the low-income and middle-income nations must exposed a growth movement meanwhile getting on 1980s (WHO 2004). Nevertheless, certain noticeable local modifications; Eastern Europe observed a quick growth in street traffic flow losses throughout the getting on 1980s, the proportion of growth of which is subsequently dropped. The arrival of quick growths in street traffic losses were happened advanced in Latin America and the Caribbean, from 1992 forwards. In compare, amounts of street traffic losses ensure increased progressively meanwhile the getting on 1980s in the Middle East and North Africa and in Asia, predominantly in the anterior (WHO, 2004).

2.5. Overview of Road Traffic Accident in Ethiopia from 2007/08-2017/18

Subsequently Ethiopia millennium the amount of road traffic accidents in Ethiopia was disturbing national. On the previous eleven years the numbers of road traffic accidents were estimated nearby

291,577. After those road traffic accidents 36796, 54731, 58987 and 141063 is existed loss, serious hurts, light hurts and material goods impairment respectively. Even though; the administration builds street and other setup the brutality of traffic accidents in the nation still in worrying step. Sometime eleven year ago Ethiopia administration also builds about 91,2956kms street link in the nation to decrease street traffic accidents in the nation designed for consuming portable and available street aimed at the operator. Just in case; the development of motor-powered truck was another issue that reasons traffic accidents in admiration to street link exposure. In the same way, long ago eleven year around 5,592,358 motor-powered trucks existed in the nation.

Files composed as from Ethiopia federal police commission later Ethiopia millennium is stated long ago past eleven year describe that in average around 9.16% development of street traffic accidents were recorded in the nation annual. Correspondingly; the road link exposure and motor-powered truck were grow in average about 10.4% and 9.34% respectively annual. The amount illustrate that the development proportion on street traffic movement accidents, road link exposure and motor-powered trucks is in equivalent amount. Consequently; the study designated the development of road link is no feasible and momentous influence in decrease of road traffic accidents in the nation. This suggests a time past eleven year road traffic accidents were contrariwise proportionate by method of road link exposure. Despite the fact, the road link exposure in a straight line linked on the way to the expansion of motor-powered truck in Ethiopia. Enclose; the administration and other participant need worry on the matters on the way to explore the possible reasons of chance in Ethiopia that disturbs the existence of humanity regular and to restriction the tricky for previous (Addis Ababa police commission, 2018).

2.6. Causes of Road Traffic Accidents

Road traffic accidents results is as of a mixture of features interrelated to the components of the arrangement as well as streets, the location, trucks and road consumers, and the method they interrelate (David, 2005).

2.6.1. Human Aspects

Human aspects are devoid of distrust the greatest difficult to separate, by way of fundamentally all exact momentary in natural surroundings. Deliberate sensory abilities, awareness, decision making, assertiveness, attentiveness, and fitness, healthiness, driving skill, age, mass, strength and independence of movement. They are correspondingly topic to the greatest modification by way of the minimum left over evidence (David et al. 2005). Human aspects in automobile crashes were

consist of wholly influences interrelated to car driver and extra road consumers that might donate to a crash (Alebachew, 2019). Human correlated reasons of RTC is beverage user car driver, age of car driver, select of a lesser amount of safe forms of travel, the practice to use cell phones, speediness, deficiency of road user information and campaign and non-use of seat-belts and head covering,

2.6.2. Road Aspects

Certain variables concerning the road correlated sources of RTA. Originally, road situations have influences on existences of road traffic accidents. In advanced nations, there were exist endless determinations to come across the security principles of streets through care review all through the scheduling, crafty, and process stage. Street type's situations like the feature of asphalts, traffic regulator tool and joints, can be aspect in accidents. According to (Berhanu, 2000) facts were out structures as well as bridge size, warped bridge and hostile surface situation as the greatest predominant aspects of bridge accidents. Moreover, occurrence and brutality of traffic accidents at bridges can be reduced from side to side the donation of acceptable evidence to allow the driver controller and direct safely on bridges. As a final point, Road lights stay and projected to make available adequate light for car driver to travel by way of wellbeing and care throughout night times or further down little visibility state of affairs. (Sandra, 2000).

2.6.3. Vehicle Aspects

Despite the fact that truck design must have significant effect on accidents, it essential be considered in agreement to its involvement to RTA. Previous studies to this unique as good as WHO (2004) ensure demonstrated that truck correlated aspects influence to accidents, from side to side truck shortcomings, stays commonly round 3% in high-income nations, near 5% in Kenya and 3% in South Africa. According to (Ung, 2007) definite that Trucks must have produced road accidents for the reason that their holders fixed not accurately preserve and 17 frequently review the truck all through the operation. Consequently the road accidents occurred at what time footbrake disappointment; tire flat, power steering disappointment, head light dissatisfaction. Furthermore toward this imperfect brake, overloaded truck, imperfect lights, imperfect steering and defective or absent glasses exist the main aspects intended for the common incidence.

2.6.4. Environment Aspects

The environmental circumstances can likewise be aspect in transportation accidents. Auxiliary this impression David (2005) and Alister and Simon (2011) maintained that, climate on streets can

donate to accidents: for instance rainy asphalt decreases resistance and graceful water greater than 1/8”profound can source the truck. Numerous accidents have happened throughout circumstances of smoke and fog, which can decrease visibility.

2.7. Impacts of Road Traffic Accidents

The economic influence of road traffic accidents were exists in real sensitive topic. The influence is no single on separate life, nonetheless correspondingly going on the administration plus on the social order at great. Road traffic accidents are at this time worsening the economic prosperity of numerous states. Incidentally, WHO (2004) and Naci and Chislom (2008) needs that, in economic positions, the price of street accidents hurts is expected at unevenly 1% of Gross National Product (GNP) in low-income nations, 1.5% in middle-income countries plus 2% in high-income nations.

The straight financial prices of worldwide road accidents have estimated at US\$ 518 billion, by way of the prices in low-income nations – expected at US\$ 65 billion – beyond the entire annual quantity acknowledged in expansion support. Furthermore to this, in positions of local differences of price of RTA Naci, Chislom et al. (2008) designated that, the financial price of road accidents have existed expected to be as considerable as US\$ 24.5 Billion in Asia, US\$ 19 Billion in Latin America and Caribbean, US\$ 18 9.9 Billion in Central and East Europe, US\$ 7.4 Billion in the Middle East and US\$ 3.7 Billion in Africa. As soon as we come to Ethiopia, RTA’s financial influence exists even worse. As much as possible the financial influence of RTA in Ethiopia exists and disturbed, Persson (2008) must have deliberated that, the financial influence of RTAs is considerable designed for Ethiopians by way of the yearly price is predictable designate about £40 million. RTA impacts are correspondingly exposed through their guidance going on social features of the income. To this respect, (WHO, 2004) rights that, over 50% of the worldwide death payable to road traffic hurt happens between early adults aged among 15 and 44 ages, plus the proportions designed for this stage groups are advanced in low-income and middle-income nations. In 2002, males justification for 73% of total road traffic losses, by way of an general proportion nearly three times that designed for females: 27.6 per 100, 000 inhabitants and 10.4 per 100, 000 inhabitants consistently. Road traffic death proportions are advanced happening on men than women in total areas nevertheless of profits level and correspondingly crosswise total age groups. This explosion correspondingly needs that, assumed these quantities, road traffic hurts have to be understood in low and middle income nations simultaneously the greatest significant healthiness complications laterally by way of sicknesses such diarrhea, malaria, HIV/AIDS and tuberculosis.

2.8. GIS and Remote Sensing Applications for Traffic Accidents Analysis

2.8.1. Spatial Distributions of Fatal Accidents and Bus stops

According to dangerous bus stops exist and ranked by means of the sum of fatal accidents were happening in the area. To see the sights accident sites and bus stops it is significant to indication the bus stop exposure and deadly accidents topics composed. Consequently detecting deadly accidents deliberations is particularly supportive happening on detecting hazardous bus stops by means of Kernel Density and Nearness Investigation (buffer). The ring sign on the map demonstrations projected hot spot, train station and hazardous bus stopover residences.

2.8.2. Distributions of Fatal Accidents

According to the fatal incident of road traffic accidents is progressive complaint that the whole lot occurs anywhere and happens at certain fact happening on period. The distributions investigations can response requests of whereby as soon as. Greatest GPS founded deadly accidents facts plus field clarifications display that a mainstream of accidents happened in major roads somewhere a great capacity of road traffic flow existed and presented.

2.8.3. Fatal Severity Prediction using IDW

By means of the title suggests, the system IDW forecasts feature standards at unsampled places constructed on the spatial detachment of well-known remarks as of these unsampled sites. Nearby clarifications to the unsampled locations remain certain the greater masses despite the fact exact withdrawn clarifications ensure a comparatively little inspiration going on the forecast. The total attributed on the way to every one recognized remark is organized by way of a supremacy restriction, the attributed in the direction of detached annotations reductions. Those influences must have well-thought-out as a flattening constraint. Uncertainty the flattening consequence is exists as well significant; the situation influence distortion certain stimulating disparities or else type the variable appearance considerable extra similar than the situation really exists. By means of a consequence, the forecast ought to be deeply flattened for the reason that the situation make sure of and not exclusively deliberate native developments.

2.9. Conceptual Frame work

There are many variables that influence stages of road traffic flow fatality calamities over time, by means of number of factors, frequently relating and contribute to their change. Furthermost literatures designate socio-economic such as quick growth population, low income level,

unemployment and poverty are influences that effect crime event. On the road traffic fatality accidents theory explains varied categories of crime phenomena that happen at different geographic levels offer help to examination on the road traffic fatality accidents occurrences, because crime analysis focuses on the area of accidents. ArcGIS methods apply to analysis and to make map about the on the road traffic fatality accidents occurrence.

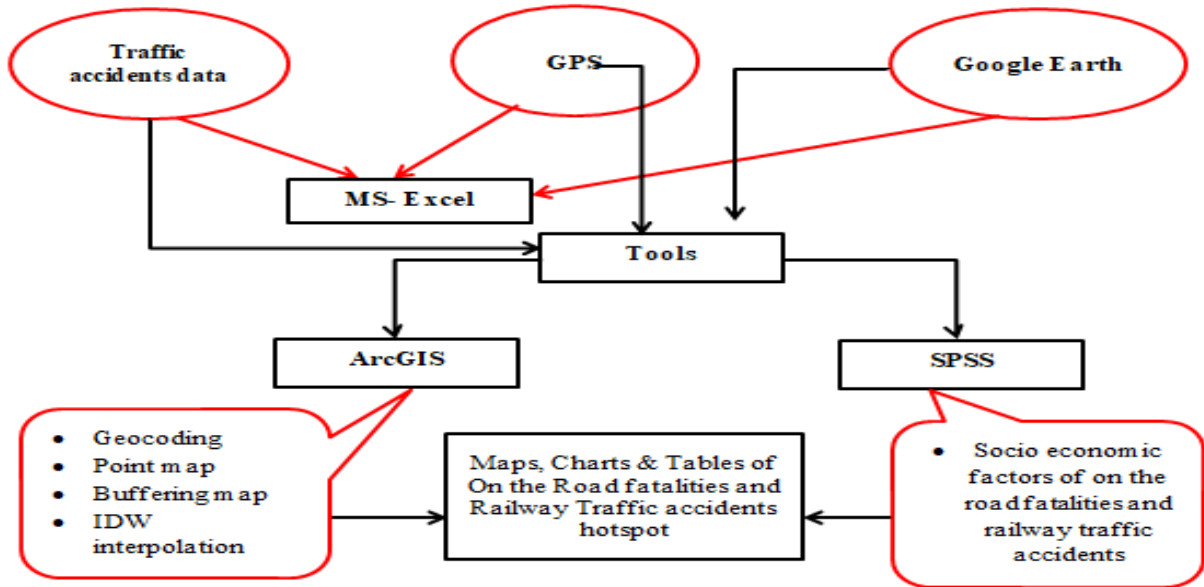


Figure 2: Paper framework

CHAPTER THREE

DESCRIPTIOPN OF THE STUDY AREA AND RESEARCH METHODS

3.1. Descriptions of the Study Area

Addis Ababa is located at the center of Ethiopia and the focal point of African Union; it is frequently called the African Principal payable on the way to its ancient history, diplomatic, and politically aware importance for the mainland. Sited on the hills of the *Entoto* foothills (mountains) and standing 3,048 meters above sea level, it is the third top capital in the globe. It is covers 540.14 square kilometers (Encyclopedia, 2019.)

In Addis Ababa, there are 11 Sub-cities. It is very costly and timewasting on the way to gather all traffic flow accidents in altogether sub-cities. Consequently, exact study locations must be choice. Designed for this study, *Yeka* sub-city nominated by way of a study place for the reason that was unique of the 2nd top sub-cities in the amount of traffic flow accidents (Addis Ababa Police commission, 2019).

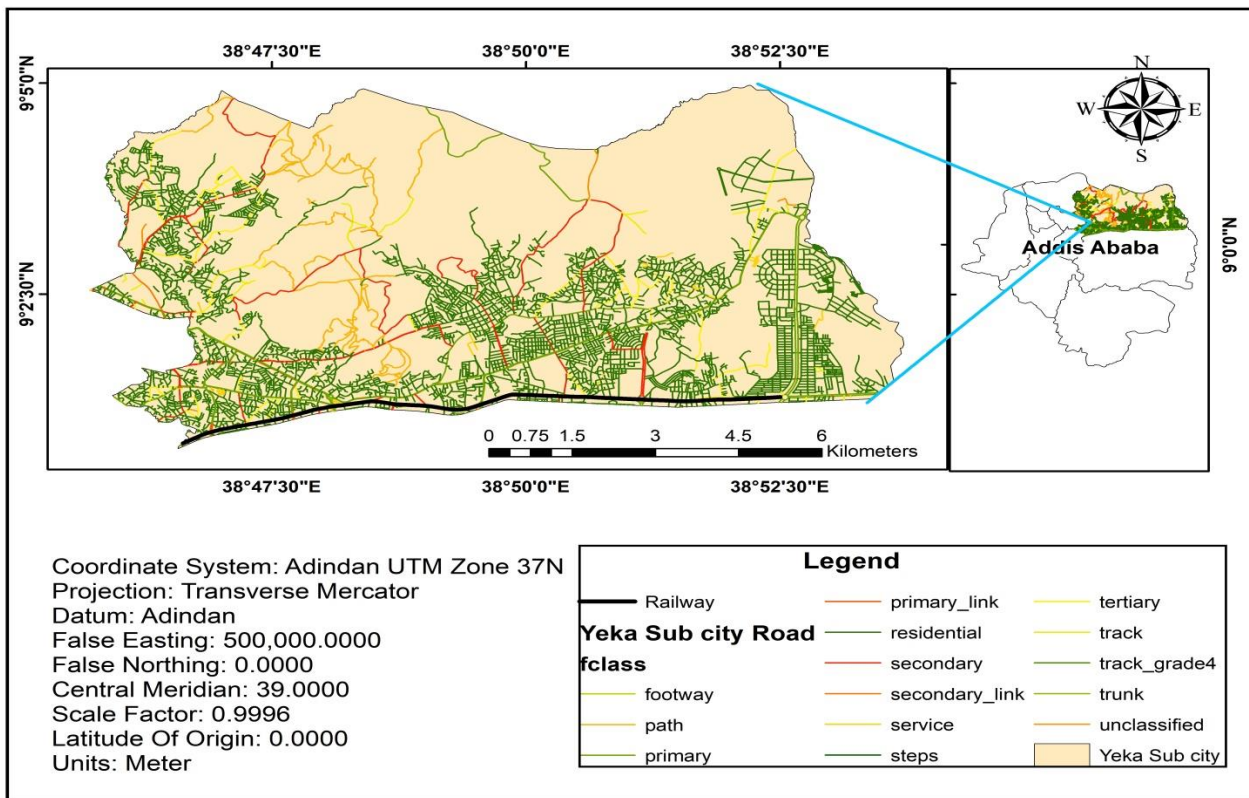


Figure 3: Descriptions of the Study Area

Source: Compiled from *Yeka* Sub City Administration

Addis Ababa city has around 630,440 registered trucks from 2014 to 2017, the amount of registered trucks enlarged by 7.1% and 119% respectively (Addis Ababa Transport office, 2020).

Moreover, there are no studies conducting on this topic subsequently faraway in the sub-city. *Yeka* sub-city is in nature found in the north-eastern part of Addis Ababa, taking vigorous topography (CSA, 2016). The study area is located $9^{\circ}2'14.28''N$ between $38^{\circ}50'6''E$. The eastern boundaries spread out beside the road from *Lambert* terminal to *Taffo* and the western scope spreads alongside in *Kebena* River. The study area coverage of the *Yeka* sub-city is 85.46 kms^2 and 3,950.1 persons live in 1 km^2 (WIKIPIDIA, 2020). Constructed on the CSA resident's estimate for the year 2016, *Yeka* sub city has 424,217 residents estimated. Nearby certain bureaus, agencies, offices, and educational colleges and universities which are originate in the sub-city, those are Road and Transport Bureau (Lamberet terminal), Ministry of Mining and Energy, Ethiopian Civil Service University, Kotebe Education University, Ethiopian Athletics Federation and, Ethiopia Leadership Institute. There are also 15 orthodox, 8 Muslim, and 16 protestant religious institutes (Addis Ababa City Government, 2017).

3.1.1. Topography

According to the DEM value of *Yeka* sub-city characterized on the northern part comparatively great altitude and south portion fairly low altitude. The topography exists and heaving a highland in the northern portions of the sub-city. Commonly, the elevation of the *Yeka* sub-city extended from 2,354 meters to 2,911 meters above sea level. The elevation of a pointer that allows considerate the surface of an area, at this time remains mapped below.

3.1.2. *Yeka* Sub-City Land Coverage and Administration Division

Yeka sub city is the 3rd largest sub city. Here are covers 82 km^2 plus the share about 16.5% of Addis Ababa city. *Yeka* Sub-city has 14 organizational districts. Among all districts, the biggest tracked by district 12, 13 and 10 which organizes 1,468.78, 1,437.76, and 1,427.70 hectares respectively. District 6 and 4 has the smallest districts that share 100.2 and 107.6 hectares respectively (Addis Ababa city government, 2017).

3.1.3. Yeka Sub-City Road Infrastructure

The road is valuable structure. It used to show the level of growth of a certain area. A road system remains the geographical appearance of roads by means of line features. The road system affords the resources to travel over the city.

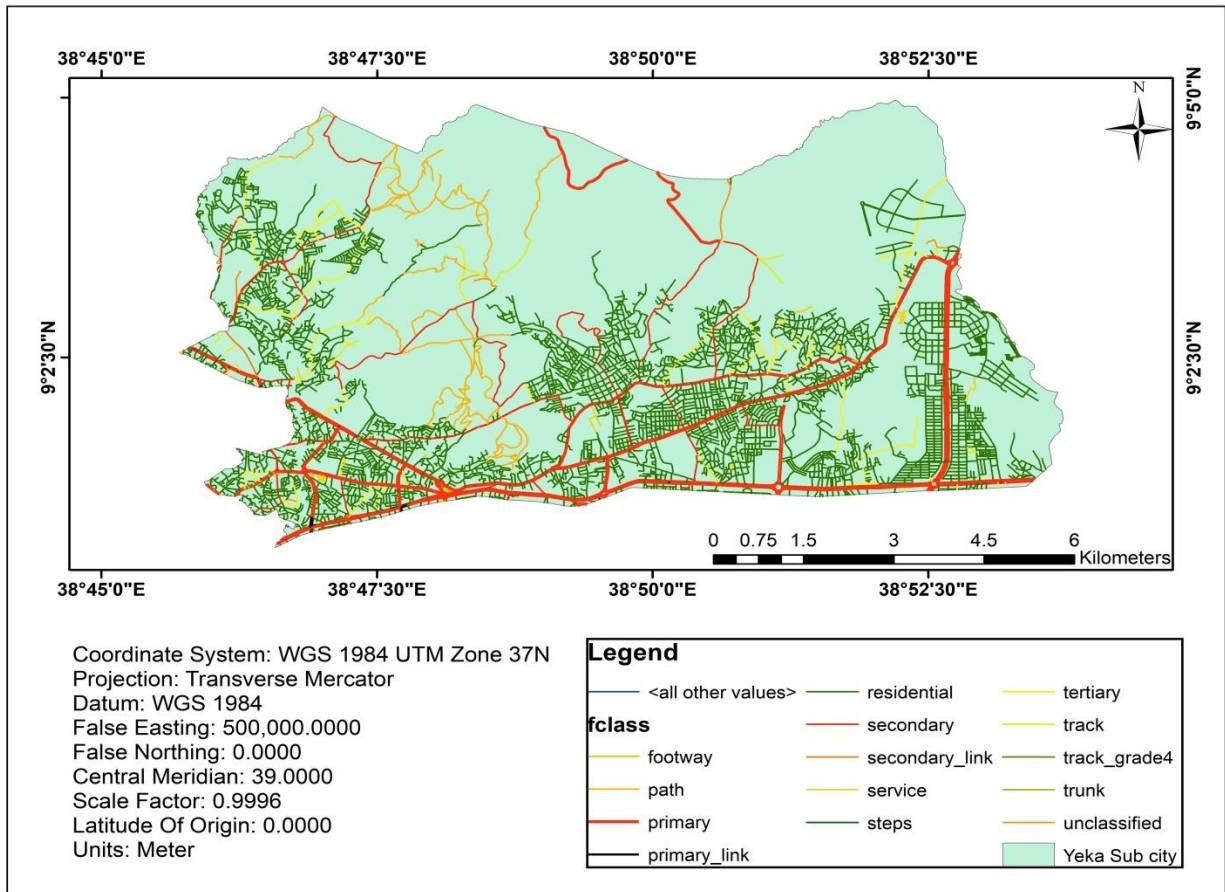


Figure 4: Yeka sub-city road network map

Source: Downloaded from DIVA GIS

Yeka sub-city has a 615.54 kms extended road link which covers a 6.63 square kilometer extent of the sub-city. Cobble stone plus asphalt stay the biggest road surface type which is 269.5 kms in addition 120 km extended (AACRA, 2018).

3.2. Research Approach and Design

Research design is a strategy to response the research question and a technique for gathering and investigating facts. This study reprocessed a mixed investigation method to conduct descriptive survey research that take in both quantitative and qualitative data. The qualitative data approaches

are associated with field methods such as observations of the research area to determine the accidents. The quantitative data approaches related with data of traffic accidents occurrence gathered from Addis Ababa city police stations, such as the location of traffic accidents collected by using GPS and field visit were quantitative data that analyzed statistically. In addition likewise longitudinal study were engagement spending the data take from the *Yeka* sub-city traffic Police Commission and Addis Ababa Transport Programs Management Office (AATPMO) of road traffic accidents data documented happening in the past three years (2018/19- 2020/21). The spatial and non-spatial data gathering were developing using Geospatial technology like ArcGIS software.

3.3. Sampling Techniques

The paper used both probability and non-probability sampling. The non-probability sampling is used to handpicked the study sub-city purposively, for the reason that *Yeka* sub-city is one of the affected sub-city by road traffic and hazardous train station accidents next to *Bole* sub-city after 2017 (Robel Aychew, 2020) After collecting the spatial location of road fatalities traffic and hazardous train station traffic accidents incident area during the past three years (2018/19 to 2020/21) were identified based on occurrences of crime by using Inverse Distance Weight (IDW) interpolation.

3.4. Technique of Data Collecting

Acquired data had intended for both qualitative and quantitative types, mutually primary and secondary sources of data are used. A personal observation applied to obtain investigation data, despite the fact GPS is used to determine the location of traffic accidents incidents for this study.

Field observation:-The field observation is substantial to recognize the location of road traffic fatalities and hazardous train station traffic accidents. The secondary data used for this study area were includes; Addis Ababa city police station necessary documents, traffic accidents record data, official reports, and legal documents.

3.5. Data Analysis Techniques and Presentation

The data were analyzed using ArcGIS 10.8.2. Traffic accidents data has recorded on paper by Addis Ababa city police station was organized in Microsoft excel worksheet, then the geographical location of traffic accidents incident collected from GPS combined with the accidents record data by using Geocoding techniques.

The Point traffic accidents map were a descriptive map that shows the location of where road fatalities and hazardous train station traffic accidents were committed across the study area.

Symbols and colors used to explain and represent point of place where crime was record in different years in the study area. (Adepoju, 2014)

GIS is a computer system that is designed to capture, store, manipulate, analyze, manage, and present geographically referenced data. Permissible to map the hotspot and cold spot areas of road traffic fatalities and hazardous train station traffic accidents were organized by IDW interpolation technique. To perform IDW interpolation technique, where the accidents place of road fatalities and hazardous train station traffic accidents committed at specific geographical location was used.

CHAPTER FOUR

ANALYSIS AND DISCUSSION

4.1. General Characteristics

The overall characteristics of the accidents were necessary to recognize the correlation among accidents. This study is recognized out of 9,791 traffic accidents 130 losses were captured as of the year 2018/19 to 2020/21 in *Yeka* sub-city. Intended for all of losses of life, the overall and particular data together with accidents year, date, time, vehicle plate code, *woreda* and specific accident locations were contained within. Away from 9,791 traffic accidents, only 130 traffic accidents were geocoded on road link. Whereas the residual 9,656 traffic accidents were not geocode because of these reasons, the accidents were pinpoint on the same site; certain accidents were occurred outside *Yeka* sub-cities road link, certain accidents locations were not stated on accidents records office and it was widespread consequently it is challenging to control and investigation.

