

Investigating road traffic accident black spot using QGIS
A case of Addis Ababa, Adama Expressway



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Thesis Submitted to

The department of Geomatic Engineering

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's (Specialization in Geoinformatics)

Office of Graduate Studies

Adama Science and Technology University

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APPROVAL SHEET

I, the advisors of the thesis entitled “Investigating road traffic accident black spot using QGIS: A case of Addis Ababa, Adama Expressway” and developed by Samuel Getu Bulga, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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DECLARATION

I hereby declare that this master thesis entitled “Investigating road traffic accident black spot using QGIS: A case of Addis Ababa, Adama Expressway” is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

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RECOMMENDATION

I, the advisor(s) of this thesis, hereby certify that I have read the revised version of the thesis entitled “Investigating road traffic accident black spot using QGIS: A case of Addis Ababa, Adama Expressway” prepared under my guidance by Samuel Getu Bulga submitted in partial fulfillment of the requirements for the degree of Master’s of Science in Geo-informatics.

Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

Dr. Tilahun Enduno

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Date

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LIST OF ACRONYMS

GIS:	Geographic information system
QGIS:	Quantum Geographic information system
GPS:	Global positioning system
RTA:	Road traffic accident
GDP:	Gross domestic product
GNP:	Gross national product
WHO:	World health organization
VMS:	Variable message system
KDE:	Kernel density estimation
NNH:	Nearest neighbor clustering
UK:	United Kingdom
UN:	United nation
EC:	Ethiopian calendar
LATM:	Local Area Traffic Management
ASMR:	Age specific mortality rate
SANET:	Spatial Analysis on a Network
ETB:	Ethiopian birr

ABSTRACT

Globally, road traffic accidents are the leading causes of death among young people in general. Currently studies show that road traffic accidents in Ethiopia specifically in Addis Ababa, Adama expressway are pressing problems. The number of fatalities, injuries, property damage and economic as well as social lose is increasing from time to time. The aim of the study is to investigating traffic accident black spots and examine possible causes of the road accident of Addis Ababa, Adama expressway from July 2019 to July 2022. The methods and procedures used in gathering the study data from the records or reports of Ethiopian toll roads enterprise road safety department. Besides, point based traffic accident sites were collected using handheld GPS devices and import into excel Comma-separated value (CSV) file software via Expert GPS then export to QGIS 3.16. Both qualitative and empirical research methods were used to assess the traffic accident level of this road. Black spot identification and traffic accident model development was the focus of this research. Black spot analysis was made using accident severity value. Binary logistic regression model was used for assessing factors contributing for road accident. Finally, black spot segment and road traffic accident severity index were mapped using spatial analyst tools of QGIS. The findings of the study shows that there are eleven black spot segment along the road from Addis Ababa to Adama. The study also indicated that age, education, direction and surface condition play significant role in the determination of road traffic accident injury where p-value less than 0.05. In conclusion, the study revealed that the stated factors have contributed for the occurrence of traffic accidents on the expressway. On the other hand, other factors other than Direction of carriageway, Road surface condition, age of driver and Education seem to have no significant effect on the determination of accident injury on the road. Based on the results the study it is possible to recommend that several remedial measures and provisions for traffic safety are suggested for reducing the risk of accidents in black spots segment areas.

Key words: QGIS, Road traffic accident black spot, Road traffic accident Severity index

CHAPTER I. INTRODUCTION

1.1 Back ground of the study

Road traffic accidents have become a global concern due to their significant impact on human lives and societal well-being. Every year, millions of individuals suffer injuries or lose their lives as a result of these accidents. Road traffic accidents not only lead to physical injuries but also cause emotional trauma, financial burdens, and societal disruptions. Understanding the causes, consequences, and possible preventive measures of road traffic accidents is crucial for both individuals and policymakers to create safer road environments and reduce the devastating effects of these incidents.

Road traffic accident may take numerous forms and occur for a variety of causes; some are controlled, such as speed, tailgating, erroneous lane shifting, drowsiness, or reckless driving; and others are not, such as car failure, bad weather, lack of road signs, or poor road conditions. Car collisions, which can be a single-car accident, rear-end collisions, sideswipe collisions, multiple vehicle crashes, or automobile rollovers, are the most common type of automotive accident. This can have significant repercussions, including injuries, disability, and, in many cases, death. Not to mention property loss and car damage, resulting in both personal and social costs. According to the World Health Organization (WHO 2022), 1.3 million fatalities and 50 million injuries occur each year.

Road traffic accidents, the leading cause of death by injury, the fifth leading source of death by injury, and the ninth-leading cause of all fatalities globally, currently account for a startlingly large percentage of the global burden on the existing and future underfunded health sector. According to the study (WHO, 2021), every year, an estimated 1.35 million people are murdered in traffic accidents, 3,700 people are killed every day, and 50 million are injured, occupying 30 percent to 70% of orthopedic beds in developing-country hospitals. If current trends continue, road traffic injuries are expected to be the third largest contributor to the worldwide burden on the health sector, mostly in developing countries, by 2030.

Road traffic accident injuries are preventable, but reliable data are important to understand the ways in which road safety interventions and technology can be successful transferred from developed nations where they have proven effective preventing RTA related injuries. Awareness

of the consequences of road traffic injuries is fail to provide information to the public and effective action by policy makers (Luzitu S, 2016). What needed is in corporation of comprehensive road safety programs international planning particularly developing countries. In developed countries, road traffic death rates have decreased since the 1960s because of successful interventions such as seat belt safety laws, enforcement of speed limits, traffic warnings sign about the dangers of mixing alcohol consumption with driving, and public awareness advertisement using mass public media. For example, road traffic fatalities increase by 5 percent in the EU and by 2 percent in US from 2020 to 2021. But traffic fatalities increased in developing countries during the same period by 21 percent in Africa and 14 percent in south area with in the same periods. More than one half of all road traffic deaths globally occur among people ages between 15-44 their most productive age group accounts for 60 percent of all daily lost because of road traffic accidents. The costs and consequences of these losses are significant. Three-quarters of all poor families who lost a member to road traffic death reported a decrease in their standard of living and 61 percent reported they had to borrow money to cover expenses following their loss (UN, 2021).

Many publisher have come out with the causes and effects of traffic accidents. Africa has one of the highest road traffic death rates in the world, with little difference in rates between those countries categorized as low-income (32.3 deaths per 100,000 populations per year). Whereas the range of fatalities per 100,000 populations in countries of African region is not very wide, 70% of all the deaths occurred in ten countries that account for 70% of the regional population: mainly sub Saharan country (WHO, 2009). Reports of the WHO indicated that the economic costs of road crashes and injuries are estimated to be 1% of Gross Domestic Product (GDP) in low-income countries (WHO, 2009). According to (William Eckersley et al., 2010) report on the road traffic crashes cost of developing countries reaches between 1–2% of their GDP.

Ethiopia is one of developing country with high traffic accident costing around 0.8% - 0.9% of the GDP for between 2001 up to 2007 (Ethiopian Federal Police