Because of the above reasons, the attempt was made to do the road traffic fatality and hazardous train station traffic accidents. The result that showed the road traffic fatality and hazardous train station traffic accidents were dedicated in the study area during study period (Table 2).

To analysis the road traffic fatality and hazardous train station traffic accidents based ArcGIS spatial analysis were displaying map of spatial dispersal of road traffic loss and hazardous train station traffic accidents that made the analysis easy for identifying the required locations based on accident characteristics.

Table 2: *Yeka* sub city road traffic fatalities and hazardous train station traffic accidents recorded

| Years | Types of accidents | 2018/19 | 2019/20 | 2020/21 | Total |
|-----------------|--|---------|---------|---------|-------|
| 2018/19-2020/21 | Road traffic fatality accidents | 48 | 40 | 25 | 113 |
| | hazardous train station traffic accident | 4 | 5 | 8 | 17 |
| Total | | 52 | 45 | 33 | 130 |

4.2. Traffic Accidents Hotspot Site Mapping

ArcGIS based spatial analysis about road traffic fatality and hazardous train station traffic accidents were gifted presenting spatial distribution of traffic accidents that creates the investigation easy for detecting the essential sites constructed based on accident characteristics. Fatality going on road

traffic and hazardous train station traffic accidents parts can be mapped based on various aspects for instance accidents locations, frequency, year, day, hour and cause.

4.2.1. Accident Distribution and Mapping Based on Location

Mapping the total quantity of road traffic loss of life and hazardous train station traffic accidents, which was take on road parts. Thematic mapping of road traffic fatality and hazardous train station traffic accidents location frequency were effective to show the spreading and repetition of traffic accidents on the study road link. Figure 6 shows geocoded 113 road traffic fatality and 17 hazardous train station traffic accidents placed created based on the referenced accident location that were spatially extent on *Yeka* sub-city road link.

Table 3: *Yeka* sub city road traffic fatality and hazardous train station traffic accidents record based on location.

| Type of Accident | Spatial distribution of road traffic fatality accidents and hazardous train station traffic accidents based on location | | | | | | | | | | | | | | |
|---|---|---------|----|---|---|----|---|---|----|----|----|----|----|----|-------|
| | | Weredas | | | | | | | | | | | | | |
| | year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | Total |
| Road traffic fatality accidents | 2018/19 | 2 | 8 | 1 | 0 | 7 | 0 | 1 | 3 | 4 | 0 | 7 | 12 | 3 | 48 |
| | 2019/20 | 2 | 3 | 0 | 1 | 4 | 0 | 2 | 5 | 4 | 1 | 4 | 9 | 5 | 40 |
| | 2020/21 | 1 | 1 | 0 | 1 | 5 | 0 | 2 | 0 | 5 | 1 | 4 | 4 | 1 | 25 |
| Sub total | | 5 | 12 | 1 | 2 | 16 | 0 | 5 | 8 | 13 | 2 | 15 | 25 | 9 | 113 |
| Hazardous train station traffic accidents | 2018/19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 4 |
| | 2019/20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 5 |
| | 2020/21 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 8 |
| Sub total | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 9 | 0 | 1 | 0 | 4 | 17 |
| Total | | 5 | 12 | 1 | 2 | 16 | 0 | 6 | 10 | 22 | 2 | 16 | 25 | 13 | 130 |

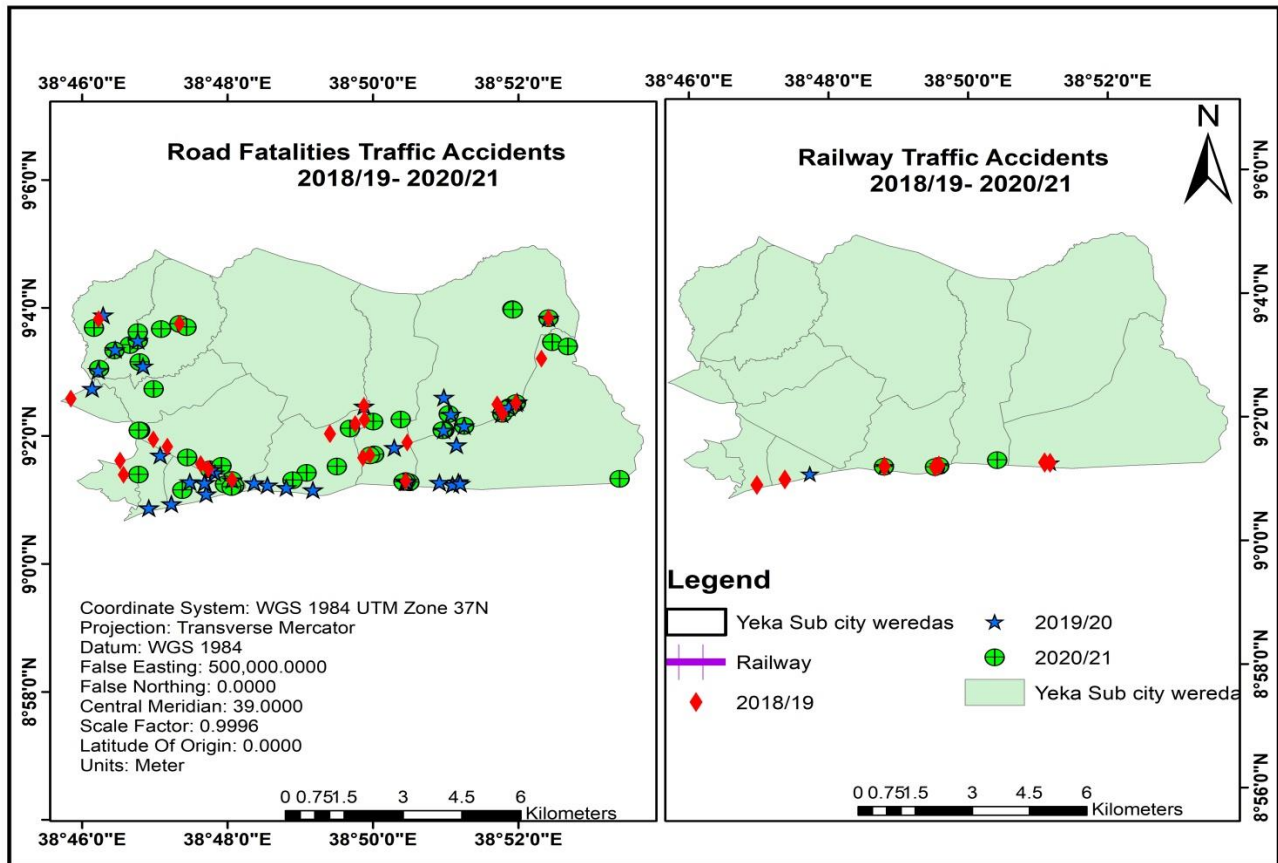


Figure 5: Road traffic fatality and hazardous train station accidents traffic accidents distribution map

During the year 2018/19 road traffic fatality accidents results in wereda 2, 5, 11 and 12 had relatively high traffic fatality accidents, in wereda 1, 3, 7, 8, 9 and 13 had few traffic fatalities accidents, but in wereda 4, 6, and 10 there was no road traffic fatality accidents. In the year 2019/20 road traffic fatality accidents results in wereda 8, 12 and 13 had relatively high traffic fatality accidents, in wereda 1, 2, 4, 5, 7, 9, 10, and 11 had few traffic fatality accidents, but in wereda 3 and 6 there was no road traffic fatality accidents. In the year 2020/21 road traffic fatality accidents results in wereda 5, 9, 11 and 12 had high traffic fatalities accidents, in wereda 1, 2, 4, 7, 10, and 13 had few traffic fatality accidents, but in wereda 3, 6 and 8 there was no road traffic fatality accidents.

During the year 2018/19 hazardous train station traffic accidents results in wereda 9 had relatively high traffic accidents in wereda 11 had few traffic accidents, but in wereda 1, 2, 3, 4, 5, 6, 7, 8, 10, 12 and 13 there was no hazardous train station traffic accidents. During the year 2019/20 hazardous train station traffic accidents results in wereda 9 had relatively high traffic accidents, in wereda 8 and 13 had few traffic accidents, but in wereda 1, 2, 3, 4, 5, 6, 7, 10, 11 and 12 there was no hazardous train station traffic accidents. During the year in 2020/21 hazardous train station traffic

accidents results in wereda 9 and 13 had relatively high traffic accidents, in wereda 7 and 8 had few traffic accidents, but in wereda 1, 2, 3, 4, 5, 6, 10, 11 and 12 there was no hazardous train station traffic accidents (Figure 6), because the drivers were violate different rules such as miss and violate about lighting rule, using alcohol, using cell phone, negligence and also driver drive the vehicle by using over speed etc.

In general, the outcome of this study demonstrations that during study period road traffic fatality accidents were distributed in different parts of study area. During the study period 48, 40 and 25 road traffic fatality and 4, 5 and 8 hazardous train station traffic accidents were dedicated in the year 2018/19, 2019/20 and 2020/21 respectively. Based on those results the dedicated road traffic fatality accidents of 2020/21 were relatively few in number but 2018/19 and 2019/20 relatively high. In addition, in wereda 5, 11 and 12 were 16, 15 and 25 road traffic fatality accidents in the study periods respectively, so those numbers indicate they have had relatively high road traffic fatality accidents. And also in wereda 9 and 13 were 9 and 4 hazardous train station traffic accidents in the study periods respectively, so those numbers indicate they have had relatively high hazardous train station traffic accidents, because the places has dense population due to commercial area, schools, government associations, stores and so on, due to this condition the driver behavior is played the main role in this case like missed the ring when the train is coming, using alcohol, using cell phone, use over speed, negligence, watching left and right spokeo problems, changing gear on the railway etc.

4.2.2. Accident Distribution and Mapping Based on Year

4.2.2.1. Road Traffic Fatality Accidents Based on Year

Road traffic fatality accidents were different as of the year to year in the study period. From the year 2018/19 to 2019/20 was increased by 16.7%, from the year 2018/19 to 2020/21 was increased by 47.9%, from the year 2019/20 to 2018/19 was decreased by 16.7%, from the year 2019/20 to 2020/21 was increased by 37.5%, from year 2020/201 to 2018/19 was decreased by 47.9%, and from the year 2020/21 to 2019/20 was decreased by 37.5%.

Table 4: Spatial distribution of road traffic fatality accidents based on year

| Accidents | Year | | | Total |
|---------------------------------|---------|---------|-----------|-------|
| | 2018/19 | 2019/20 | 2020/2021 | |
| Road traffic fatality accidents | 48 | 40 | 25 | 113 |

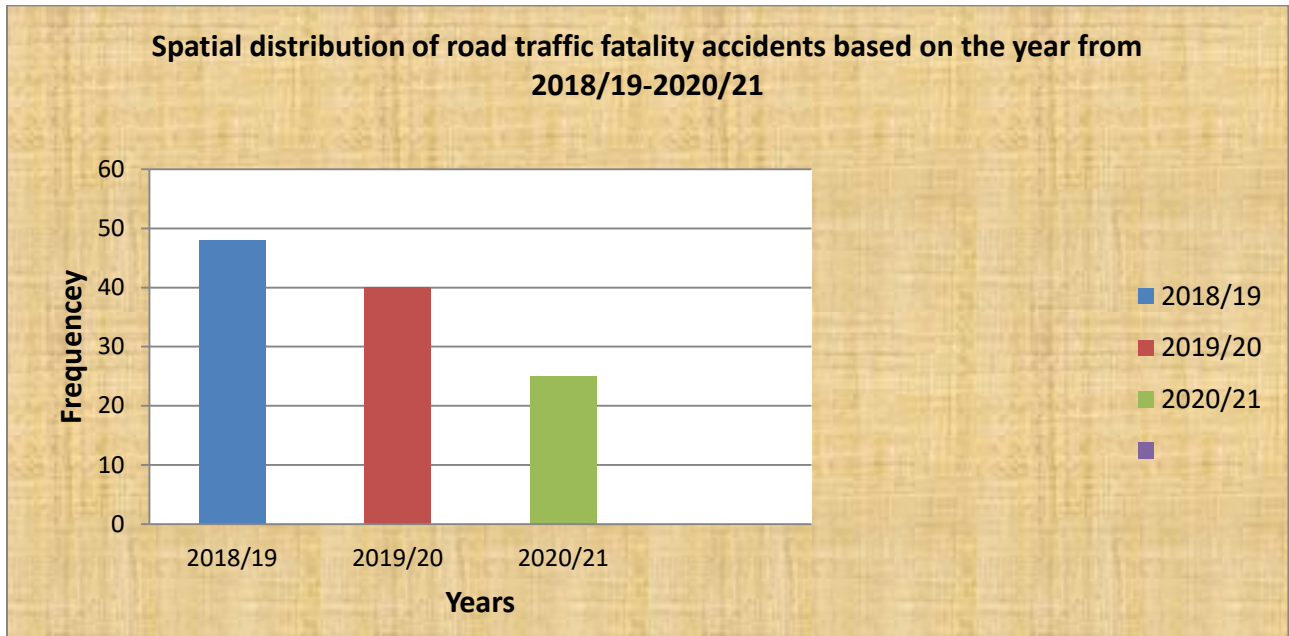


Figure 6: Spatial distribution of road traffic fatality accidents based on year

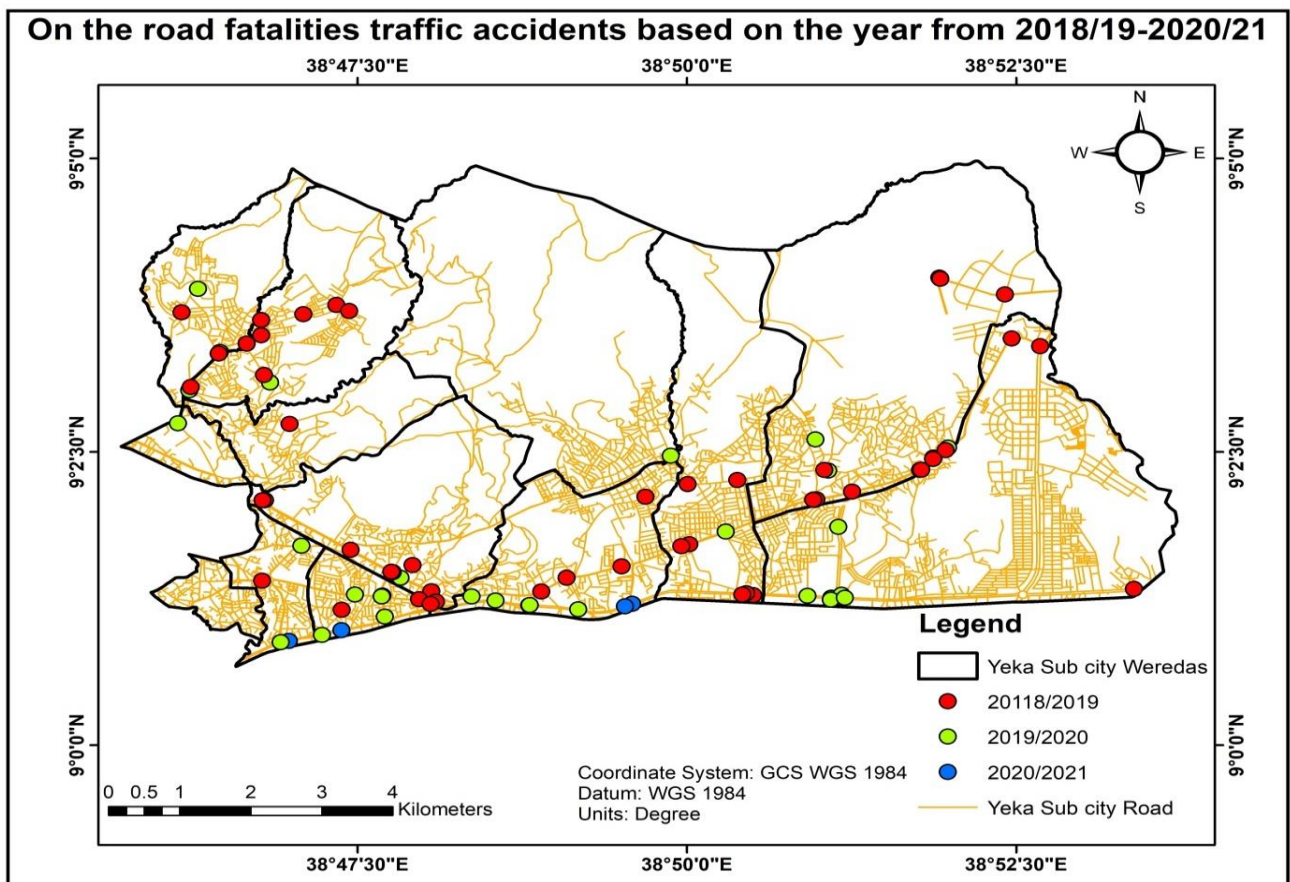


Figure 7: Road traffic fatality accidents based on year from 2018/19-2020/21

Based on above data results, during the year in 2018/19 had more road traffic fatality accidents, because the driver behavior were played the main role like violate the lighting, using alcohol, using cell phone, use over speed, negligence, watching left and right spokeo problems, the road condition, vehicle condition etc. In general, road traffic fatalities decrease from year to year (Figure 8).

4.2.2.2. Hazardous Train Station Traffic Accidents Based on Year

Hazardous train station traffic accidents were different as of the year to year in the study period. As of the year 2018/19 to 2019/20 was decreased by 20%, from the year 2018/19 to 2020/21 was decreased by 50%, from the year 2019/20 to 2018/19 was increased by 20%, from the year 2019/20 to 2020/21 was decreased by 37.5%, from year 2020/201 to 2018/19 was increased by 50%, and from the year 2020/21 to 2019/20 was increased by 37.5%.

Table 5: Spatial distribution of hazardous train station traffic accidents constructed by year

| Accidents | Year | | | Total |
|---|---------|---------|-----------|-------|
| | 2018/19 | 2019/20 | 2020/2021 | |
| hazardous train station traffic accidents | 4 | 5 | 8 | 17 |

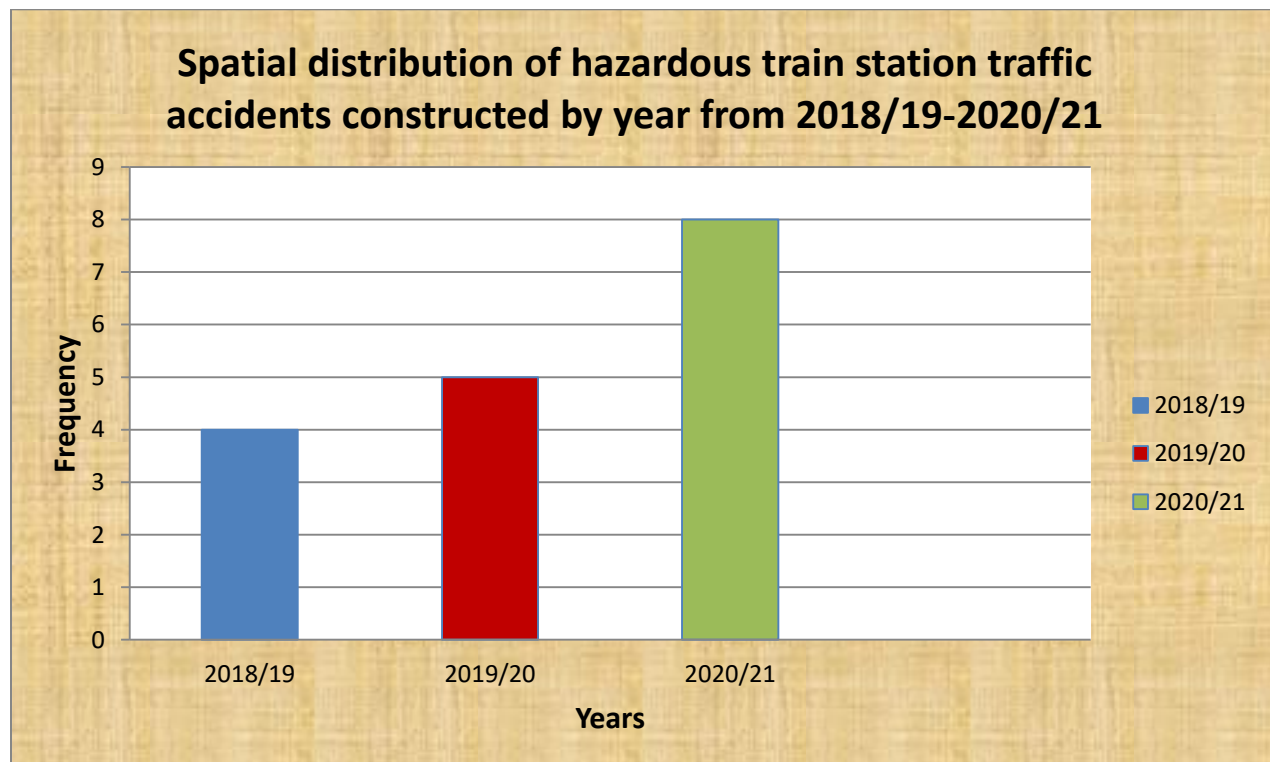


Figure 8: Spatial distribution of hazardous train station traffic accidents based on the year

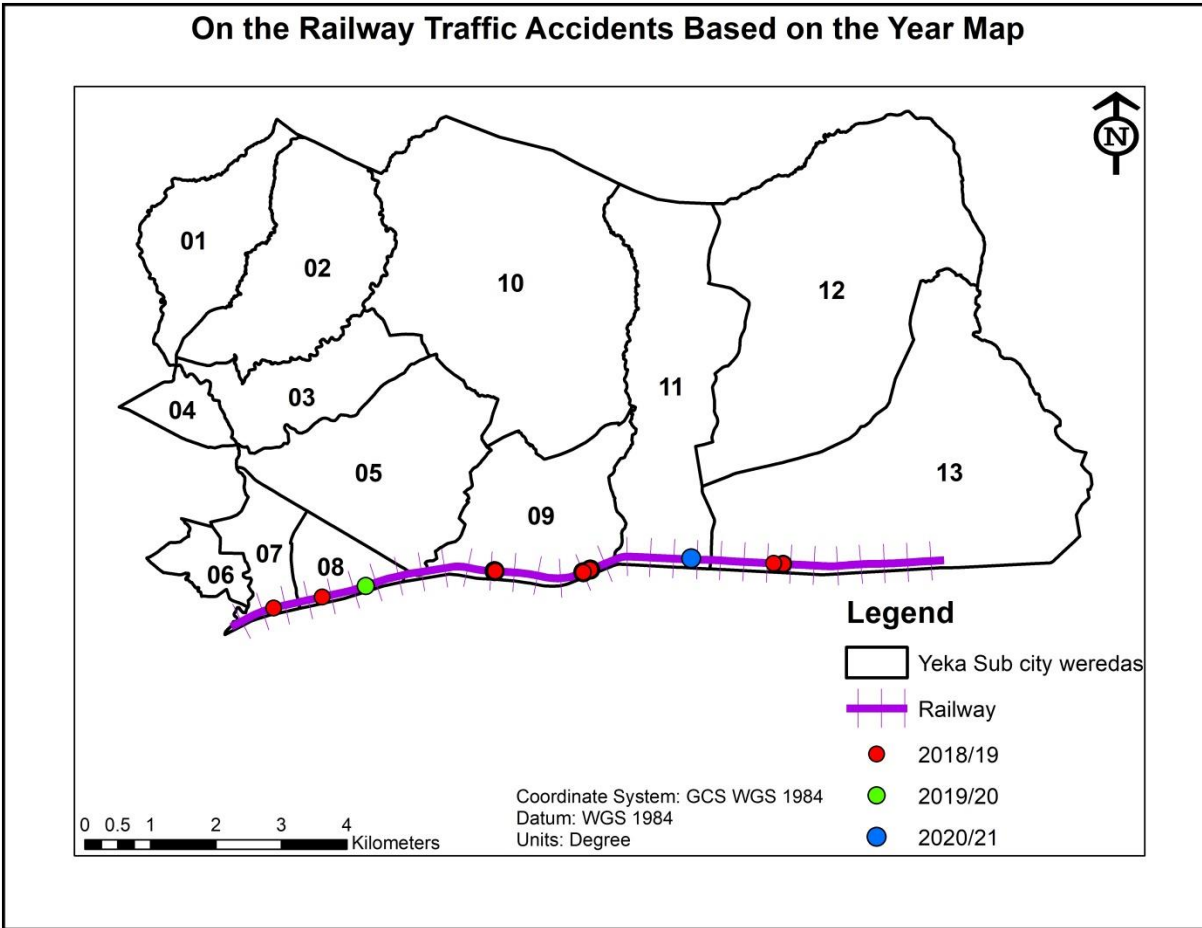


Figure 9: Spatial distribution of hazardous train station traffic accidents based on the year

Based on above data results, during the year 2020/21 had more hazardous train station traffic accidents, because of the driver behavior like using alcohol, using cell phone, use over speed, negligence, watching left and right *spokeo* problems, the road and railway condition, vehicle condition, changing gear on the railway etc. In general, hazardous train station traffic increases from year to year (Figure 10).

4.2.3. Accident Distribution and Mapping based on Day of Week

4.2.3.1. Road Traffic Fatality Accidents Distribution based on Day of Week

Road traffic fatality accidents were different based on days of the week. In 2018/19, substantial accidents were documented in all days of the week, except for on Tuesday which are recorded 3 number of fatality accidents. On Monday, Thursday, Saturday and Sunday had large number of fatality accidents record, which were 9, 8, 8, and 10 traffic fatality accidents respectively and the greatest one was on Sunday. In 2019/20, on Tuesday, Friday and Saturday had large number of fatality accidents record, which were 7, 7 and 8 respectively and on Wednesday and Sunday lowest

number of fatality accidents which were 4 and 4 respectively. In 2020/21, especially on Tuesday has large number of fatality accidents record, which was 8 and on Thursday lowest number of fatality accidents which was 1.

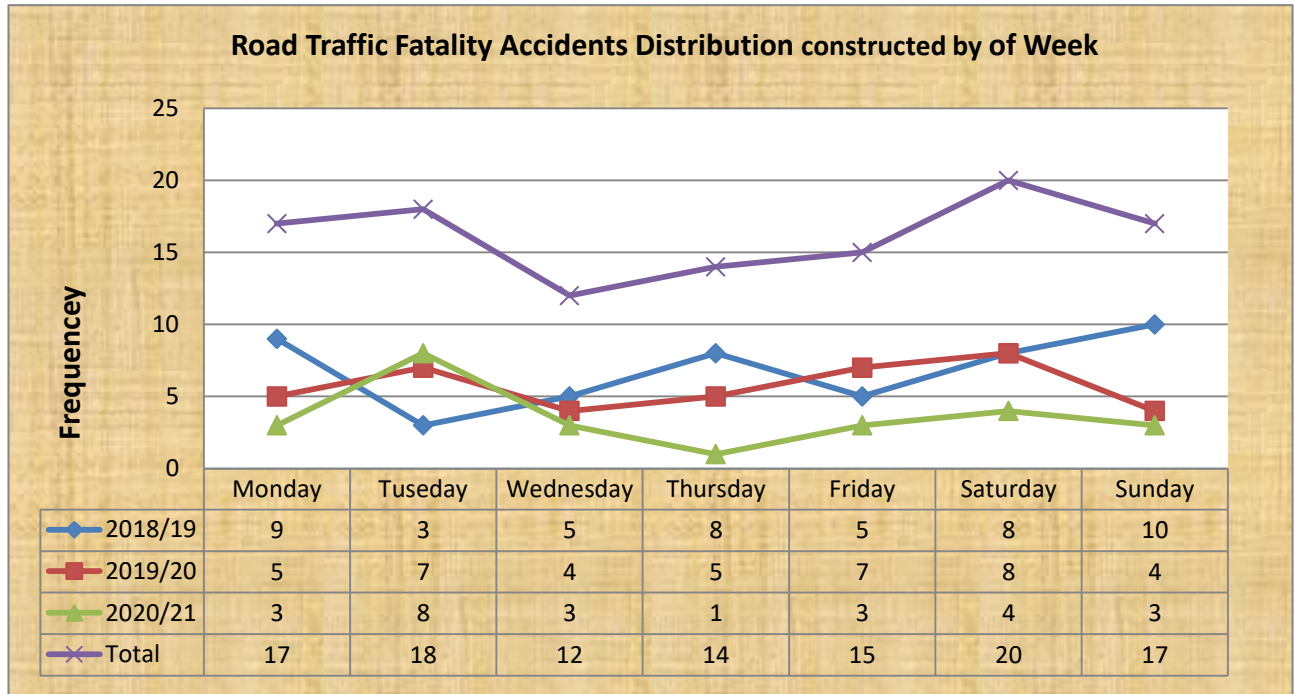


Figure 10: Road traffic fatalities accidents distribution based on day of the week

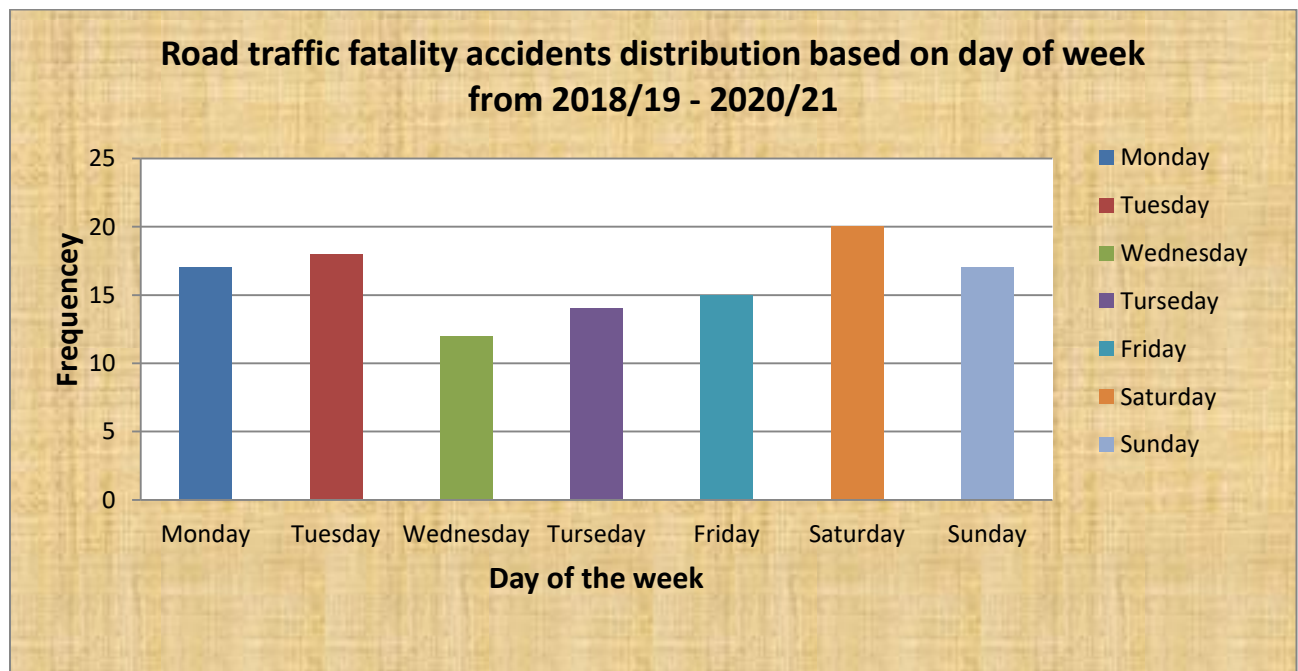


Figure 11: Road traffic fatalities accidents distribution based on day of the week

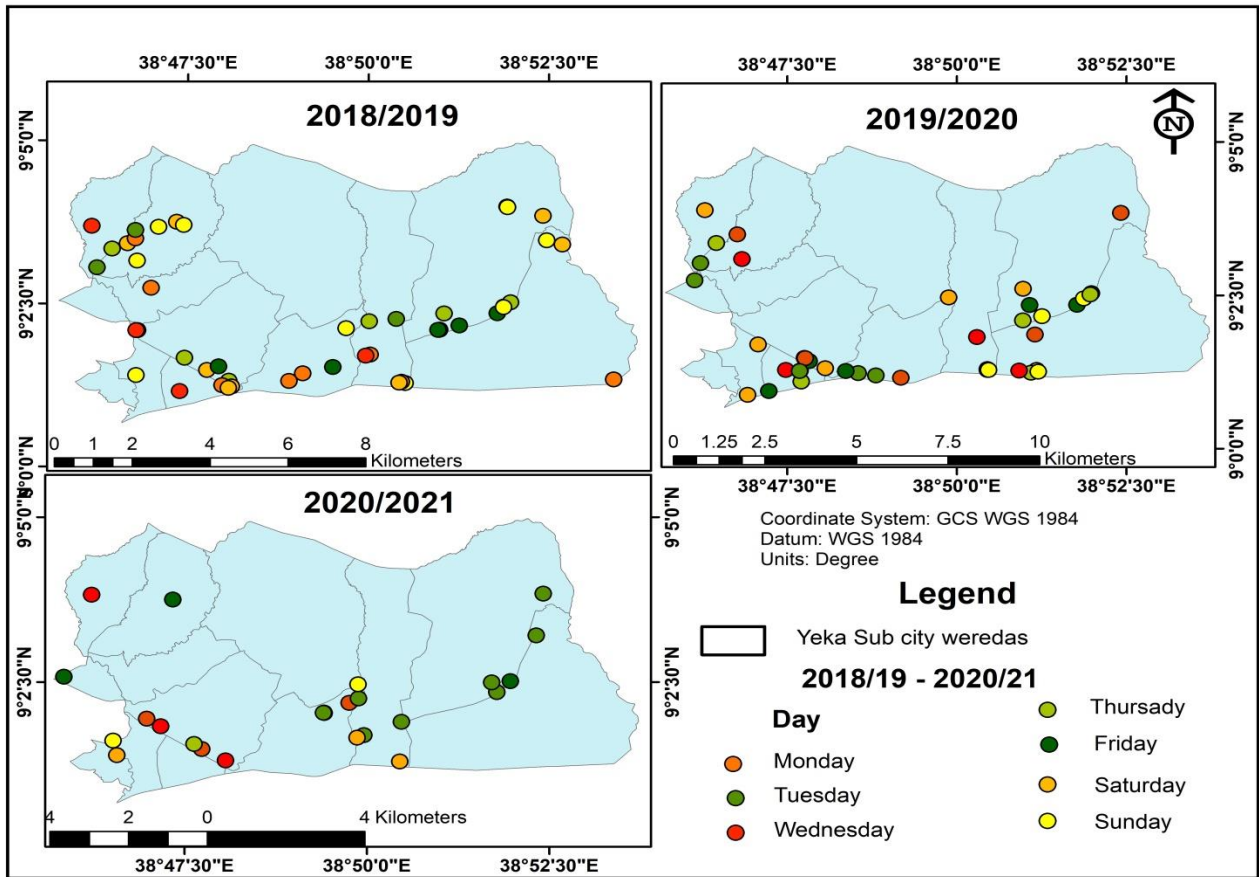


Figure 12: Road traffic fatalities accidents distribution based on day of the week

In general, from the figure 13, 14 and 15 road traffic fatality accidents were relatively great on Monday, Tuesday, Saturday and Sunday. From the whole years of the weeks the highest value was on Saturday, because there was a weekend and the person wants to enjoy out of home by drinking alcohol in different club, the person tried to drive a vehicle by using alcohol and miss the traffic lighting rules.

4.2.3.2. Hazardous Train Station Traffic Accidents Distribution based on Day of Week

Hazardous train station traffic accidents were different based on days of the week. In 2018/19, accidents were recorded on some days of the week. On Monday, Tuesday, Friday and Saturday had accidents recorded, which were 1, 1, 1, and 1 hazardous train station traffic accidents respectively, but on Wednesday, Thursday and Sunday had no accidents. In 2019/20, accidents were not recorded in some days of the week, such as on Tuesday, Wednesday, Thursday, and Sunday. On Friday had large number of hazardous train station traffic accidents recorded which are 3, but in Monday and Saturday had little about hazardous train station traffic accidents. In 2020/21, accidents were not recorded in some days of the week, such as on Sunday. On Monday, Tuesday, Wednesday, Thursday,

Friday and Saturday had hazardous train station traffic accidents recorded, which were 1, 1, 3, 1, 1 and 1 hazardous train station traffic accidents respectively and peak one was on Wednesday, but in Sunday there was no hazardous train station traffic accidents.

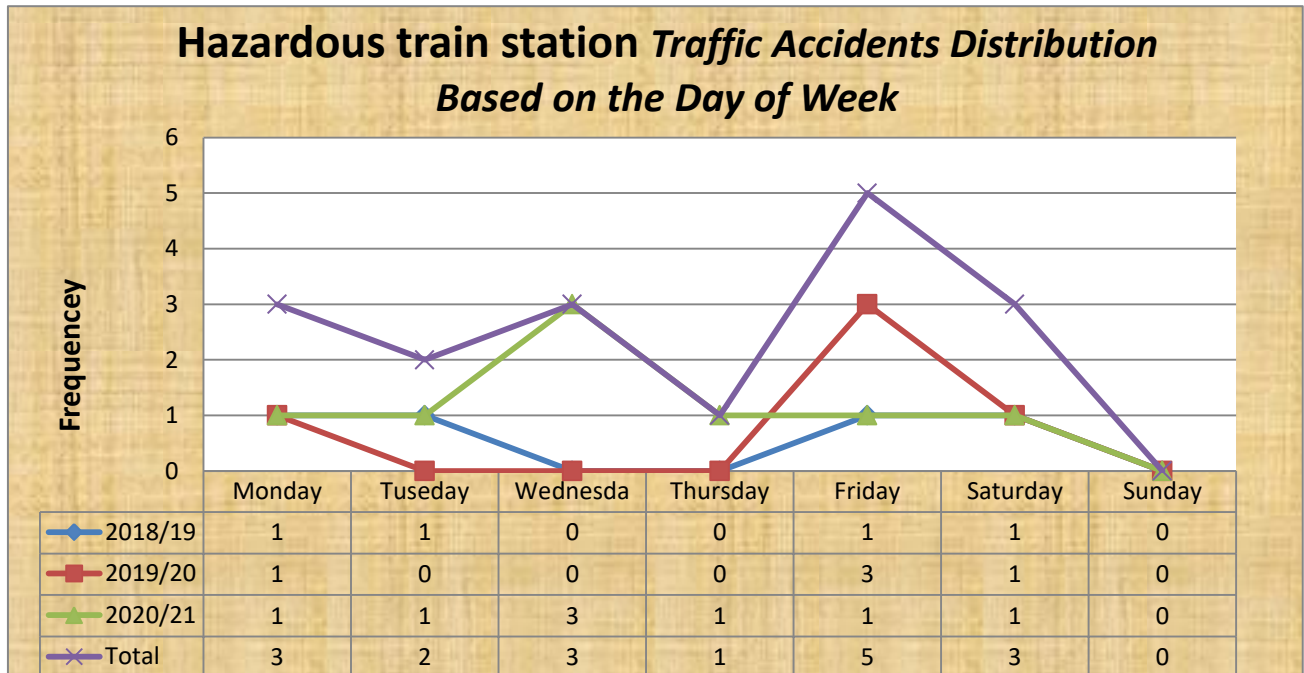


Figure 13: Hazardous train station traffic accidents distribution based on day of the week

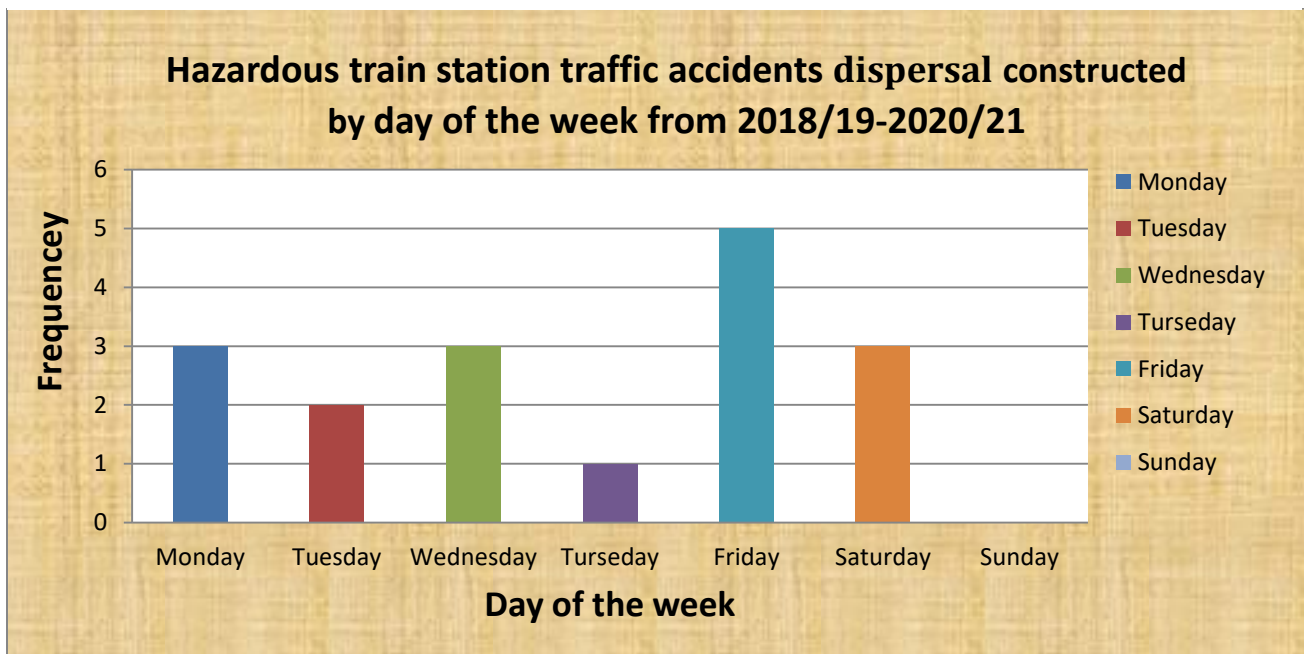


Figure 14: Hazardous train station traffic accidents distribution based on day of the week

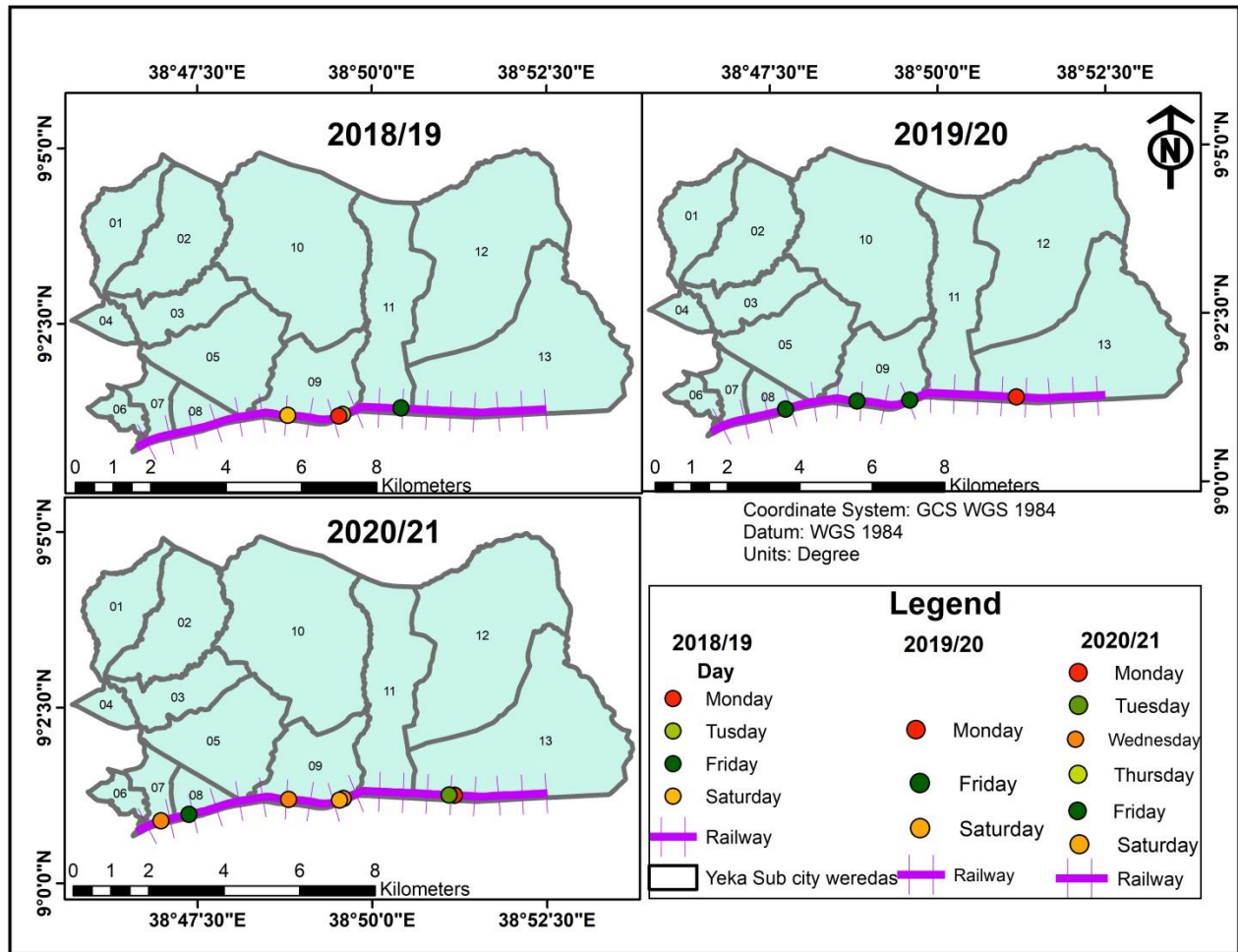


Figure 15: Hazardous train station traffic accidents distribution based on day of the week

In general, from figure 16, 17 and 18, hazardous train station traffic accidents were high on Monday, Wednesday, Friday and Saturday. For the all years the highest value was on Friday. In Tuesday there were relatively few accidents, but in Sunday there were no hazardous train station traffic accidents. Because the road user tried to cross the railway, they were using their cell phone; they were not giving attention for the road, and the driver use alcohol etc.

4.2.4. Accident Distribution and Mapping based on Hour of Day

4.2.4.1. Road Traffic Fatalities Accidents Distribution based on Hour of Day

Currently, it is known about road traffic fatality accidents are significantly increased in Ethiopia. Most of the traffic congestions were dedicated and exit on working hours. The data in Figure 17 and 18 show the peak times of road traffic fatalities.

Table 6: Road traffic fatality accidents distribution based on day and night

| Year | Day | Night | Total |
|--------------|-----------|-----------|------------|
| 2018/19 | 29 | 19 | 48 |
| 2019/20 | 23 | 17 | 40 |
| 2020/21 | 8 | 17 | 25 |
| Total | 60 | 53 | 113 |

Table 7: Based on hours maximum and minimum road traffic fatality accidents distribution

| | Maximum | | Minimum | | Total |
|--------------|------------|-------------|-------------|-------------|------------|
| | 6:01-12:00 | 00:01-6:00 | 12:01-18:00 | 18:01-24:00 | |
| 2018/19 | 19 | 13 | 8 | 8 | 48 |
| | 6:01-12:00 | 18:01-24:00 | 12:01-18:00 | 00:01-6:00 | |
| 2019/20 | 14 | 11 | 9 | 6 | 40 |
| | 6:01-12:00 | 18:01-24:00 | 12:01-18:00 | 00:01-6:00 | |
| 2020/21 | 5 | 15 | 3 | 2 | 25 |
| Total | 38 | 39 | 20 | 16 | 113 |

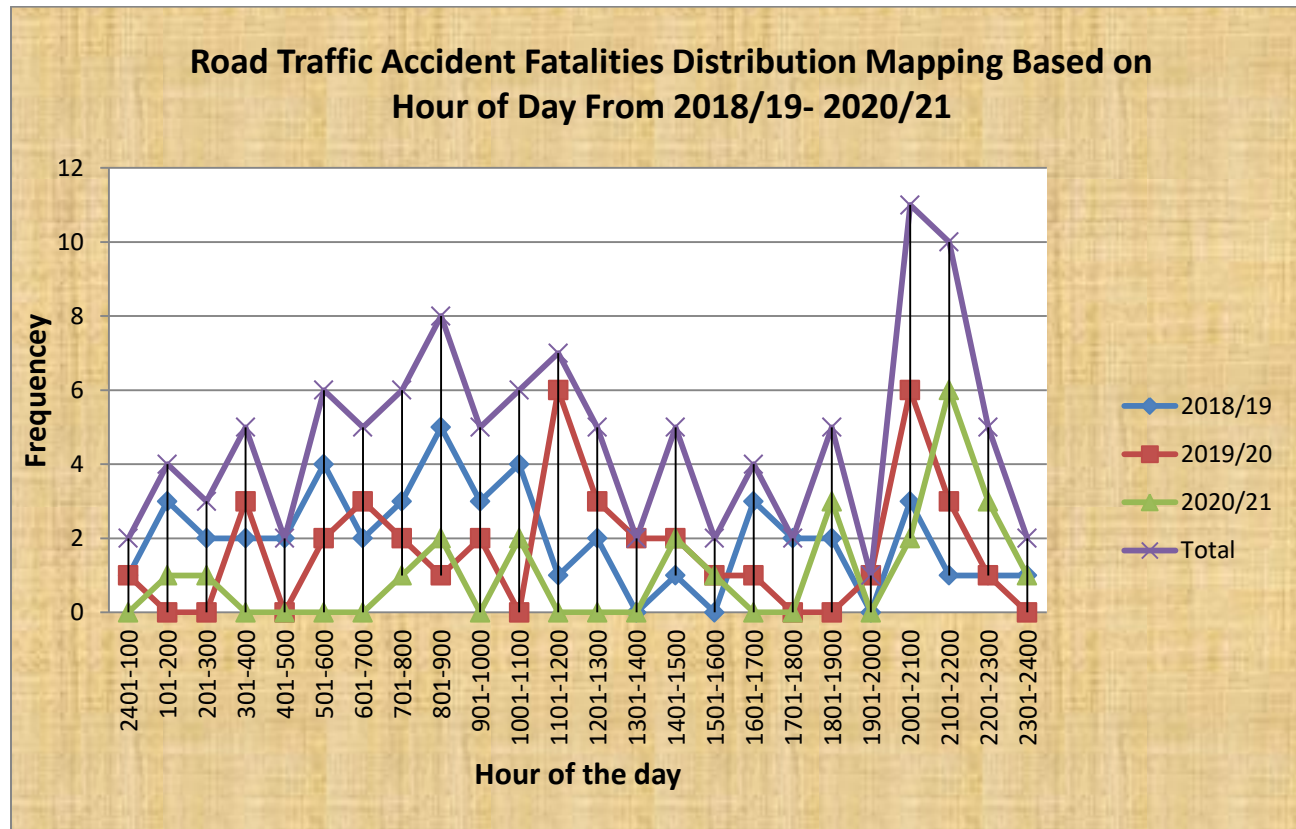


Figure 16: Road traffic fatality accidents distribution mapping based on hour of the day

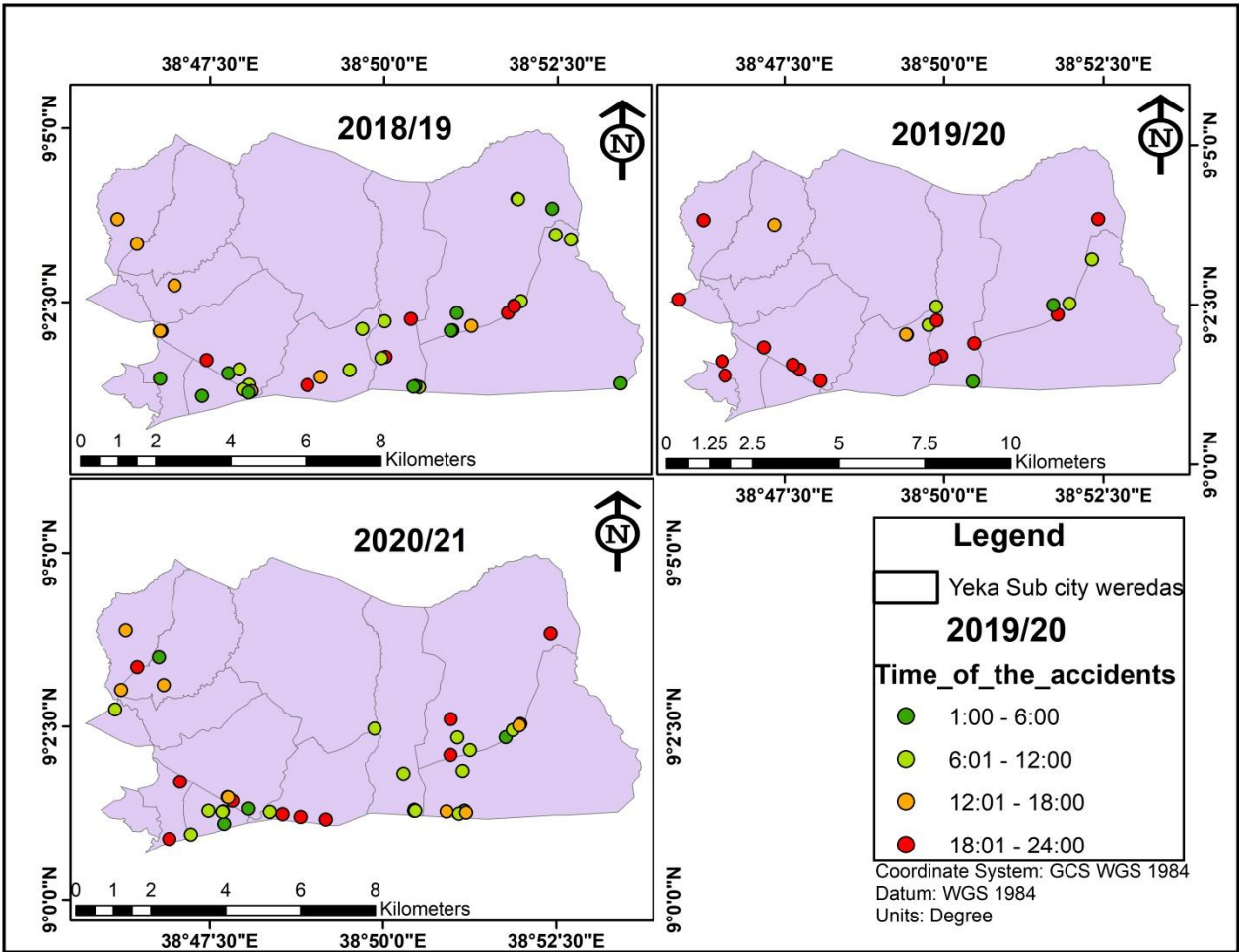


Figure 17: Road traffic accident fatalities distribution mapping based on hour of the day

The road traffic fatality accidents on the study road network happened through the day in all studied years were high (Table 6). Table 7 shows that data used for each year which indicates here were two intervals that road traffic fatality accidents proportions were maximum and minimum.

In general, the overall year of road traffic fatality accidents were record during the day and also the extreme amount of road traffic fatality accidents were recorded throughout the time interval among 6:01 (12:01 AM) to 12:00 (6:00 AM), due to this kind of time interval the person get into the work, so number of road user has been more fluctuate in this time and they never think about road, they were think about the entry time to work Figure 17 and 18.

4.2.4.2. Hazardous Train Station Traffic Accidents Distribution based on Hour of Day

Hazardous train station traffic accidents were increase year to year in Ethiopia based on the data taken. Therefore, there were many reasons for this problem, increase in the number of train user,

driver negligence etc. The data in Figures 19 and 20 show the peak times of hazardous train station traffic accidents.

Table 8: Hazardous train station traffic accidents distribution based on day and night

| Year | Day | Night | Total |
|--------------|-----------|----------|-----------|
| 2018/19 | 4 | 0 | 4 |
| 2019/20 | 4 | 1 | 5 |
| 2020/21 | 6 | 2 | 8 |
| Total | 14 | 3 | 17 |

Table 9: Based on hours maximum and minimum hazardous train station traffic accidents distribution

| | Maximum | | Minimum | | Total |
|--------------|------------|----------|-------------|----------|-----------|
| | 6:01-12:00 | | 12:01-18:00 | | |
| 2018/19 | 3 | | 1 | | 4 |
| 2019/20 | 3 | | 1 | 1 | 5 |
| 2020/21 | 3 | 3 | 2 | | 8 |
| Total | 9 | 3 | 4 | 1 | 17 |

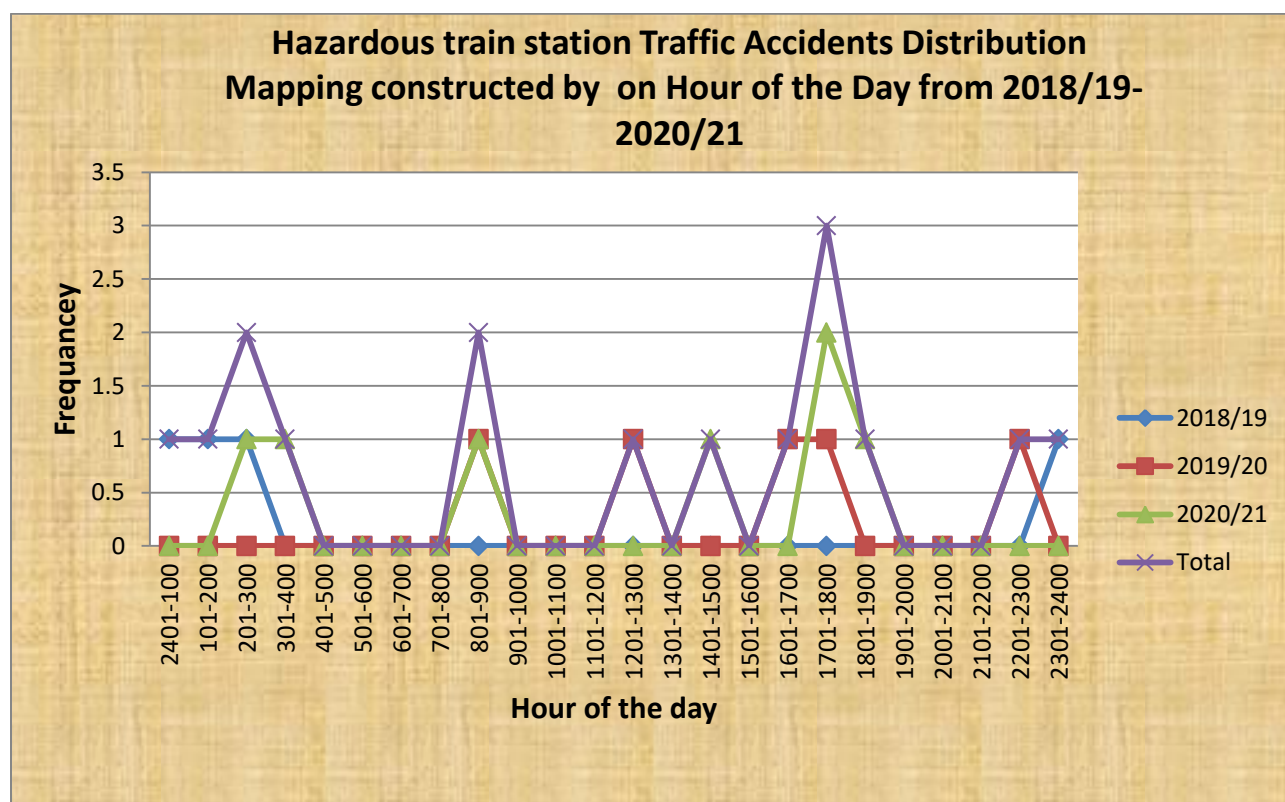


Figure 18: Hazardous train station traffic accidents distribution based on the hour of the day

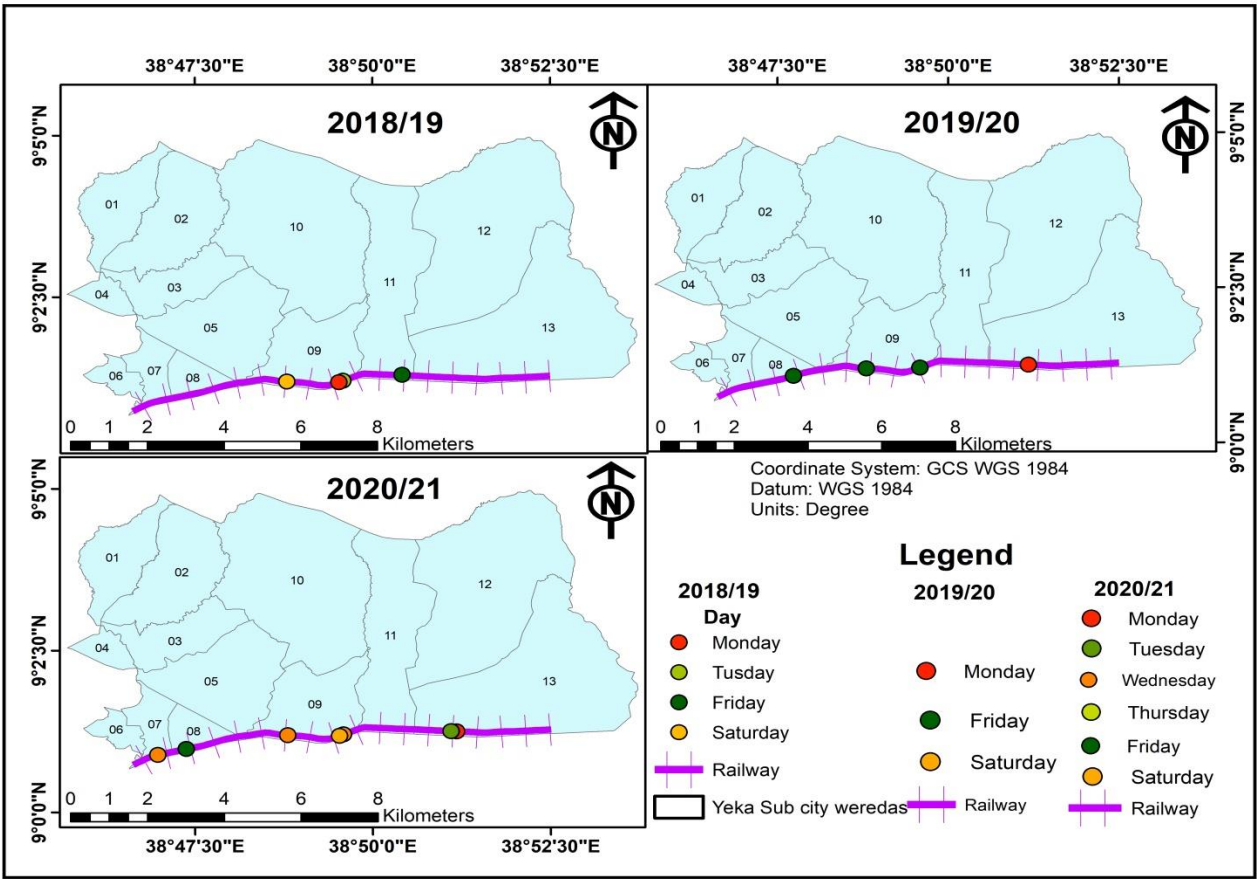


Figure 19: Hazardous train station traffic accidents distribution based on hour of the day

Hazardous train station traffic accidents on study road network happened throughout the day in all studied years was high (Table 8). Table 9 shows that data for each year which indicates there are two intervals that hazardous train station traffic accident rates were maximum and minimum. In general, overall year of hazardous train station accidents were record during the day and also the maximum number of hazardous train station traffic accidents was record during the time interval between 6:01 (12:01 AM) to 12:00 (6:00 AM) and 12:01 (6:01 AM) to 18:00 (12:00 PM), due to this kind of time interval the person try to get into the work and out from the work, number of road user and crossing railway has been more in this time (Figure 19 and 20).

4.2.5. Accident Dispersal & Mapping based on Vehicular Plate Code

4.2.5.1. Road Traffic Fatality Accidents Map based on Vehicular Code

The most substantial problems that play the main role of road traffic fatality accidents were plate code.

Table 10: Road traffic fatality accidents based on vehicular plate code

| | 1 | 2 | 3 | 4 | 5 | 35 | Bicycle | Defense | Police | Total |
|--------------|----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|------------|
| 2018/19 | 4 | 12 | 30 | 2 | 0 | 0 | 0 | 0 | 0 | 48 |
| 2019/20 | 3 | 4 | 27 | 4 | 1 | 0 | 1 | 0 | 0 | 40 |
| 2020/21 | 1 | 2 | 16 | 5 | 1 | 0 | 0 | 0 | 0 | 25 |
| Total | 8 | 18 | 73 | 11 | 2 | 0 | 1 | 0 | 0 | 113 |

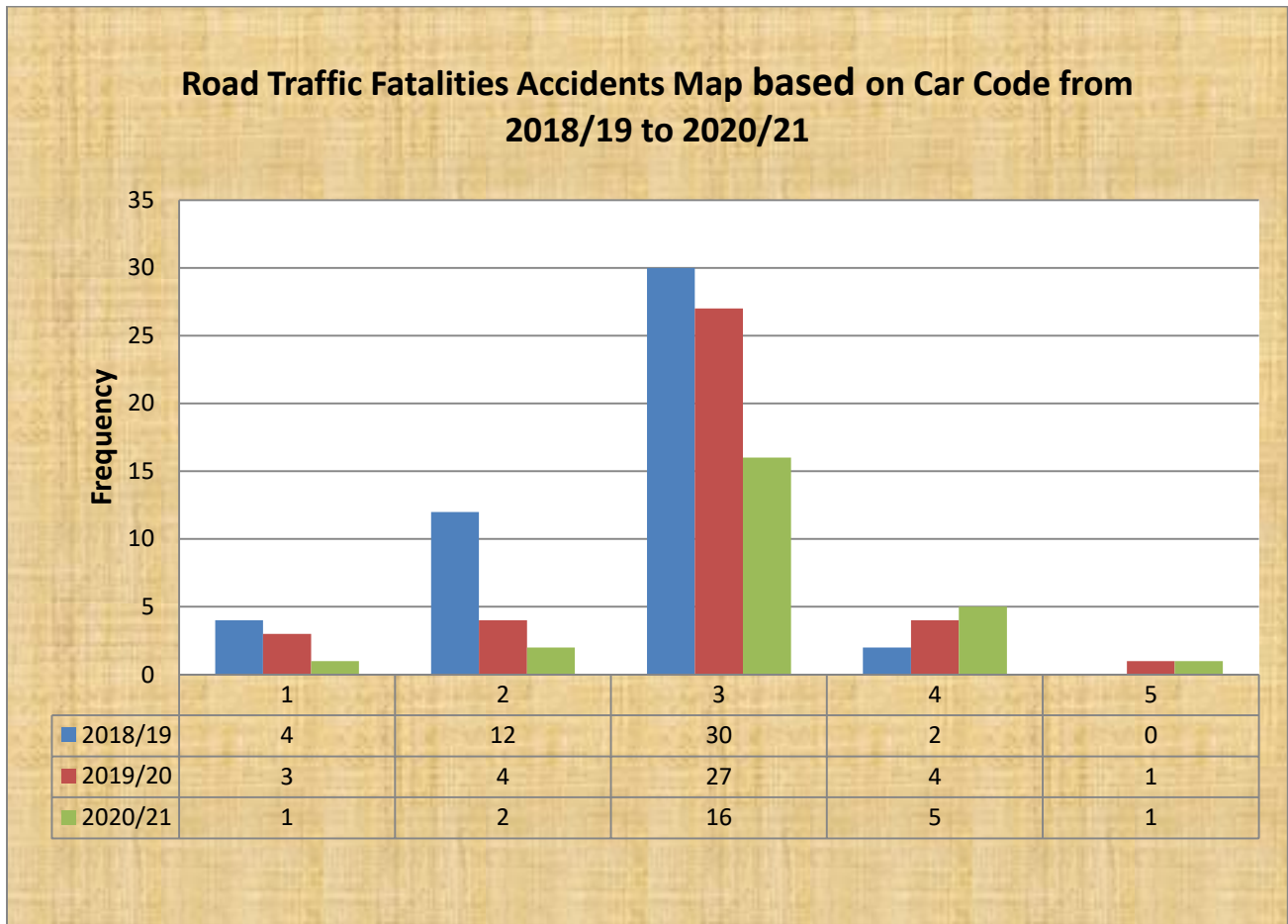


Figure 20: Road traffic fatality accidents distribution based on vehicular plate code

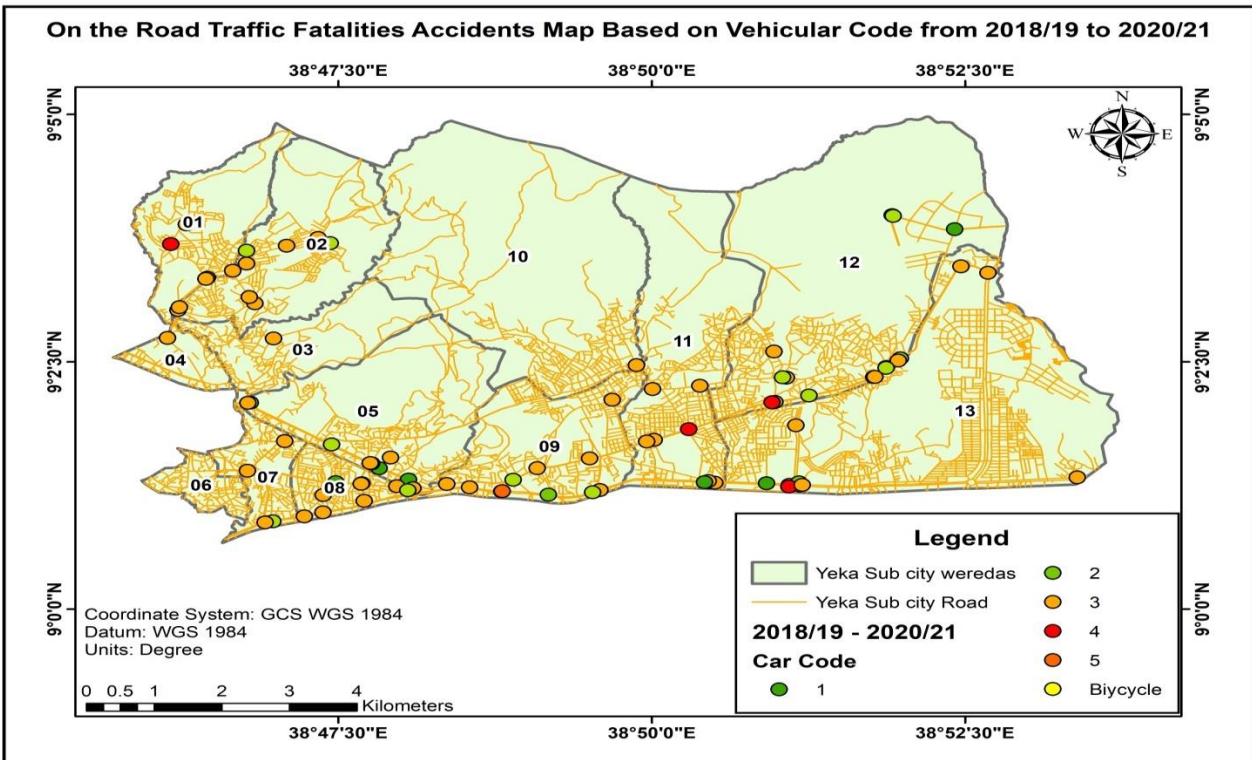


Figure 21: Road traffic fatality accidents distribution based on vehicular plate code

Dissimilar plate codes which are revealed on figure 21 and 22 denote diverse vehicles, holders and their purposes. In Ethiopia, Taxi (1), Private vehicles (2), Commercial/Business vehicle (3), Governmental vehicles (4), Red Cross vehicles (5), Aid Organization vehicles (35) and others includes vehicles with temporary plate code.

In general, the fatality was caused by truck plate code three, two, four, one, five, bicycle, 35, defense and police in decreasing order. In studied years plate code three was the highest amount of road traffic fatality accidents, because most of plate code three is minibus, so the minibus driver wants to get more income by driving fast, overloading in minibus as a person or things, violating the light rules and they were driven by experience etc.

4.2.5.2. Hazardous Train Station Traffic Accidents Map based on Vehicular Code

Plate code is one of the most significant problems that play the main role on hazardous train station traffic accidents. Most of accidents were caused by vehicle Plate code one, two, three and a little bit plate code four and train.

Table 11: Hazardous train station traffic accidents based on by vehicular code

| | 1 | 2 | 3 | 4 | 5 | 35 | Train | Bicycle | Defense | Police | Total |
|--------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| 2018/19 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 |
| 2019/20 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 |
| 2020/21 | 1 | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 8 |
| Total | 4 | 5 | 6 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 17 |

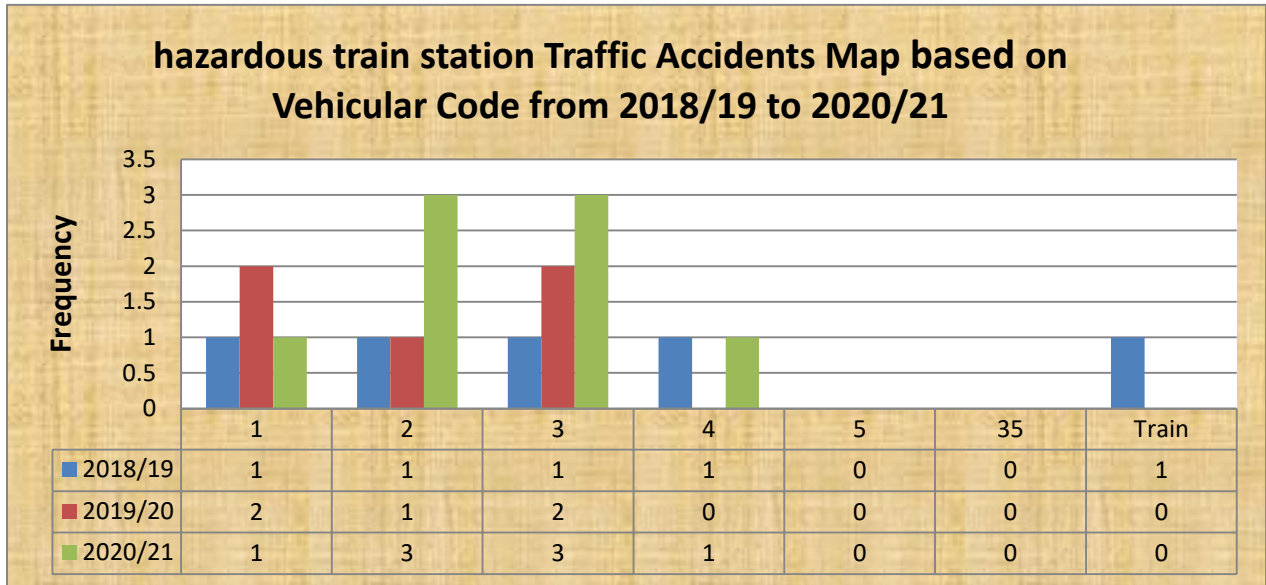


Figure 22: Hazardous train station traffic accidents map based vehicular code

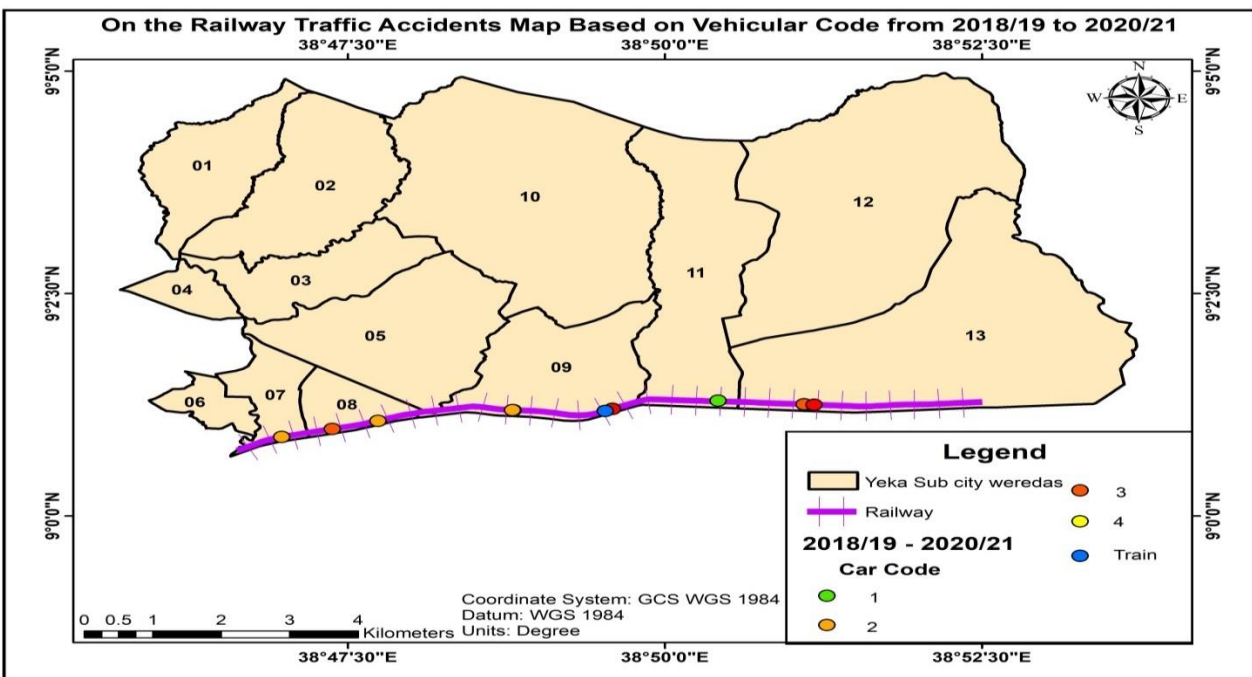


Figure 23: Hazardous train station traffic accidents map based on vehicular code

In general, the accidents about hazardous train station were cause by vehicle plate code three, two, one, four, train, five, 35, bicycle, defense and police in decreasing order. In studied years plate code three was create high amount about hazardous train station traffic accidents, because most of plate code three were minibus, so the minibus driver want to get more income by driving fast, overloading in minibus as a person or things, violate the light, changing gear on the railway etc.

4.2.6. Accident Distribution based on Cause Fatalities and Accidents

4.2.6.1. Road Traffic Fatality Accidents Based on Cause

The cause about the fatality was frequently a good pointer of fatality donating causes. According to Figure 25 and table 12, 100% registered of road traffic fatality accidents were related to driver behavior.

Table 12: Road traffic fatality accidents based on main cause

| Cause of accidents | 2018/19 | 2019/20 | 2020/21 | Total | Percent |
|------------------------------------|-----------|-----------|-----------|------------|------------|
| Drunk driving | 0 | 1 | 0 | 1 | 0.9 |
| Vehicle passenger fall out | 0 | 1 | 0 | 1 | 0.9 |
| Falling while riding a bicycle | 0 | 1 | 0 | 1 | 0.9 |
| Improper backward driving | 1 | 1 | 1 | 3 | 2.7 |
| Adequate distance | 3 | 2 | 2 | 7 | 6.2 |
| Without caution | 2 | 2 | 1 | 5 | 4.4 |
| Steering wheel to right | 5 | 2 | 1 | 8 | 7.1 |
| Steering wheel improperly | 6 | 4 | 3 | 13 | 11.5 |
| Steering wheel to left | 5 | 3 | 5 | 13 | 11.5 |
| Not giving priority to pedestrians | 5 | 19 | 2 | 19 | 16.8 |
| Priority prohibition | 21 | 4 | 12 | 42 | 37.2 |
| Total | 48 | 40 | 27 | 113 | 100 |

Source: Addis Ababa police commission

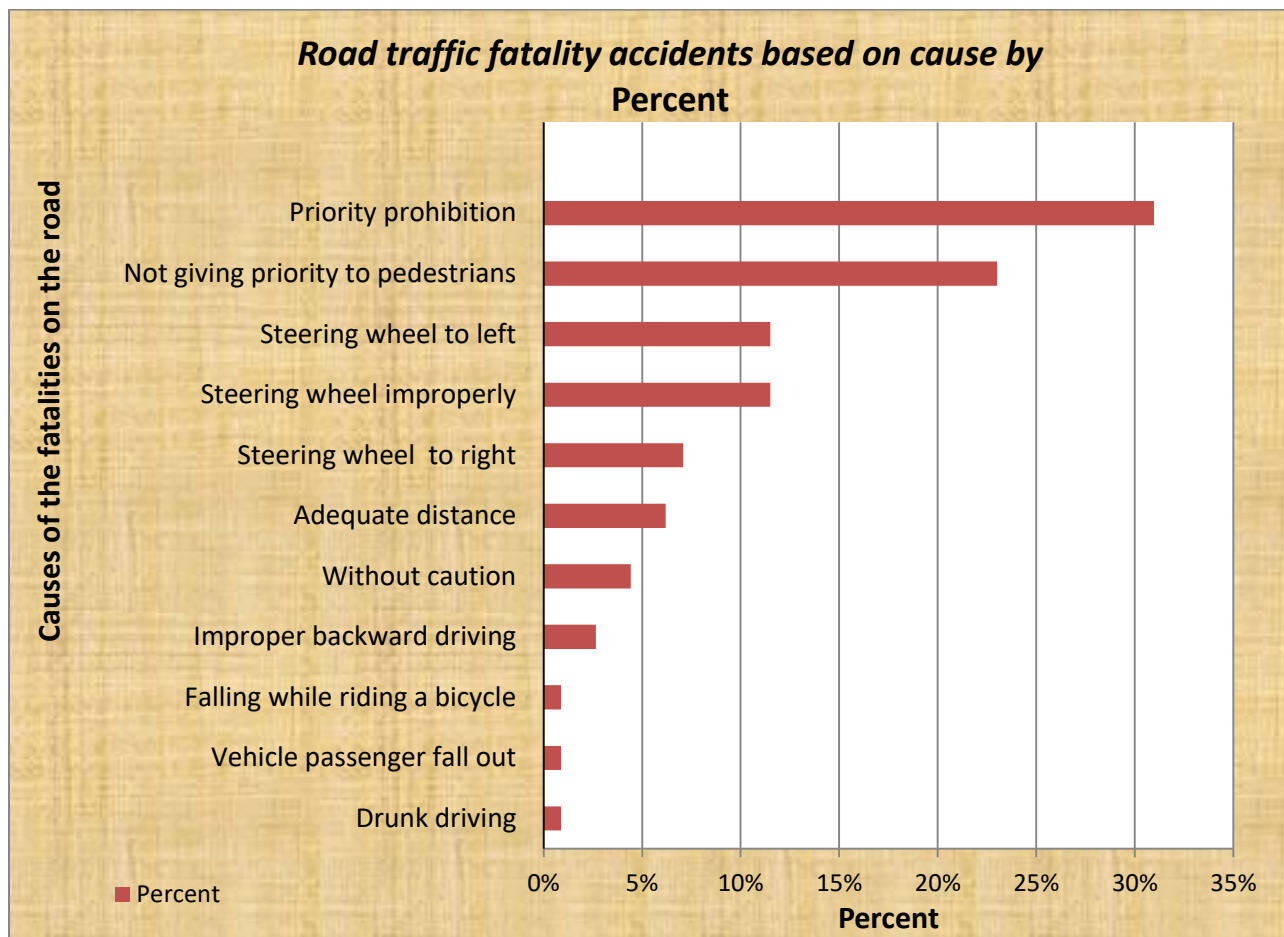


Figure 24: Road traffic fatality accidents recorded cause by traffic accidents in Yeka Sub city

Source: Addis Ababa police commission

31% of fatalities were reason by priority prohibition, 23% of the fatalities were cause by not giving priority to pedestrians, 11.5% of the fatalities were cause by steering wheel to left and steering wheel improperly, 7.1% of the fatalities were cause by steering wheel to right, 4.4% of the fatalities were cause by without caution, 6.2% of the fatalities were cause by adequate distance, 2.7% of the fatalities were cause by improper backward driving, 0.9% of the fatalities were cause by drunk driving, vehicle passenger fall out and falling while riding a bicycle.

Most probably car drivers permanently tried to blameworthiness the road conditions, the truck tools failure. Even though the realities were honestly offered, the manner of the associated car driver was typically the primary cause. Numbers of fatalities accidents were cause by use excessive speed or forceful car driver behavior. Although furthestmost of the road traffic fatality accidents were cause by car driver activities, according to diverse study 95% road traffic flow losses of life were consist of certain degree of car driver activities combined with other influences which involved equipment failure, road design, poor road repairs and so on Figure 25 and 26.

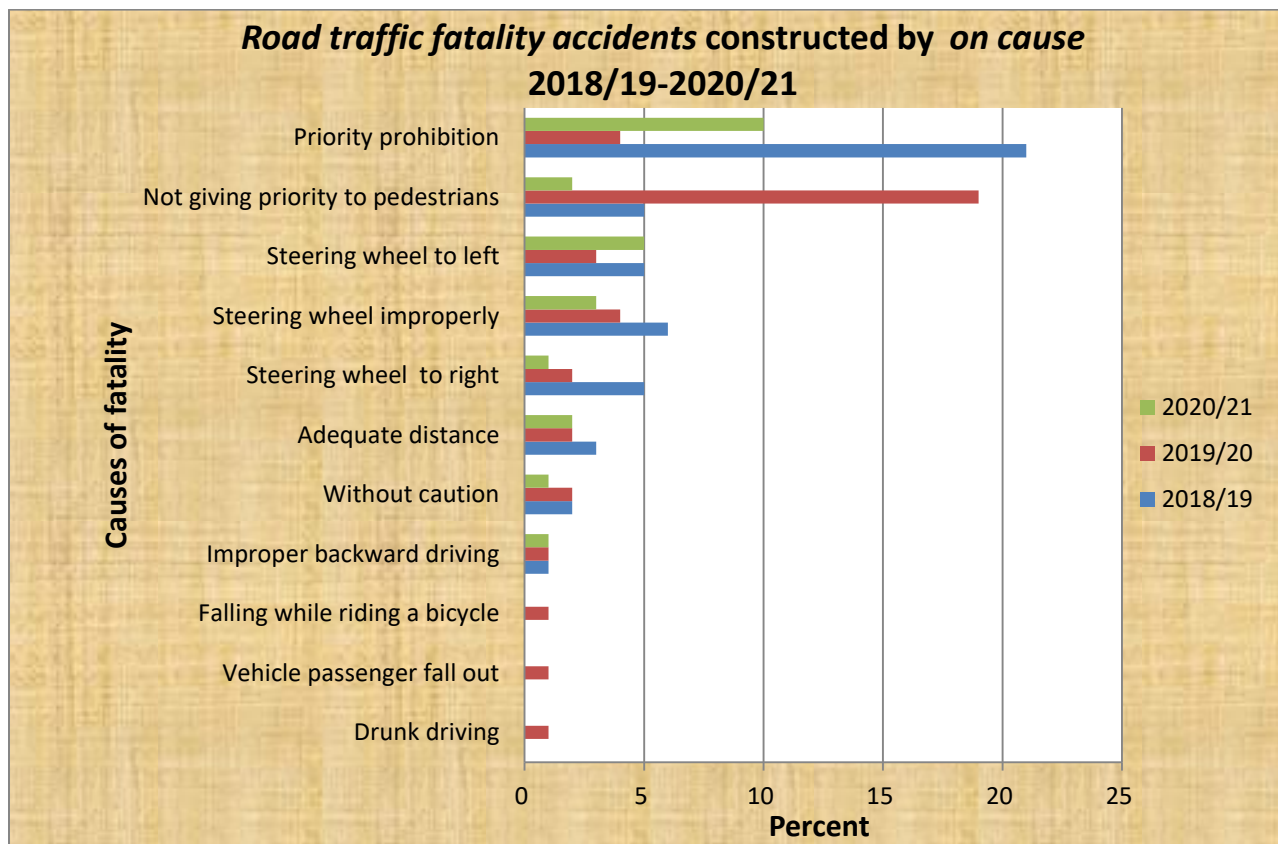


Figure 25: Evaluated cause of road traffic flow fatality accidents in Yeka Sub city

Source: Addis Ababa police commission

Road traffic fatality accidents had diverse design in all years on the study period. In 2018/19, 2019/20 and 2020/21 fatality accidents caused by priority prohibition were 21, 4, and 10 respectively, so this results is indicated more fatalities in 2018/19; In 2018/19, 2019/20 and 2020/21 fatality accidents caused by not giving priority to pedestrians were 5, 19, and 2 respectively, so this results is indicate more fatalities in 2019/20; In 2018/19, 2019/20 and 2020/21 fatality accidents caused by steering wheel left and steering wheel improperly were 5, 3, 5 and 6, 4, 3 respectively, so this results is indicated more fatalities in 2018/19 due to steering wheel left and steering wheel improperly; In 2018/19, 2019/20 and 2020/21 fatality accidents caused by steering wheel to right were 5, 2, and 1 respectively, so this results is indicated more fatalities in 2018/19; In 2018/19, 2019/20 and 2020/21 fatality accidents caused by without caution were 2, 2, and 1 respectively, so this results is indicated more fatalities in 2018/19 and 2019/20; In 2018/19, 2019/20 and 2020/21 fatality accidents caused by adequate distance were 3, 2, and 2 respectively, so this results is indicated more fatalities in 2018/19; In 2018/19, 2019/20 and 2020/21 fatality accidents caused by improper backward driving were 1, 1, and 1 respectively, so this results has indicated equal

fatalities in year; In 2018/19, 2019/20 and 2020/21 fatality accidents caused by falling while riding a bicycle, vehicle passenger fall out and drunk driving were 0, 1, 0, and 0, 1, 0 and also 0, 1, 0 respectively, so this results is indicated more fatalities in 2019/20 due to falling while riding a bicycle, vehicle passenger fall out and drunk driving Figure 28. In addition from all on the road traffic fatality causes priority prohibition has high rank from 2018/19 and 2020/21, from 2019/20, not giving priority to pedestrians has high.

In general, the number indicates there were big deals in the study area during studied period, because the driver behaviors were main role such as by violating lighting rules, using alcohol, using over speed, watching left and right spoken problems etc.

4.2.6.2. Hazardous Train Station Traffic Accidents based on Cause

The causes of the injury were frequently a good pointer of accident donating reasons. Affording to Figure 27 and table 13, 100% registered hazardous train station traffic accidents were relate to driver behavior.

Table 13: Hazardous train station traffic accidents constructed by cause

| Cause of accidents | 2018/19 | 2019/20 | 2020/21 | Total | Percent |
|-----------------------------|----------|----------|----------|-----------|------------|
| Inadequate distance | 1 | 1 | 2 | 4 | 23.5 |
| Steering wheel improperly | 1 | 1 | 3 | 5 | 29.4 |
| Using cell phone on railway | 2 | 3 | 3 | 8 | 47.1 |
| Total | 0 | 0 | 0 | 17 | 100 |

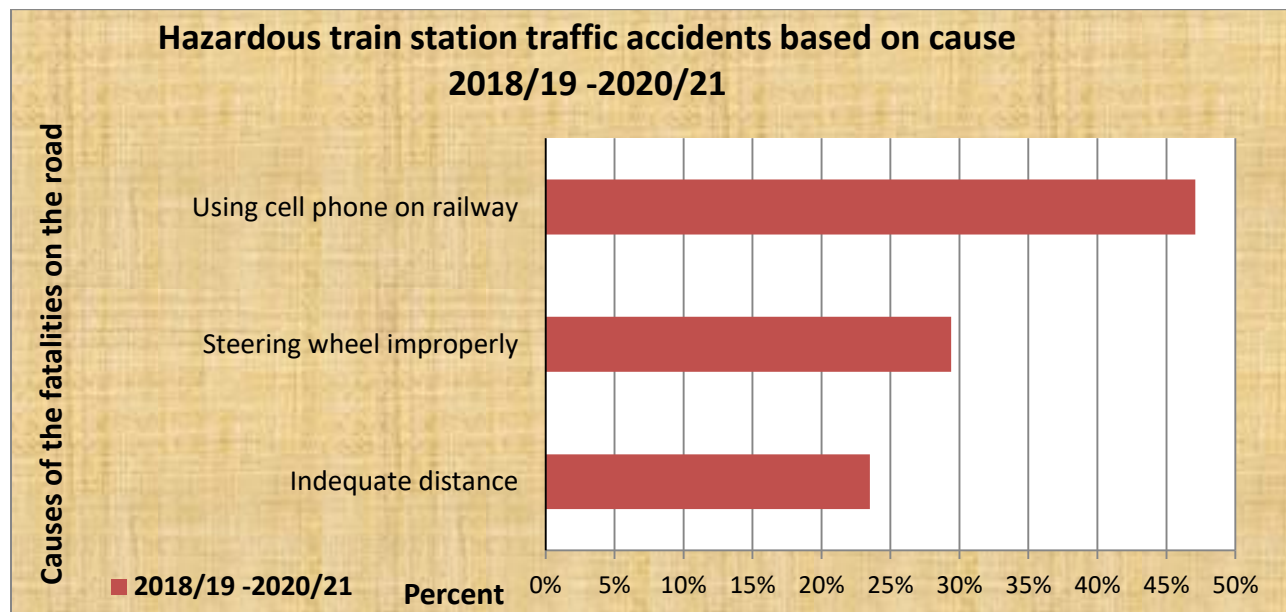


Figure 26: Hazardous train station recorded cause of traffic accidents in Yeka Sub city

Source: Addis Ababa police commission

47.1% of accidents were caused by using cell phone on railway, 29.4% of the accidents were caused by steering wheel improperly and 23.5% of the accidents were caused by inadequate distance.

Most of the car driver constantly annoyed to blame worthiness the road environments, the truck tools failure. Even though the actualities were truly presented, the manner of the associated driver was typically the primary cause. Most of accidents were caused by unnecessary speediness or forceful driver behavior. Even if most hazardous train station accidents was caused by car driver behavior, by way of further influences which involved equipment failure, road design, and poor road repairs and so on.

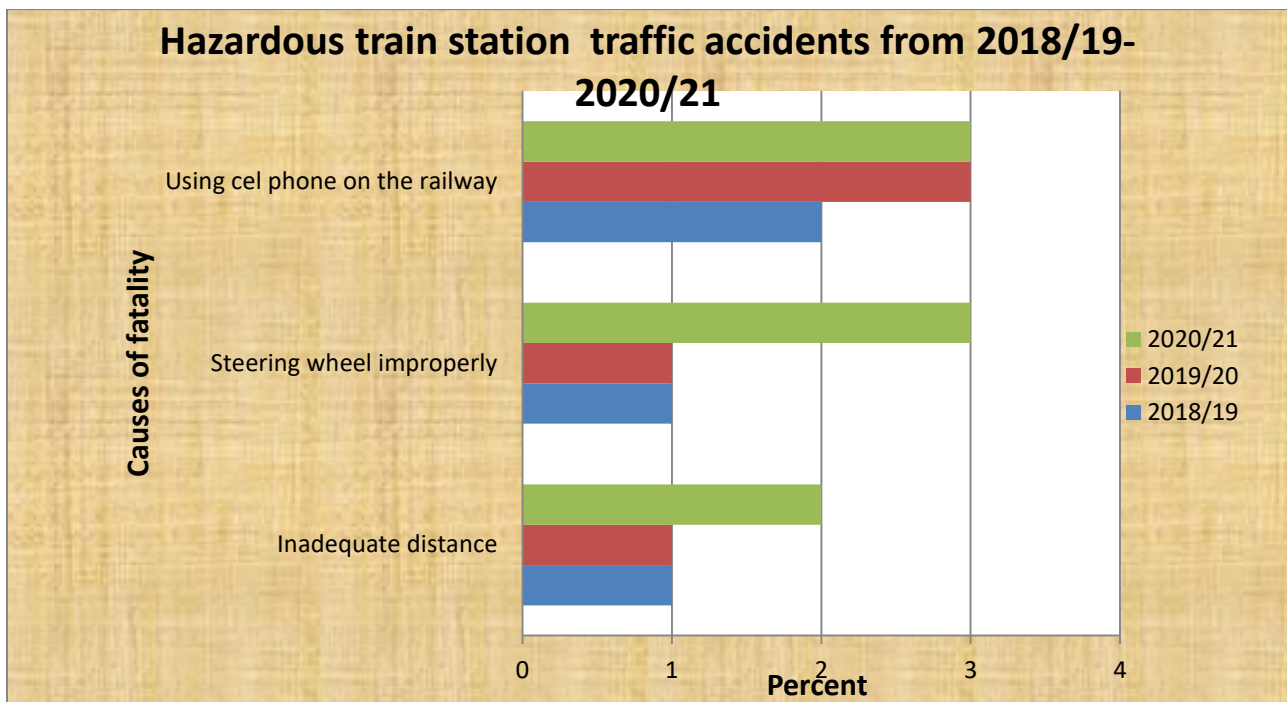


Figure 27: Assessed cause of hazardous train station traffic accidents in Yeka Sub city

Source: Addis Ababa police commission

Hazardous train station traffic accidents had diverse design as of the year to year in the study period. In 2018/19, 2019/20 and 2020/21 accidents caused by using cell phone on the railway were 2, 3, and 3 respectively, so this results is indicated more accidents in 2019/20; In 2018/19, 2019/20 and 2020/21 accidents caused by steering wheel improperly were 1, 1, and 3 respectively, so this results is indicated more accidents in 2020/21; In 2018/19, 2019/20 and 2020/21 accidents caused by inadequate distance were 1, 1 and 2 respectively, so this results is indicated more accidents in 2020/21 Figure 28. Furthermore as of all year hazardous train station traffic accidents caused using cell phone on the railway has high rank.

4.2.7. Seasonal Pattern of Road Traffic Fatalities and Hazardous Train Station Traffic Accidents

4.2.7.1. Seasonal Pattern of Road Traffic Fatality Accidents

Season is the most critical problems for truck and for the driver to control vehicle. The arrangements of road fatalities were reasonably changed from season to season. During the study period 2018/19, 2019/20 and 2020/21 the road traffic fatality accidents dedicated 32, 26, 32, and 23 were performed during autumn, winter, spring and summer season respectively (Table 16).

Table 14: Seasonal traffic fatality accidents recorded on road on Yeka sub city

| Type of Accident | Number of traffic fatality accidents dedicated on the road | | | | | |
|--|--|--------|--------|--------|--------|-------|
| | Seasons | | | | | |
| | | Spring | Summer | Autumn | Winter | Total |
| On the Road fatalities traffic accidents | 2018/19 | 20 | 8 | 9 | 11 | 48 |
| | 2019/20 | 9 | 7 | 17 | 7 | 40 |
| | 2020/21 | 3 | 11 | 6 | 5 | 25 |
| Total | | 32 | 26 | 32 | 23 | 113 |

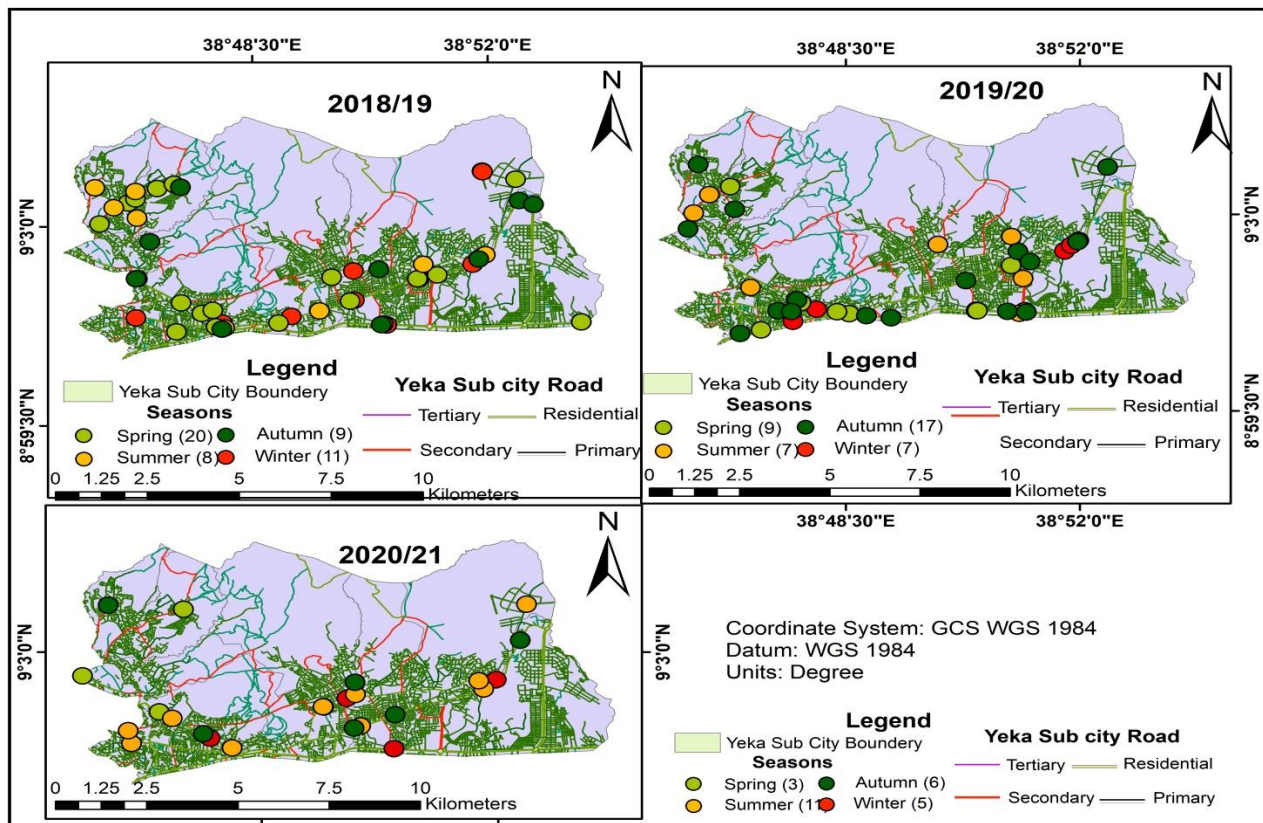


Figure 28: Seasonal spatial pattern of road traffic fatalities accidents

Road traffic fatality accidents were dedicated from 2018/19 up to 2020/21. In 2018/19 road traffic fatality accidents were high in spring than summer, autumn and winter seasons. In 2019/20 road traffic fatality accidents were high in autumn than spring, summer and winter seasons. In 2020/21 road traffic fatality accidents were high in summer than spring, autumn and winter seasons (Figure 28). In spring and autumn seasons, there was rain, so during this seasons braking system is abnormal and also the driver behavior has main role in this case like violate lighting rules, using alcohol, using cell phone, use over speed etc.

In General, spatial distribution about road traffic fatality accidents across study areas were not regularly allocate in spot area, rather it's dense in some area and sparse in others parts of the study area. The all over three years seasonal pattern of road traffic fatality accidents were 32 in spring, 26 in summer, 32 in autumn and 23 in winter season, so in spring and autumn season the results showed high instead of 2018/19, 2019/20 and 2020/21 (Figure 28).

4.2.7.2. Seasonal Pattern of Hazardous Train Station Traffic Accidents

The arrangement of hazardous train station traffic accidents were enlarged on the period of season. During the study time 2018/19, 2019/20 and 2020/21 hazardous train station traffic accidents dedicated 6, 5, 1, and 5 were performed during autumn, winter; spring and summer season respectively (Table 15).

Table 15: Seasonal hazardous train station traffic accidents record on *yeka* sub city

| Type of Accident | Number of hazardous train station traffic accidents dedicated on railway | | | | | |
|---|--|--------|--------|--------|--------|-------|
| | Seasons | | | | | |
| | year | Spring | Summer | Autumn | Winter | Total |
| hazardous train station traffic accidents | 2018/19 | 2 | 1 | 1 | 0 | 4 |
| | 2019/20 | 1 | 2 | 0 | 2 | 5 |
| | 2020/21 | 3 | 2 | 0 | 3 | 8 |
| Total | | 6 | 5 | 1 | 5 | 17 |

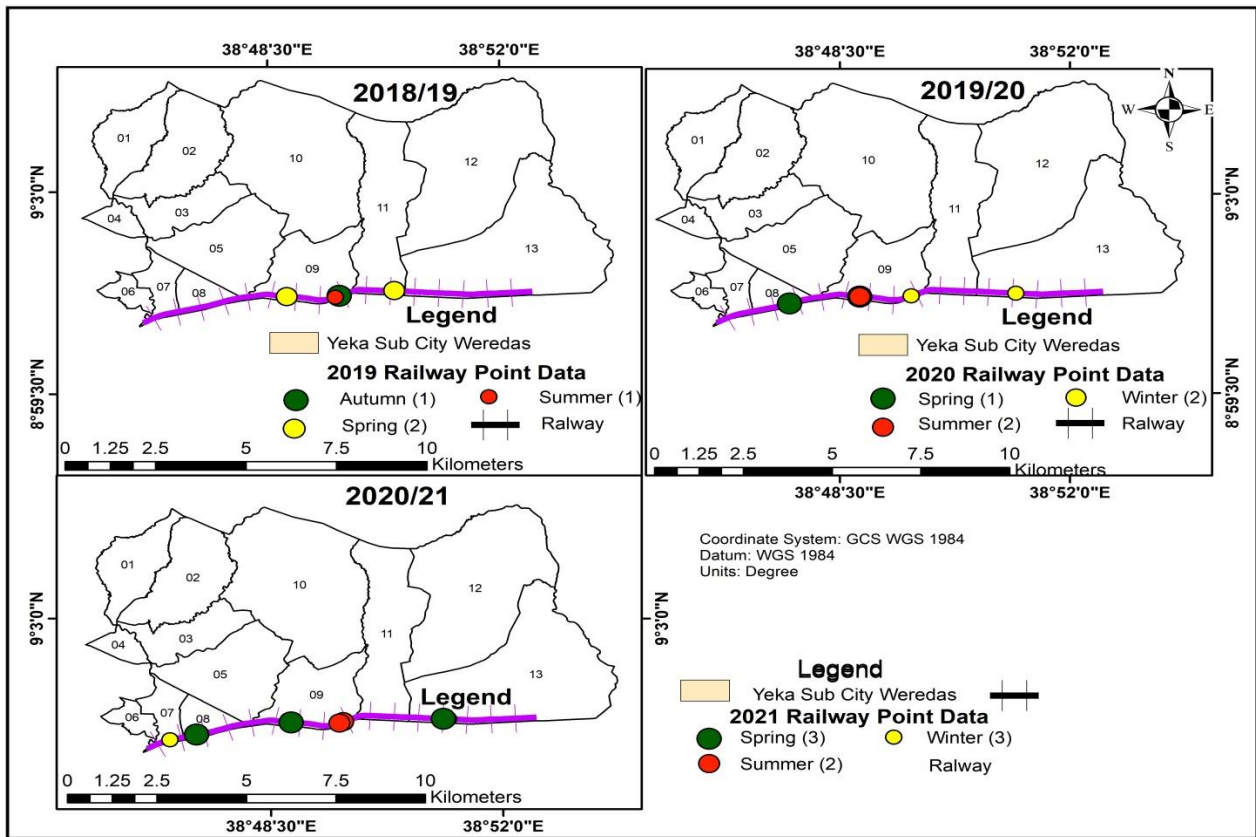


Figure 29: Seasonal pattern of hazardous train station traffic accidents

Hazardous train station traffic accidents were dedicated from 2018/19 up to 2020/21. In 2018/19 hazardous train station traffic accidents were high in spring than summer, autumn seasons but there were no hazardous train station traffic accidents in winter season. In 2019/20 hazardous train station traffic accidents were high summer and winter than spring seasons but there was no hazardous train station traffic accidents in autumn season. In 2020/21 hazardous train station traffic accidents were high spring and winter than summer but there were no hazardous train station traffic accidents in autumn season.

In General, spatial distribution of hazardous train station traffic accidents across study areas were not regularly allocate. The all over three years seasonal pattern of hazardous train station traffic accidents were 6 in spring, 5 in summer, 1 in autumn and 5 in winter season, so in spring, autumn and winter seasons the results showed high but in autumn season there was few hazardous train station traffic accidents committed, because of the driver behavior had main role in this case like violate lighting rules, using alcohol, using cell phone, use over speed, negligence etc. (Figure 32).

4.3. Traffic Accidents Hotspot Analysis

4.3.1. Road Traffic Fatality Accidents Hot Spot Analysis by Using IDW

IDW (Inverse Distance Weight) is one of the most important methods to identify hot spot and cold spot area from the given data's. The figure shows road traffic fatality accidents hot spot and cold spot areas. The white color indicates the area where road traffic fatality accident events were very high, whereas green color indicates very low traffic fatality accidents.

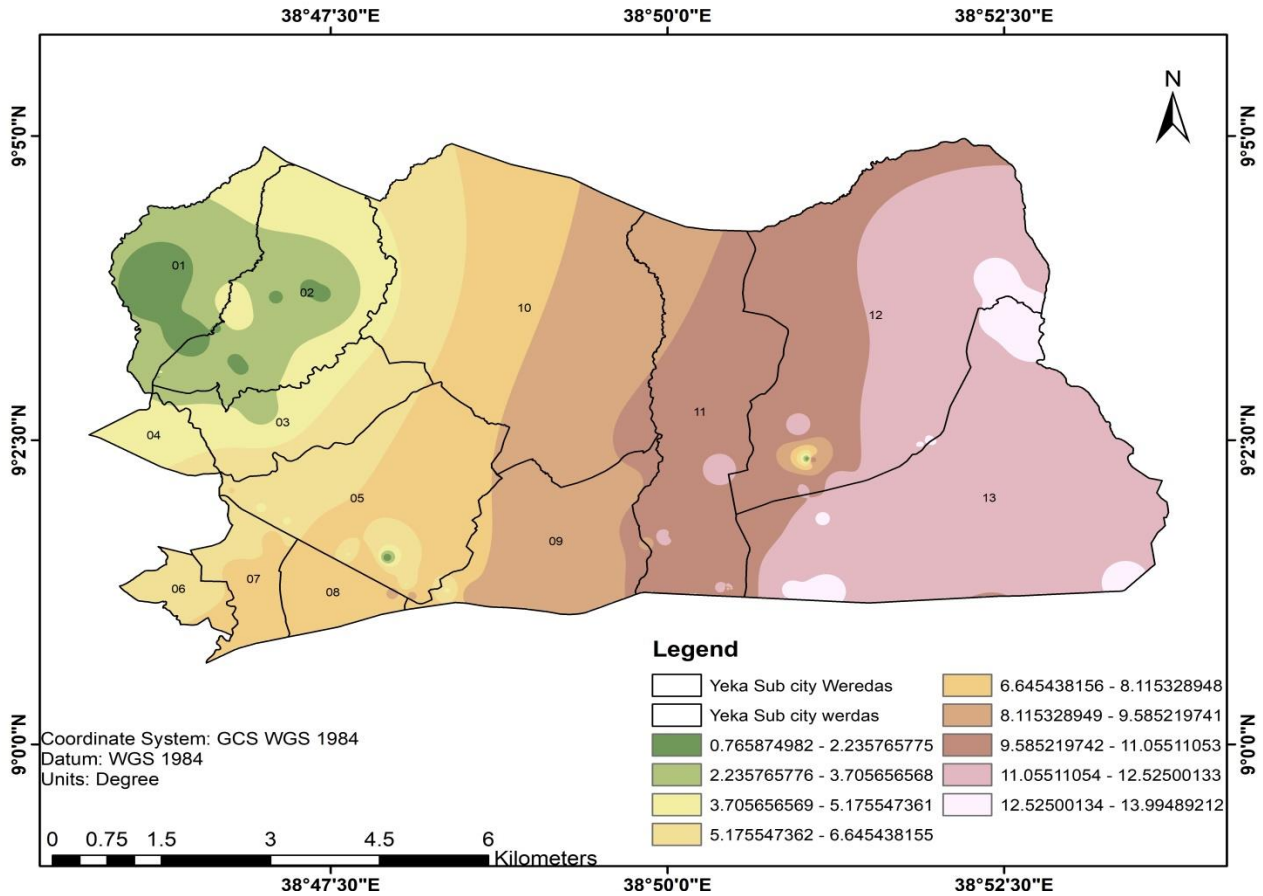


Figure 30: Road traffic fatality accidents hotspot and cold spot area by using IDW

During the study period (2018/19-2020/21), hot spot road traffic fatality accidents were relatively very high in wereda 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13 of the study area, whereas relatively low in wereda 1 and 2 and at the tip of wereda 3 of study area, because of the drivers were violate different rules such as violate lighting rule, using alcohol, using cell phone, negligence and also driver drive the vehicle by using over speed etc. (Figure 30).

4.3.2. Hazardous Train Station Traffic Accidents Hot Spot Analysis by Using IDW

The figure is showing hazardous train station traffic fatality accidents hot spot and cold spot areas. The white color indicates the area where road traffic fatality accident events were very high occurred, whereas green color indicates very low traffic fatality accidents.

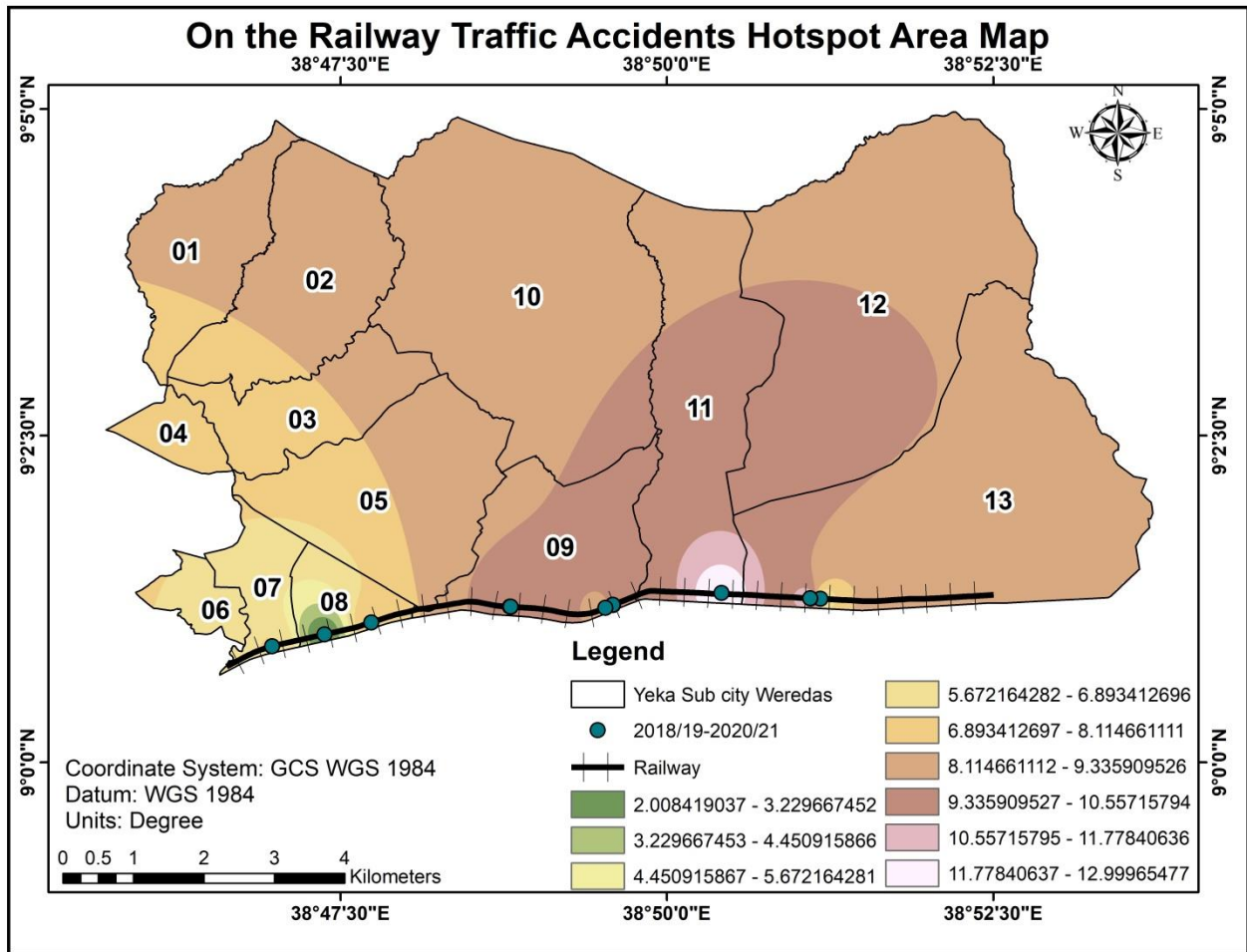


Figure 31: Hazardous train station traffic accidents hotspot and cold spot area by using IDW

During the study period (2018/19-2020/21), hot spot of hazardous train station traffic accidents were relatively very high in wereda 5, 7, 9, 11 and 13 of the study area, whereas relatively low in wereda 8 of study area because of the drivers were violate different rules such as violate lighting rule, using alcohol, using cell phone, negligence and also driver drive the vehicle by using over speed etc. (Figure 31).

4.3.3. Annual Road Fatalities Traffic Accidents Hotspot Analysis by Using IDW

Based on IDW results, shows the road traffic fatality accidents hot spot and cold spot areas. The white color indicates the area where road traffic fatality accident events were very high occurred, whereas green color indicates very low traffic fatality accidents (Figure 32).

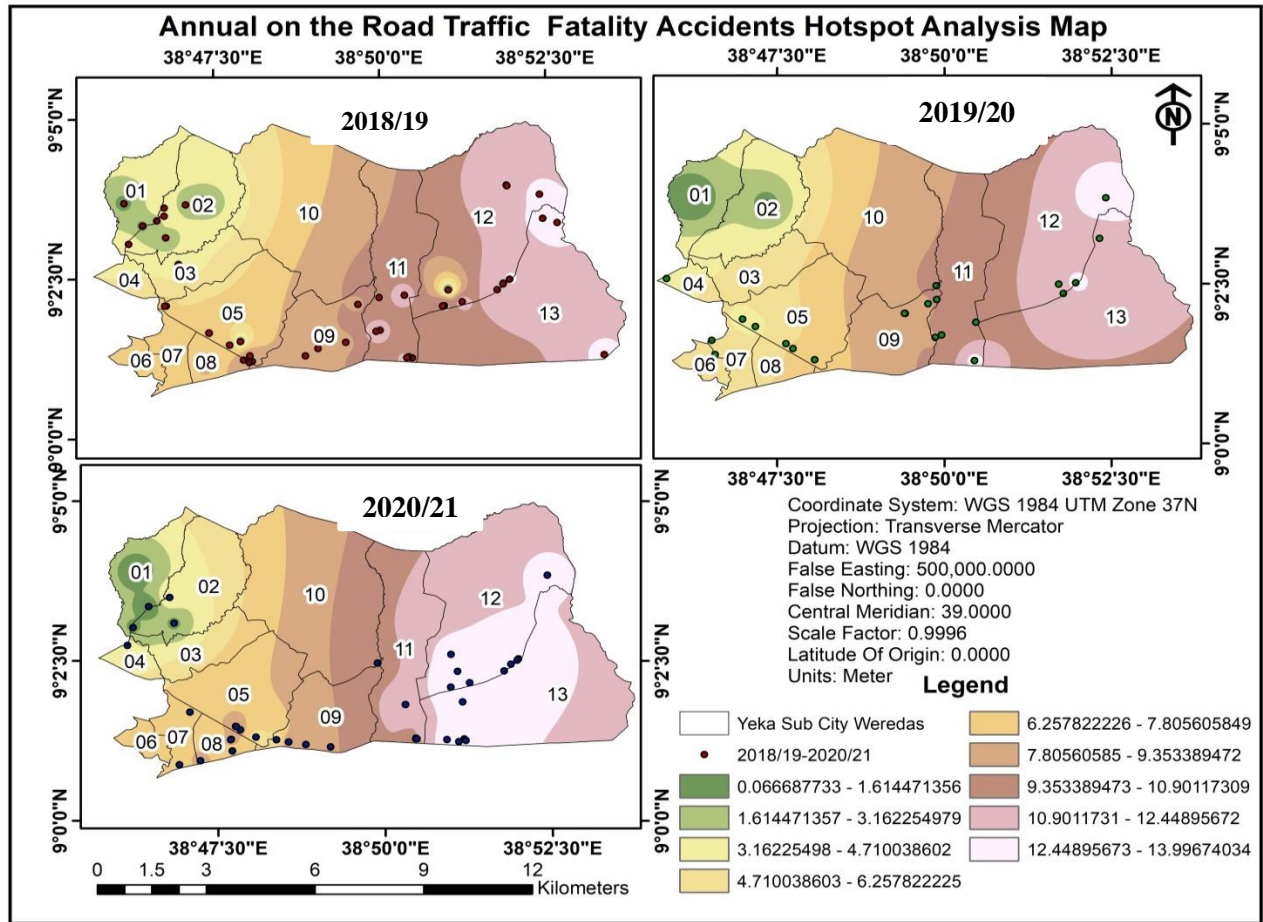


Figure 32: Annual road traffic fatalities accidents hotspot analysis map

During the study period 2018/19, the above figure shows the hot spot road traffic fatality accidents were relatively very high in wereda 3,4,5,6,7,8,9,10,11,12 and 13, whereas relatively low in wereda 1 and 2, in 2019/20 the hot spot road traffic fatality accidents were relatively very high in wereda 3,4,5,6,7,8,9,10,11,12 and 13, whereas relatively low in wereda 1 and 2, and in 2020/21 the hot spot road traffic fatality accidents were relatively very high in wereda 3,4,5,6,7,8,9,10,11,12 and 13, whereas relatively low in wereda 1 and 2, because the drivers were violate lighting rule, using alcohol, using cell phone, negligence and also driver drive the vehicle by using over speed (Figure 32).

4.3.4. Annual Hazardous Train Station Traffic Accidents Hotspot Analysis by Using IDW

Based on IDW results, shows about hazardous train station traffic accidents hot spot and cold spot areas. The white color indicates the area where hazardous train station traffic accident events were very high, whereas green color indicates very low traffic accidents (Figure 33).

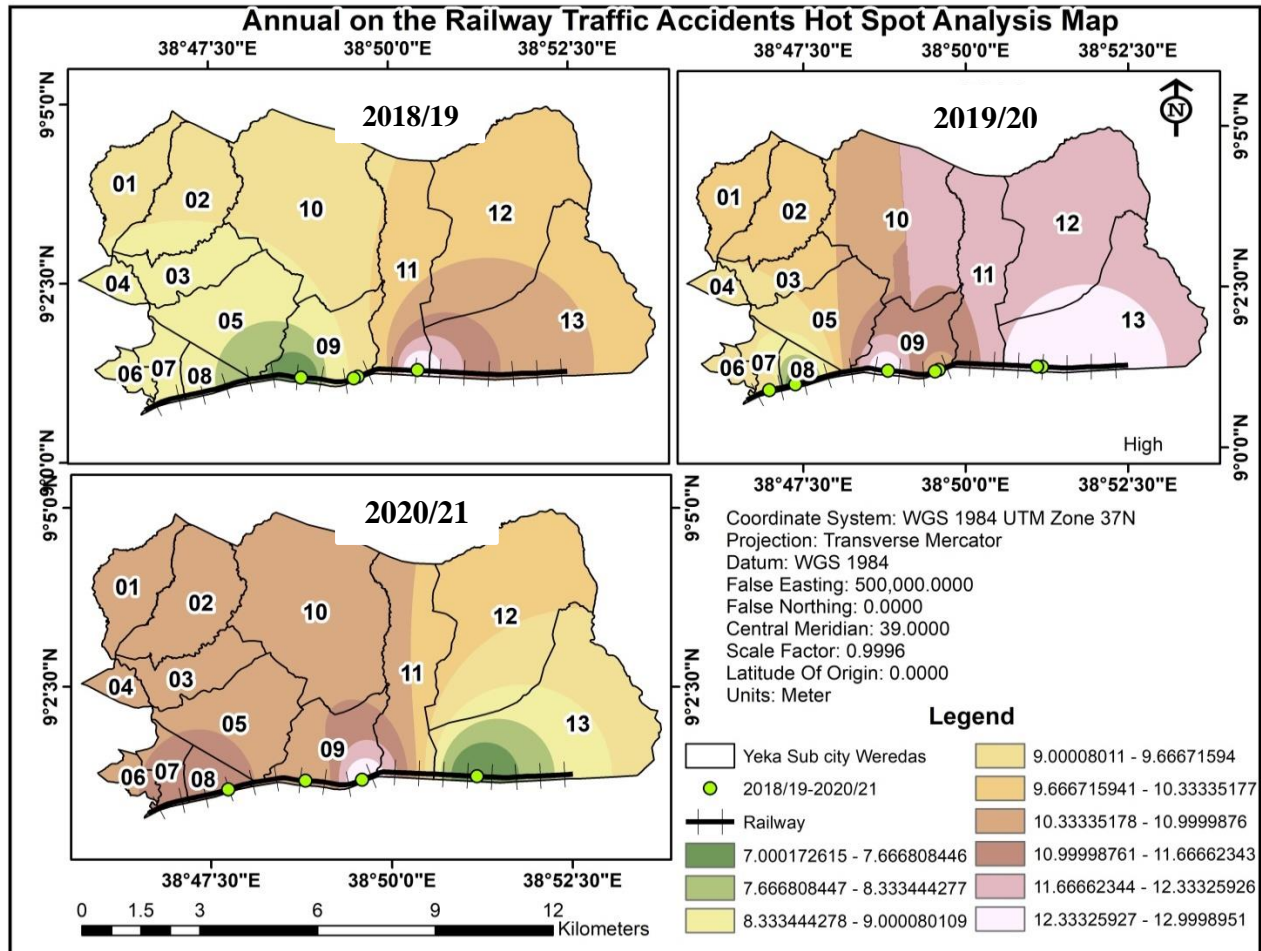


Figure 33: Annual hazardous train station traffic accidents hot spot analysis map

During the study period 2018/19, the above figure shows the hotspot hazardous train station traffic accidents were relatively very high in wereda 7, 11 and 13, whereas relatively low in wereda 5, 8 and 9, in 2019/20 hotspot hazardous train station traffic accidents were relatively very high in wereda 5,7,9,11 and 13, whereas relatively low in wereda 8, and in 2020/21 hotspot hazardous train station traffic accidents were relatively very high in wereda 5, 7, 8, 9 and 11, whereas relatively low in wereda 13, because the drivers were violate traffic rules, like lighting, use alcohol, used cell phone etc. and also driver drive the vehicle by using over speed (Figure 33).

4.4. Suggested Counter measure for the Designated Hot Spot Road Segment

4.4.1. Megenagna, Kotebe Kara and Gurd Shola Road Segment

Around Megenagna, Kotebe Kara and Gurd Shola road segments were detected by way of the greatest susceptible and hazardous section suggested by GIS based kernel density investigation and investigation constructed by location.

Data Analysis: The data designated road traffic fatality accidents were around 16 fatality accidents involved at around Megenagna road segments by way of the study period. Greatest fatal accidents stayed caused by collision among truck, outstanding to Priority prohibition and failure to give way for pedestrian. The data designated road traffic fatality accidents were around 25 fatality accidents complicated at around Kotebe Kara road parts within the study period. Supreme fatal accidents were caused by collision between truck, Priority prohibition, failure to give way for pedestrian and driver drive a car by using high speed. And also the data indicated hazardous train station traffic accidents were around 9 accidents were involved on around Gurd Shola train station fragments by way of study period.

Supreme of the fatal accidents stayed caused by inadequate distance. In both areas the accidents were recorded between the time intervals from 6:01 (12:01 AM) to 12:00 (6:00 AM).

Main accident causes: - Priority prohibition, failure to give way for walkers (pedestrians) and inadequate distance.

Place examination: the road is located around Megenagna, Kotebe Kara and Gurd Shola. Greatest of the accidents were locations around commercial area, school, and large stores and lighting area. Due to those kinds of causes, it could invite walkers (pedestrians) and trucks. For the period of the site official visit the researcher observed that road was in upright condition. Subsequently the road around Megenagna is gentle gradient but around at Gurd Shola and Kotebe Kara has little bit steep gradient, mainly the place somewhere openly linked to the ring road.



Figure 34: Around Megenagna road section (Hot Spot)



Figure 35: Around Kotebe Kara road section (Hot Spot)



Figure 36: Around Gurd Shola hazardous train station division (Hot Spot)

Most trucks are moved by way of high speed once they arrive into the road. Furthermore, road points of reference and traffic symbols were deficient in beginning some portions of the road.

Suggested Counter measure: The suggested counter measures is important to decreasing walkers (pedestrian) coverage to trucks and develop visibility among walkers (pedestrian) and truck:

A. Decrease walkers (pedestrian) coverage to trucks

- The authority expert ought to construct speediness restrictions marks that are proper to the main purpose of the road make available a balance among mobility and care for road users.
- By way of a speed reduction measure, breaker ought to use on gentle and steep-slop areas.
- Road traffic fatality accidents and hazardous train station traffic accidents attentiveness promotions for road consumers ought to accomplished for the close area.
- Traffic polices ought to distributed to implement traffic guidelines and support walkers (pedestrians) throughout passage the road, particularly on the day at what time most of the mortal accidents recorded.
- Severe and fixed regulation implementation ought to be applied on the walkers (pedestrian).

- The government road maker must give priority to pedestrian when they try to create the road by making metal coverage to isolate from the road to pedestrian.

B. Develop visibility among motor trucks and walkers (pedestrians).

- Offer street light to avoid night road traffic fatality accidents and hazardous train station traffic accidents.
- Cross walk improvements round out with warning signs and detectable cross walk marks ought to be delivered.
- Traffic marks demonstrating speed decline, and unsafe places ought to be presentation on the start of the section.
- Trucks ought not stopover so nearby to the cross walk (Zebra) and on the bridge. For that reason, prevention of stop sign ought to be placed in advance 20-50 meters.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Road traffic fatality accidents are nowadays universal badly behaved problems in addition to one of the chief developing problems in Addis Ababa. To escape and decrease this tricky a number of studies were conduct and several researchers used various styles. By way of the enlargement of supercomputer technology, there must have spatial evidence to investigate proceeding on maps. ArcGIS compromises a significant instrument designed for exploration about road traffic fatality accidents and hazardous train station traffic accident databases.

Traffic accidents can be posing by spatial information. The location about road traffic fatality and hazardous train station traffic accidents were identified by their position, subsequently the spatial information be situated challenging to present if it is not renewed into coordinates. By means of the help of geocoding implements, spatial geographic coordinates about road traffic fatality and hazardous train station traffic accidents were produce. Road traffic fatality and hazardous train station traffic an accident is close spatial connection by way of the road network. That one was stress-free (easy) to apply GIS to fix the road network, wherever each road traffic fatality and hazardous train station traffic accidents were happened, and exactly how many fatality and accidents were happen on every road and hazardous train station network respectively.

This paper presented the general characteristics and mapping about road traffic fatality and hazardous train station traffic accidents were distribute along ‘*Yeka*’ sub-city road system. Road traffic fatality accidents were decreased as of year to year, but hazardous train station traffic accidents were increased as of year to year in the interior of study period research. The supplementary features had designated that road traffic fatality accidents were high on Saturday, but hazardous train station traffic accidents were high on Friday which was the take a break (weekend) and the people entertain by using alcohol. Particularly, among the time interval of 6:01 (12:01 AM) to 12:00 (6:00 AM) and 18:01 (12:01) to 24:00 (6:00) were the most venerable. Most of the fatalities about road traffic fatality and hazardous train station traffic accidents were cause by vehicle plate code three. Based on cause, not giving priority to pedestrian were the key causes as of the documented road fatality accidents causes, but using cell phone on hazardous train station was the main cause from recorded traffic accidents. In addition, based on seasonal pattern road traffic fatalities accidents were high in spring and autumn seasons, but on the hazardous train station

traffic accidents were high in spring season. This paper approved the method that took significant clustered hotspots and coldspots based on ArcGIS investigation to detect accident exposed along Yeka sub-city road system.

Finally, road traffic fatality and hazardous train station traffic accidents were predict based on IDW (inverse distance weight) method based on the accidents occurred place where. This method predicted the accidents were occurred place where on the unfamiliar location constructed the neighborhood known accidents. As of this method, it were clear that road traffic fatality accidents were relatively very high in wereda 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13, whereas relatively low in wereda 1 and 2 of study area, but on the hazardous train station traffic accidents were relatively very high in wereda 7, 9, 11 and 13, whereas relatively low in wereda 5 and 8 of study area.

5.2. Recommendation

Because of the lack of well-organized data, Yeka sub-city road network traffic fatality and hazardous train station traffic accidents datasets were not simplified easily in to the centerline of the road. In the upcoming research, happening command to create the consequences more precise, the network road traffic fatality and hazardous train station traffic accidents dataset must be advanced if important evidence was available.

Now this study, the researcher simply attentive on detecting the locations where round road traffic fatality and on the hazardous train station traffic accidents commonly happened. The following step is to study the factors that may influence traffic accident data and how to implement any rules to reduce road traffic fatality and hazardous train station traffic accidents. Single methods to distinguish these influences were: to study the likenesses between traffic fatality accidents prone areas to decrease the accidents. Subsequently that transportation organization can proceeds correct movements to avoid the accident from up-to-the-minute by control these aspects. Ethiopian police institution at any level should formulate accidents data collection standard (attribute) that useful for traffic accidents mapping and analysis. All police commission institution at federal and regional level collaborated with others higher education institutions should be prepared education curriculum of the geospatial technology of GIS for different traffic accidents prevention, accidents investigation.

In addition, Police organization should be prepares different types of term training to police members on how to gather the spatial location about traffic accidents event in different methods of

spatial data collection like by GPS, different geospatial application available in smart phone, and Google earth. This makes the analysis easy and more accurate.

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Annexes

Annex 1: Yeka sub-city road traffic fatality accidents (2018/19 to 2020/21) on Excel

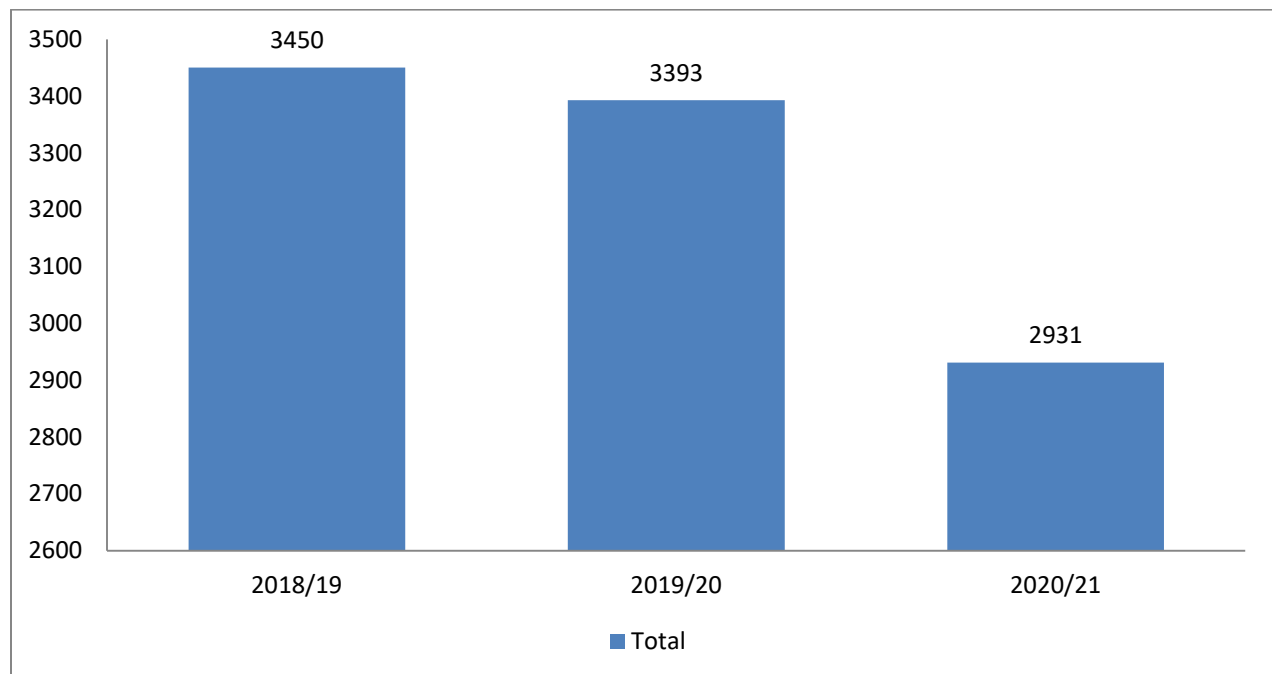
| No | Latitude | Longitude | Elevation | Place of accident | The Seasons | Sea | Arrive | Accidents | Accident | Day | Sex | Time | Cond | Date of acci | Age | Education | Driving ex | Kind of ve | Car code | Vehicle us | Vehicle dr | Kind of ro | Clima |
|----|----------|-----------|-----------|-------------------|-------------|-----|--------|------------|-------------|--------|--------|------|-------|--------------|-----|-----------|------------|----------------|----------|------------|------------|------------|-------|
| 1 | 9.066379 | 38.86529 | 2540 | Yeka Abac | 12 Winter | 4 | Death | Vehicle tc | Enough di | Wedn | Male | 500 | Morn | 20/10/2010 | 25 | | 8 | 1 Isuzu | 1-22323 | 9 | Without | Asphalt Rr | Good |
| 2 | 9.034821 | 38.84953 | 2456 | In front of | 12 Winter | 4 | Death | Vehicle tc | Priority pi | Mon | Male | 1000 | Night | 16/11/2010 | 32 | | 10 | 4 Isuzu | 3- 65986 | | Without | Asphalt Rr | Good |
| 3 | 9.037077 | 38.83343 | 2465 | In front of | 11 Winter | 4 | Death | Vehicle tc | Priority pi | Thurs | Female | 730 | Day | 19/10/2010 | 22 | | 10 | 2 Pickup | 3A-49733 | | Without | Asphalt Rr | Good |
| 4 | 9.039108 | 38.86301 | 2546 | Kara on th | 12 Winter | 4 | Death | Vehicle tc | Priority pi | Friday | Male | 2030 | Night | 20/11/2010 | 29 | | 12 | 2 Isuzu | 3-77871 | | Without | Asphalt Rr | Good |
| 5 | 9.023753 | 38.81811 | 2401 | Lamberet | 9 Winter | 4 | Death | Vehicle tc | Steering \ | Mon | Male | 1630 | Night | 23/11/2010 | 69 | Diploma | | 25 Pickup | 2A-5572 | 12 | Without | Asphalt Rr | Good |
| 6 | 9.028528 | 38.83365 | 2420 | Wesen gr | 11 Winter | 4 | Death | Vehicle tc | Steering \ | Mon | Female | 1830 | Morn | 21/11/2010 | 40 | | 12 | 10 Isuzu | 3-14425 | 15 | Without | Asphalt Rr | Good |
| 7 | 9.021294 | 38.84172 | 2389 | In front of | 11 Winter | 4 | Death | Vehicle tc | Priority pi | Sunda | Male | 830 | Day | 20/11/2010 | 28 | Degree | | 4 Minibus | 3A-58016 | | Without | Asphalt Rr | Good |
| 8 | 9.06623 | 38.86542 | 2539 | Yeka Abac | 12 Winter | 4 | Death | Vehicle tc | Priority pi | Sunda | Female | 830 | Day | 20/11/2010 | 26 | Degree | | 2 Yaris | 2A-12555 | | Without | Asphalt Rr | Good |
| 9 | 9.034902 | 38.84973 | 2458 | In front of | 12 Winter | 4 | Death | Vehicle tc | Steering \ | Thurs | Female | 900 | Day | 25/12/2010 | 35 | Degree | | 5 Land cros | 2B-10090 | 10 | Without | Asphalt Rr | Good |
| 10 | 9.021834 | 38.80101 | 2396 | Megenagr | 10 Winter | 4 | Death | Vehicle tc | Priority pi | Thurs | Male | 730 | Day | 24/12/2010 | 28 | Diploma | | 4 Bajaj | 1-07040 | | Without | Asphalt Rr | Good |
| 11 | 9.023322 | 38.77959 | 2377 | Adwa brid | 7 Winter | 4 | Death | Vehicle tc | Priority pi | Sunda | Male | 400 | Morn | 27/12/2010 | 50 | | 9 | 20 Minibus | 3A-11910 | 12 | Without | Asphalt Rr | Good |
| 12 | 9.021571 | 38.84086 | 2391 | In front of | 8 Spring | 1 | Death | Vehicle tc | Priority pi | Mon | Male | 200 | Morn | 5/1/2011 | 28 | Degree | | 2 Dolfin | 3-29867 | | Without | Asphalt Rr | Good |
| 13 | 9.034842 | 38.84935 | 2455 | In front of | 9 Spring | 1 | Death | Vehicle tc | Steering \ | Friday | Male | 200 | Eveni | 4/1/2010 | 34 | 10+1 | | 4 Minibus | 4-23365 | 4 | Without | Asphalt Rr | Good |
| 14 | 9.057014 | 38.77764 | 2528 | Ferencay | 2 Spring | 1 | Death | Vehicle tc | Priority pi | Satur | Male | 215 | Morn | 12/1/2011 | 40 | | 12 | 4 Minibus | 3-11310 | 25 | Without | Asphalt Rr | Good |
| 15 | 9.024613 | 38.79593 | 2398 | Shola Ligh | 8 Spring | 1 | Death | Vehicle tc | Steering \ | Satur | Female | 130 | Morn | 12/1/2011 | 26 | Degree | | 4 Minibus | 3-97073 | | Without | Asphalt Rr | Good |
| 16 | 9.020725 | 38.79945 | 2384 | Megenagr | 9 Spring | 1 | Death | Vehicle tc | Steering \ | Mon | Male | 1100 | Morn | 21/1/2011 | 40 | | 10 | 10 Sheger bu | 3A-42818 | 6 | Without | Asphalt Rr | Good |
| 17 | 9.061214 | 38.78479 | 2563 | Ferencay | 2 Spring | 1 | Death | Vehicle tc | With out \ | Sunda | Female | 2030 | Day | 20/1/2011 | 25 | Diploma | | 1 Minibus | 3- 54546 | | Without | Asphalt Rr | Good |
| 18 | 9.058219 | 38.77945 | 2544 | Ferencay | 5 Spring | 1 | Death | Vehicle tc | Priority pi | Sunda | Male | 900 | Day | 14/1/2011 | 28 | 10+1 | | 4 Minibus | 3-53711 | | Without | Asphalt Rr | Good |
| 19 | 9.028254 | 38.83266 | 2417 | In front of | 12 Spring | 1 | Death | Vehicle tc | Steering \ | Wedn | Male | 650 | Day | 23/1/2011 | 26 | 10+3 | | 3 Pickup | 3-45115 | 10 | Without | Asphalt Rr | Good |
| 20 | 9.050863 | 38.77055 | 2485 | In front of | 4 Spring | 1 | Death | Vehicle tc | Priority pi | Tuesd | Male | 1640 | Eveni | 29/12/2010 | 53 | | 12 | 5 Dolfin | 3-27138 | 5 | Without | Asphalt Rr | Good |
| 21 | 9.027736 | 38.79077 | 2414 | In front of | 8 Spring | 1 | Death | Vehicle tc | Priority pi | Thurs | Male | 2230 | Day | 1/2/2011 | 35 | 10+2 | | 2 Anbesa bu | 3-77574 | | Without | Asphalt Rr | Good |
| 22 | 9.025548 | 38.79862 | 2411 | In front of | 1 Spring | 1 | Death | Vehicle tc | Priority pi | Friday | Male | 1100 | Night | 2/2/2011 | 25 | | 10 | 5 Isuzu | 3A-05473 | | Without | Asphalt Rr | Good |
| 23 | 9.035269 | 38.82809 | 2456 | O2 Square | 9 Spring | 1 | Death | Vehicle tc | Priority pi | Sunda | Male | 930 | Day | 11/2/2011 | 31 | | 10 | 4 Higher bu | 3-44676 | | Without | Asphalt Rr | Good |
| 24 | 9.02219 | 38.88992 | 2405 | In front of | 13 Spring | 1 | Death | Vehicle tc | Priority pi | Mon | Male | 420 | Eveni | 12/2/2011 | 28 | 10+3 | | 2 Aysuzu | 3-44311 | 10 | Without | Asphalt Rr | Good |
| 25 | 9.019231 | 38.78966 | 2366 | In front of | 8 Spring | 1 | Death | Vehicle tc | Priority pi | Wedn | Male | 545 | Morn | 14/2/2011 | 30 | | 10 | 3 Dolfin | 3-55440 | 2 | Without | Asphalt Rr | Good |
| 26 | 9.034785 | 38.77995 | 2413 | In front of | 6 Spring | 1 | Death | Vehicle tc | Priority pi | Sunda | Male | 1100 | Morn | 25/2/2011 | 26 | | 10 | 2 Lifan | 2A-93873 | 3 | Without | Asphalt Rr | Good |
| 27 | 9.062514 | 38.78897 | 2597 | Ferencay | 3 Spring | 1 | Death | Vehicle tc | Steering \ | Satur | Male | 600 | Day | 23/2/2011 | 28 | 10+4 | | 4 Minibus | 3-61901 | | Without | Asphalt Rr | Good |
| 28 | 9.064018 | 38.8736 | 2484 | Abaso Coc | 13 Spring | 1 | Death | Vehicle tc | Priority pi | Satur | Male | 100 | Morn | 15/3/2011 | 29 | | 8 | 3 Bajaj | 1-40399 | | Without | Asphalt Rr | Good |
| 29 | 9.040804 | 38.86452 | 2567 | Kara Squa | 12 Spring | 1 | Death | Vehicle tc | Steering \ | Thurs | Male | 2340 | Morn | 13/3/2011 | 30 | | 10 | 4 Vitz | 2A-06502 | 10 | Without | Asphalt Rr | Good |
| 30 | 9.035991 | 38.85425 | 2485 | In front of | 12 Spring | 1 | Death | Vehicle tc | Priority pi | Friday | Male | 1730 | Morn | 28/3/2011 | 50 | 10+1 | | 10 Pickup | 2B-07393 | | Without | Asphalt Rr | Good |
| 31 | 9.021801 | 38.81491 | 2400 | In front of | 9 Spring | 1 | Death | Vehicle tc | Priority pi | Mon | Male | 2030 | Night | 8/3/2011 | 46 | Diploma | | 2 Vitz | 2-52525 | | Without | Asphalt Rr | Good |
| 32 | 9.060392 | 38.77945 | 2544 | In front of | 5 Summer | 2 | Death | Vehicle tc | Steering \ | Tuesd | Male | 600 | Day | 17/4/2011 | 40 | | 10 | 4 Anbesa bu | 2-70790 | | Without | Asphalt Rr | Good |
| 33 | 9.041884 | 38.8661 | 2564 | Kara Beg T | 13 Summer | 2 | Death | Vehicle tc | Priority pi | Thurs | Male | 830 | Day | 1/5/2011 | 25 | | 12 | 1 Minibus | 3-24270 | 20 | Without | Asphalt Rr | Good |
| 34 | 9.052572 | 38.77984 | 2507 | Ferencay | 2 Summer | 2 | Death | Vehicle tc | With out \ | Sunda | Male | 700 | Day | 10/5/2011 | 29 | | 10 | 5 Vitz | 3-75395 | | Without | Asphalt Rr | Good |
| 35 | 9.055629 | 38.77407 | 2524 | Kela | 1 Summer | 2 | Death | Vehicle tc | Steering \ | Thurs | Female | 1230 | Eveni | 15/5/2011 | 28 | | 11 | 4 Yaris | 3-58987 | 15 | Without | Asphalt Rr | Good |
| 36 | 9.020385 | 38.80158 | 2385 | On Ring M | 9 Summer | 2 | Death | Vehicle tc | Priority pi | Satur | Male | 1300 | Eveni | 18/5/2011 | 43 | | 12 | 10 Tesabi | 3-02554 | 15 | Without | Asphalt Rr | Good |
| 37 | 9.039075 | 38.85075 | 2494 | Kotebe Mesal | Summer | 2 | Death | Vehicle tc | Adequate | Thurs | Female | 700 | Morn | 28/5/2011 | 22 | Diploma | 2 Months | Yaris | 2A-56483 | | Without | Asphalt Rr | Good |
| 38 | 9.025383 | 38.82506 | 2400 | In front of | 9 Summer | 2 | Death | Vehicle tc | Priority pi | Friday | Male | 1200 | Day | 8/6/2011 | 46 | | 12 | 15 Sinotrak | 3-07546 | 10 | Without | Asphalt Rr | Good |
| 39 | 9.061484 | 38.76939 | 2528 | 22 Kebele | 1 Summer | 2 | Death | Vehicle tc | Priority pi | Wedn | Male | 1700 | Day | 27/6/2011 | 31 | | 10 | 1 Land cros | 4-03907 | 15 | Without | Asphalt Rr | Good |
| 40 | 9.034769 | 38.77963 | 2413 | In front of | 7 Autumn | 3 | Death | Vehicle tc | Priority pi | Wedn | Male | 1500 | Night | 18/7/2011 | 40 | | 12 | 10 Isuzu | 3-22505 | | Without | Asphalt Rr | Good |
| 41 | 9.06166 | 38.79059 | 2605 | In front of | 2 Autumn | 3 | Death | Vehicle tc | To the be | Sunda | Female | 903 | Day | 6/8/2011 | 40 | Diploma | | 7 Vitz | 2-45987 | 10 | Without | Asphalt Rr | Good |
| 42 | 9.057755 | 38.87445 | 2476 | Gedera sq | 13 Autumn | 3 | Death | Vehicle tc | Priority pi | Sunda | Female | 800 | Day | 6/8/2011 | 26 | 10+4 | | 2 Minibus | 3-91851 | 8 | Without | Asphalt Rr | Good |
| 43 | 9.045602 | 38.78307 | 2479 | Yeka were | 3 Autumn | 3 | Death | Vehicle tc | Steering \ | Mon | Male | 1730 | Morn | 14/8/2011 | 26 | | 8 | 4 Minibus | 3-68945 | 10 | Without | Asphalt Rr | Good |
| 44 | 9.037637 | 38.83972 | 2471 | In front of | 12 Autumn | 3 | Death | Vehicle tc | Steering \ | Tuesd | Female | 1830 | Eveni | 29/8/2011 | 32 | | 10 | 4 Aysuzu | 3-09469 | 10 | Without | Asphalt Rr | Good |
| 45 | 9.02004 | 38.80091 | 2384 | In front of | 7 Autumn | 3 | Death | Vehicle tc | Steering \ | Satur | Male | 400 | Morn | 3/9/2011 | 54 | Degree | | 10 Taxi | 2-75042 | 10 | Without | Asphalt Rr | Good |
| 46 | 9.056658 | 38.87804 | 2454 | Tafo Squa | 14 Autumn | 3 | Death | Vehicle tc | Steering \ | Satur | Male | 1030 | Day | 24/9/2011 | 28 | | 10 | 5 Minibus | 3-49891 | 19 | Without | Asphalt Rr | Good |
| 47 | 9.021394 | 38.84036 | 2392 | In front of | 13 Autumn | 3 | Death | Vehicle tc | Steering \ | Satur | Male | 300 | Morn | 24/9/2011 | 41 | Degree | | 10 Moter cycle | | 3 | Without | Asphalt Rr | Good |
| 48 | 9.04064 | 38.8645 | 2567 | Kara Squa | 12 Autumn | 3 | Death | Vehicle tc | Adequate | Sunda | Male | 2130 | Morn | 25/9/2011 | 30 | 10+4 | | 5 Atoz | 2A-65931 | | Without | Asphalt Rr | Good |
| 49 | 9.021571 | 38.84086 | 2391 | In front of | 13 Winter | 4 | Death | Vehicle tc | Steering \ | Tuesd | Male | 1400 | Morn | 30/11/2011 | 28 | | 10 | 3 Bajaj | 1-67256 | | Without | Asphalt Rr | Good |

| | | | | | | | | | | | | | | | | | | | | |
|-----|----------|----------|------|-------------|----|--------|---|-------|-------------------------------------|------|-------|------------|----|---------|----------------|--------------|-----------|---------|-----------------|------------------|
| 50 | 9.021834 | 38.80101 | 2396 | Megenagr | 5 | Winter | 4 | Death | Vehicle tc Priority pi Saturd Male | 325 | Morn | 5/12/2011 | 54 | 9 | 4 | Minibus | 3-12179 | 15 | Without | Asphalt Rr Good |
| 51 | 9.039088 | 38.86284 | 2544 | Kara on th | 12 | Winter | 4 | Death | Vehicle tc With out r Friday Male | 100 | Morn | 17/12/2011 | 50 | 10 | 2 | Pickaup | ?/?-09259 | 2 | Without | Asphalt Rr Good |
| 52 | 9.018225 | 38.79511 | 2373 | In front of | 7 | Winter | 4 | Death | Vehicle tc Steering \ Thursc Femak | 530 | Morn | 16/12/2011 | 45 | 11 | 1 | Isuzu | 3A-20368 | | Without | Asphalt Rr Good |
| 53 | 9.021218 | 38.79481 | 2382 | Shola met | 8 | Winter | 4 | Death | Vehicle tc Steering \ Tuesdi Male | 1445 | Eveni | 21/12/2011 | 69 | 10 | 15 | Anbesa bl | 4-17554 | 8 | Without | Asphalt Rr Good |
| 54 | 9.021376 | 38.84081 | 2391 | In front of | 5 | Winter | 4 | Death | Vehicle tc Priority pi Saturd Male | 1930 | Morn | 25/12/2011 | 48 | 10+4 | 15 | Higher bu | 3-46513 | | Without | Asphalt Rr Good |
| 55 | 9.040804 | 38.86452 | 2567 | Kara squai | 13 | Winter | 4 | Death | Vehicle tc Steering \ Sunda Male | 1120 | Day | 26/12/2011 | 30 | 11 | 2 | Minibus | 3-54307 | 10 | Without | Asphalt Rr Good |
| 56 | 9.034821 | 38.84953 | 2456 | In front of | 13 | Spring | 1 | Death | Vehicle tc Priority pi Thursc Femak | 2100 | Morn | 1/1/2012 | 35 | 10 | 5 | Minibus | 3-13568 | | Without | Asphalt Rr Good |
| 57 | 9.042244 | 38.86638 | 2561 | Kara beg t | 12 | Spring | 1 | Death | Vehicle tc Priority pi Friday Male | 1200 | Eveni | 5/1/2012 | 30 | 8 | 30 | Toyota | 2-95319 | | Without | Asphalt Rr Good |
| 58 | 9.020522 | 38.80913 | 2383 | In front of | 9 | Spring | 1 | Death | Vehicle tc Not givin Tuesdi Male | 2100 | Eveni | 13/1/2012 | 44 | 10+3 | 4 | Land cruse | 3A-12844 | 10 | Without | Asphalt Rr Good |
| 59 | 9.015642 | 38.78714 | 2362 | 22 gologol | 8 | Spring | 1 | Death | Vehicle tc With out r Friday Female | 920 | Day | 16/1/2012 | 26 | 10+2 | 6 | Minibus | 3-25689 | | Without | Asphalt Rr Good |
| 60 | 9.021363 | 38.8411 | 2390 | In front of | 12 | Spring | 1 | Death | Vehicle tc Not givin Sunda Male | 1000 | Day | 2/2/2012 | 32 | 10 | 6 | Isuzu | 3-53933 | 15 | Without | Asphalt Rr Good |
| 61 | 9.021101 | 38.80608 | 2394 | In front of | 5 | Spring | 1 | Death | Vehicle tc Not givin Friday Male | 1200 | Eveni | 7/2/2012 | 36 | 12 | 9 | Anbesa bl | 3A-85505 | 15 | Without | Asphalt Rr Good |
| 62 | 9.021351 | 38.85289 | 2391 | In front of | 13 | Spring | 1 | Death | Vehicle in Not givin Saturd Male | 345 | Morn | 1/2/2012 | 35 | 10 | 1 | Minibus | 2B-18552 | | Without | Asphalt Rr Good |
| 63 | 9.02375 | 38.79709 | 2394 | In front of | 8 | Spring | 1 | Death | Vehicle tc Drunk dri Friday Male | 2030 | Morn | 28/3/2012 | 29 | 10 | 3 | Minibus | 1-11264 | 23 | With | Asphalt Rr Good |
| 64 | 9.058219 | 38.77945 | 2544 | Ferensay l | 5 | Spring | 1 | Death | Falling fro Vehicle p Mond: Male | 350 | Morn | 15/3/2012 | 26 | 10 | 2 | Minibus | 3-33575 | | Without | Asphalt Rr Good |
| 65 | 9.043411 | 38.8496 | 2528 | In front of | 12 | Summer | 2 | Death | Vehicle tc Steering \ Saturd Male | 2040 | Morn | 4/4/2012 | 22 | Diploma | 2 | Sinotrck | 3-67204 | 5 | Without | Asphalt Rr Good |
| 66 | 9.020638 | 38.85157 | 2390 | Cmc squar | 13 | Summer | 2 | Death | Vehicle tc Not givin Thursc Male | 730 | Day | 14/4/2012 | 22 | 10+2 | 2 | Marchedi | 4-14731 | 10 | Without | Asphalt Rr Good |
| 67 | 9.030982 | 38.8525 | 2433 | In front of | 13 | Summer | 2 | Death | Vehicle tc Not givin Mond: Male | 640 | Night | 20/4/2012 | 36 | 10 | 8 | Isuzu Ktk | 3-50759 | 15 | Without | Asphalt Rr Good |
| 68 | 9.041096 | 38.8313 | 2500 | Hana mari | 9 | Summer | 2 | Death | Vehicle tc Steering \ Saturd Female | 730 | Day | 25/4/2012 | 23 | 11 | 1 | Higher bu | 3-46803 | 11 | Without | Asphalt Rr Good |
| 69 | 9.028311 | 38.78455 | 2413 | In front of | 7 | Summer | 2 | Death | Vehicle tc Steering \ Saturd Male | 2030 | Night | 25/4/2012 | 28 | 10 | 8 | FSR | 3-37735 | | Without | Asphalt Rr Good |
| 70 | 9.050385 | 38.77036 | 2476 | Ferensay l | 2 | Summer | 2 | Death | Vehicle tc Not givin Tuesdi Male | 1330 | Eveni | 3/6/2012 | 37 | 12 | 10 | Pickaup | 3A-44215 | 20 | Without | Asphalt Rr Good |
| 71 | 9.055838 | 38.77426 | 2524 | Ferensay l | 1 | Summer | 2 | Death | Vehicle tc Steering \ Thursc Male | 2130 | Night | 19/6/2012 | 27 | 10 | 5 | Minibus | 3-62892 | | Without | Asphalt Rr Good |
| 72 | 9.051511 | 38.78058 | 2494 | In front of | 2 | Autumn | 3 | Death | Vehicle tc Not givin Wedn: Male | 1530 | Eveni | 9/7/2012 | 23 | 9 | 3 | Isuzu | 3-21413 | 10 | Without | Asphalt Rr Good |
| 73 | 9.024613 | 38.79593 | 2398 | Shola met | 8 | Autumn | 3 | Death | Vehicle tc Not givin Friday Male | 530 | Morn | 12/7/2012 | 28 | 10+2 | 12 | Dolfin | 3A-75911 | 5 | Without | Asphalt Rr Good |
| 74 | 9.019892 | 38.81345 | 2385 | Century M | 9 | Autumn | 3 | Death | Vehicle tc Not givin Tuesdi Male | 2200 | Night | 15/7/2012 | 40 | Dgree | 2 | Pickaup | 5-02555 | 10 | Without | Asphalt Rr Good |
| 75 | 9.021387 | 38.79134 | 2374 | In front of | 7 | Autumn | 3 | Death | Vehicle tc Not givin Wedn: Female | 605 | Morn | 16/7/2012 | 25 | Dgree | 5 | Dolfin | | | Without | Asphalt Rr Good |
| 76 | 9.030311 | 38.83825 | 2424 | Wesen mi | 11 | Autumn | 3 | Death | Vehicle tc Not givin Wedn: Male | 1130 | Day | 23/7/2012 | 39 | 10+2 | 11 | Pickaup | 4-22274 | 5 | Without | Asphalt Rr Good |
| 77 | 9.064803 | 38.77146 | 2577 | In front of | 1 | Autumn | 3 | Death | Vehicle tc Adequate Saturd Male | 1430 | Night | 25/7/2012 | 46 | 12 | 6 | Months Vitz | 3A-62317 | 18 | Without | Asphalt Rr Good |
| 78 | 9.024556 | 38.79612 | 2398 | Shola met | 8 | Autumn | 3 | Death | Vehicle tc Adequate Mond: Male | 28 | | | 9 | 6 | Months Minibus | 3A-64733 | 10 | Without | Asphalt Rr Good | |
| 79 | 9.021201 | 38.84861 | 2393 | Dimond A | 13 | Autumn | 3 | Death | Falling fro Falling w/ Wedn: Male | 1230 | Eveni | 14/8/2012 | 18 | 11 | 2 | Biycle | | | Without | Asphalt Rr Good |
| 80 | 9.014607 | 38.78193 | 2364 | In front of | 7 | Autumn | 3 | Death | Vehicle tc Not givin Saturd Male | 2230 | Night | 24/8/2012 | 47 | 12 | 10 | Minibus | 3-51025 | 10 | Without | Asphalt Rr Good |
| 81 | 9.041884 | 38.8661 | 2564 | Kara beg t | 12 | Autumn | 3 | Death | Vehicle tc Not givin Thursc Male | 1230 | Eveni | 13/9/2012 | 37 | 10 | 1 | Minibus | 3-20194 | | Without | Asphalt Rr Good |
| 82 | 9.038989 | 38.85122 | 2492 | In front of | 12 | Autumn | 3 | Death | Vehicle tc Adequate Mond: Male | 1630 | Eveni | 20/10/2012 | 30 | 12 | 2 | Vitz | 3A-74836 | | Without | Asphalt Rr Good |
| 83 | 9.064018 | 38.8736 | 2484 | Abado cor | 12 | Autumn | 3 | Death | Vehicle tc Not givin Mond: Female | 2045 | Day | 24/9/2012 | 23 | Dgree | 1 | Minibus | | | Without | Asphalt Rr Good |
| 84 | 9.045686 | 38.76894 | 2487 | In front of | 4 | Autumn | 3 | Death | Bajaj to pl Improper Tuesdi Female | 830 | Morn | 28/9/2012 | 22 | 10 | 2 | Months Isuzu | 3A-98856 | | Without | Asphalt Rr Good |
| 85 | 9.020937 | 38.85333 | 2391 | Cmc squar | 13 | Autumn | 3 | Death | Vehicle tc Not givin Sunda Female | 1224 | Morn | 1/10/2012 | 29 | Dgree | 6 | Isuzu | 3-04207 | | Without | Asphalt Rr Good |
| 86 | 9.035991 | 38.85425 | 2485 | In front of | 12 | Autumn | 3 | Death | Vehicle tc Not givin Sunda Male | 700 | Day | 10/10/2012 | 35 | 10+4 | 4 | Minibus | 3-61859 | | Without | Asphalt Rr Good |
| 87 | 9.019275 | 38.81959 | 2376 | In front of | 9 | Autumn | 3 | Death | Vehicle tc Not givin Mond: Male | 2130 | Night | 15/10/2012 | 40 | Dgree | 3 | Anbesa bl | 2A-53847 | | Without | Asphalt Rr Good |
| 88 | 9.02111 | 38.7947 | 2382 | Shola met | 8 | Autumn | 3 | Death | Vehicle tc Steering \ Tuesdi Male | 1130 | Day | 30/10/2012 | 60 | 10 | 20 | Platz | 3-68186 | 8 | Without | Asphalt Rr Good |
| 89 | 9.041884 | 38.8661 | 2564 | Kara beg t | 13 | Winter | 4 | Death | Passenger Adequate Friday Male | 830 | Day | 10/11/2012 | 36 | 10 | 5 | Anbesa bl | 3-71662 | | Without | Asphalt Rr Good |
| 90 | 9.036396 | 38.8293 | 2460 | In front of | 9 | Winter | 4 | Death | Vehicle tc Adequate Mond: Male | 1030 | Day | 27/11/2012 | 64 | Degree | 20 | Mini bus | 2A-32877 | | Without | Asphalt Rr Cloud |
| 91 | 9.03393 | 38.82352 | 2451 | In front of | 9 | Winter | 4 | Death | Vehicle tc Priority pi Saturd Male | 1420 | Night | 9/12/2012 | 28 | 10 | 4 | Isuzu Ktk | 3A-63283 | 10 | Without | Asphalt Rr Good |
| 92 | 9.024709 | 38.79559 | 2400 | Shola met | 8 | Winter | 4 | Death | Vehicle tc Steering \ Mond: Male | 2030 | Night | 11/12/2012 | 30 | 10 | 12 | Isuzu | 3A-01378 | 10 | Without | Asphalt Rr Good |
| 93 | 9.021571 | 38.84086 | 2391 | In front of | 13 | Winter | 4 | Death | Vehicle tc Steering \ Saturd Male | 223 | Eveni | 30/12/2012 | 26 | 10 | 5 | Dolfin | 3-42034 | | Without | Asphalt Rr Good |
| 94 | 9.043006 | 38.7641 | 2487 | In front of | 4 | Spring | 1 | Death | Vehicle tc Steering \ Friday Female | 2110 | Night | 27/1/2013 | 28 | 10+4 | 4 | Mini bus | 3-45689 | | Without | Asphalt Rr Good |
| 95 | 9.062514 | 38.78897 | 2597 | Ferensay l | 2 | Spring | 1 | Death | Vehicle tc Priority pi Friday Male | 1500 | Day | 27/1/2013 | 25 | 12 | 1 | Mini bus | 3-67855 | 2 | Without | Asphalt Rr Good |
| 96 | 9.032397 | 38.78303 | 2422 | In front of | 5 | Spring | 1 | Death | Vehicle tc Not givin Mond: Male | 2405 | Eveni | 21/3/2013 | 55 | Diploma | 7 | Minibas | 5-01728 | 2 | Without | Asphalt Rr Good |
| 97 | 9.037529 | 38.83141 | 2462 | In front of | 11 | Summer | 2 | Death | Vehicle tc Steering \ Tuesdi Male | 2300 | Day | 6/4/2013 | 22 | 10+2 | 2 | Vitz | 3-08521 | | Without | Asphalt Rr Good |
| 98 | 9.03383 | 38.82358 | 2451 | In front of | 9 | Summer | 2 | Death | Vehicle tc Priority pi Sunda Male | 1100 | Day | 11/4/2013 | 25 | 10 | 5 | Higher bu | 3-44989 | 5 | Without | Asphalt Rr Good |
| 99 | 9.028254 | 38.83266 | 2417 | In front of | 11 | Summer | 2 | Death | Vehicle tc Priority pi Tuesdi Male | 1900 | Day | 20/4/2013 | 38 | Degree | 8 | Land cross | 4-00723 | 2 | Without | Asphalt Rr Good |
| 99 | 9.028254 | 38.83266 | 2417 | In front of | 11 | Summer | 2 | Death | Vehicle tc Priority pi Tuesdi Male | 1900 | Day | 20/4/2013 | 38 | Degree | 8 | Land cross | 4-00723 | 2 | Without | Asphalt Rr Good |
| 100 | 9.033897 | 38.82342 | 2451 | In front of | 9 | Summer | 2 | Death | Vehicle tc Priority pi Tuesdi Male | 1600 | Eveni | 27/4/2013 | 19 | Diploma | 2 | Tera cycle | 3-23564 | 2 | Without | Asphalt Rr Good |
| 101 | 9.030506 | 38.78624 | 2426 | In front of | 5 | Summer | 2 | Death | Vehicle tc Steering \ Wedn: Male | 2230 | Day | 5/5/2013 | 31 | 12 | 3 | Pickup | 4-02151 | 5 | Without | Asphalt Rr Good |
| 102 | 9.021834 | 38.80101 | 2396 | Megenagr | 8 | Summer | 2 | Death | Vehicle tc Priority pi Wedn: Female | 2300 | Night | 5/5/2013 | 28 | 10 | 4 | Mini bus | 3-67892 | | Without | Asphalt Rr Good |
| 103 | 9.039108 | 38.86301 | 2546 | Kara dage | 12 | Summer | 2 | Death | Vehicle tc Steering \ Tuesdi Male | 1830 | Day | 11/5/2013 | 28 | 10 | 1 | Land cross | 4-00972 | 10 | Without | Asphalt Rr Good |
| 104 | 9.02317 | 38.77619 | 2390 | Women Si | 6 | Summer | 2 | Death | Vehicle tc Steering \ Saturd Female | 2200 | Eveni | 20/6/2013 | 25 | 12 | 1 | Mini bus | 3-68957 | | Without | Asphalt Rr Good |
| 105 | 9.064018 | 38.8736 | 2484 | Abado kor | 14 | Summer | 2 | Death | Vehicle tc With out r Tuesdi Male | 1900 | Day | 23/6/2013 | 40 | 8 | 5 | Azyuzi | 3-78780 | 2 | Without | Asphalt Rr Good |
| 106 | 9.026857 | 38.77537 | 2400 | Awarew S | 6 | Summer | 2 | Death | Vehicle tc Priority pi Sunda Male | 2245 | Night | 28/6/2013 | 30 | 10 | 5 | Taxi | 1-18954 | 10 | Without | Asphalt Rr Good |
| 107 | 9.041547 | 38.86183 | 2553 | In front of | 12 | Summer | 2 | Death | Vehicle tc Steering \ Tuesdi Female | 130 | Eveni | 30/6/2013 | 22 | 10 | 2 | Moter | | 2 | Without | Asphalt Rr Good |
| 108 | 9.02599 | 38.79385 | 2407 | Yeka bar a | 5 | Autumn | 3 | Death | Vehicle tc Not givin Thursc Female | 2140 | Day | 2/7/2013 | 28 | 10+2 | 4 | Minib bus | 3-56497 | | Without | Asphalt Rr Good |
| 109 | 9.027608 | 38.83108 | 2414 | In front of | 9 | Autumn | 3 | Death | Vehicle tc Improper Saturd Male | 2030 | Night | 4/7/2013 | 21 | 10 | 1 | Vitz | 3A-90167 | 10 | Without | Asphalt Rr Good |
| 110 | 9.06372 | 38.77045 | 2560 | Kela Turni | 1 | Autumn | 3 | Death | Vehicle tc Steering \ Wedn: Male | 2130 | Night | 9/7/2103 | 22 | 10+4 | 2 | Yaris | 3-66523 | | Without | Asphalt Rr Good |
| 111 | 9.041096 | 38.8313 | 2500 | Hana mari | 10 | Autumn | 3 | Death | Vehicle tc Priority pi Sunda Male | 900 | Day | 26/7/2013 | 42 | 12 | 7 | Land cross | 4-23235 | 2 | Without | Cobblestc Good |
| 112 | 9.053451 | 38.87201 | 2499 | In front of | 12 | Autumn | 3 | Death | Vehicle tc Priority pi Tuesdi Male | 715 | Morn | 5/8/2013 | 36 | 10 | 30 | Marchedi | 3-82485 | 20 | Without | Asphalt Rr Good |
| 113 | 9.031579 | 38.8412 | 2432 | TeKi Bar ai | 11 | Autumn | 3 | Death | Vehicle tc Priority pi Tuesdi Male | 2200 | Day | 5/8/2013 | 34 | Degree | 2 | Azyuzi | 4-25162 | 2 | Without | Asphalt Rr Good |

Annex 2: Yeka sub-city hazardous train station traffic accidents (2018/19 to 2020/21) on Excel

| No | Latitude | Longitude | Elevation | Place of accident | The Season | Severity | Accident Cause | Accident Type | Day | Sex | Time of the day | Condition | Date of accident | Age | Education | Driving License | Kind of vehicle | Car code | Vehicle used | Vehicle damaged | Kind of road | Climate condition |
|----|----------|-----------|-----------|-------------------|------------|----------|----------------|---------------|----------|-----|-----------------|------------|------------------|-------|-----------|-----------------|-----------------|----------|--------------|-----------------|--------------|-------------------|
| 1 | 9.021601 | 38.84031 | 2393 | Meri St.M | 13 Spring | 1 Easy | Steering v | Vehicle/ T | Friday | M | 1800 Evening | 9/1/2011 | 40 | Elev | 17 | Taksi(min | 1-30860 | 5 | Without | Railway | Good | |
| 2 | 9.020063 | 38.82645 | 2378 | Sahlitemh | 9 Autumn | 3 Easy | Inadequat | vehicle/ T | Tuesday | M | 740 Day | 22/8/2011 | 45 | Degr | 20 | Load | 3A-60376 | 2 | With out | Railway | Good | |
| 3 | 9.019842 | 38.8133 | 2385 | Century nr | 7 Spring | 1 Death | Using cell | Vehicle/ f | Saturday | F | 700 Day | 28/2/2013 | 38 | Diplc | 5 | Anbesa bi | 3A- 28397 | 2 | Without | Railway | Good | |
| 4 | 9.01969 | 38.82549 | 2373 | Salite mih | 9 Summ | 2 Easy | Using cell | Vehicle/ f | Monday | M | 800 Morning | 20/4/2012 | 28 | 10 | | Minibus | 3- 24986 | 12 | Without | Railway | Good | |
| 5 | 9.020851 | 38.85294 | 2390 | Cmc squar | 3 Winter | 4 Easy | Using cell | Vehicle tc | Monday | M | 1300 Evening | 1/11/2011 | 26 | 10 | 2 | Pickup | 3-06197 | 10 | With out | Road | Good | |
| 6 | 9.020077 | 38.82643 | 2377 | Salite mih | 10 Winter | 4 Easy | Inadequat | Vehicle tc | Friday | M | 820 Day | 10/12/2011 | 38 | 10 | 4 | Bajaj | 1-27617 | 4 | With out | Road | Good | |
| 7 | 9.019817 | 38.81338 | 2385 | Century nr | 9 Spring | 1 Death | Using cell | Vehicle tc | Saturday | M | 1740 Day | 17/1/2012 | 26 | 9 | 2 | Minibus | 1-18076 | 15 | With out | Road | Good | |
| 8 | 9.01782 | 38.79561 | 2371 | Leks plaza | 8 Spring | 1 Easy | Using cell | Vehicle tc | Friday | M | 1620 Day | 7/2/2012 | 53 | Mast | 15 | Minibus | 3-96611 | 4 | With out | Road | Good | |
| 9 | 9.019848 | 38.81339 | 2385 | Century nr | 5 Summ | 2 Easy | Steering v | Vehicle tc | Friday | M | 1900 Day | 5/4/2012 | 29 | 8 | 4 | Minibus | 3-25355 | 6 | With out | Road | Good | |
| 10 | 9.020851 | 38.85294 | 2390 | Cmc squar | 13 Winter | 4 Easy | Steering v | Vehicle tc | Monday | M | 1800 Day | 29/10/2012 | 58 | 12 | 12 | Corola | 2B-38228 | 6 | Without | Railway | Good | |
| 11 | 9.014799 | 38.78296 | 2385 | Haya Hule | 7 Winter | 4 Easy | Inadequat | Vehicle tc | Wednes | M | 630 Day | 22/11/2012 | 23 | 3rd y | 2 | Diaks | 2-61861 | 15 | Without | Railway | Good | |
| 12 | 9.020903 | 38.85166 | 2390 | Cmc squar | 13 Winter | 4 Easy | Using cell | Vehicle tc | Thursda | M | 1000 Morning | 30/11/2012 | 32 | 10+3 | 2 mont | Mini bus | 1-40637 | | Without | Railway | Good | |
| 13 | 9.019848 | 38.81339 | 2385 | Century nr | 13 Spring | 1 Easy | Using cell | Vehicle tc | Wednes | M | 1500 Day | 13/1/2013 | 43 | 6 | 10 | Land cross | 4-21341 | 10 | Without | Railway | Good | |
| 14 | 9.020924 | 38.85163 | 2390 | Cmc squar | 11 Spring | 1 Death | Steering v | Vehicle tc | Tuesday | M | 900 Day | 26/1/2013 | 26 | Diplc | 2 | Sheger bu | 3A-37780 | 3 | Without | Railway | Good | |
| 15 | 9.016308 | 38.78963 | 2373 | Hayahule | 2 Spring | 1 Easy | Steering v | Vehicle tc | Friday | M | 1840 Day | 29/1/2013 | 36 | 11 | 10 | Isuzu | 3-25039 | 25 | Without | Railway | Good | |
| 16 | 9.020077 | 38.82643 | 2377 | Sehalite n | 9 Summ | 2 Easy | Inadequat | Vehicle tc | Wednes | M | 1730 Day | 26/5/2013 | 27 | 10 | 3 | Pikup | 3A-26389 | | Without | Railway | Good | |
| 17 | 9.01969 | 38.82549 | 2373 | Sehalite n | 9 Summ | 2 Easy | Using cell | Vehicle tc | Saturday | M | 2000 Day | 13/6/2013 | 38 | 8 | 15 | Mini bus | 2-03877 | 15 | Without | Railway | Good | |

Equation 3: Yeka sub-city trend of road traffic accidents (2018/19 to 2020/21)



Equation 4: *Yeka* sub- city trend of hazardous train station traffic accidents (2018/19 to 2020/21)

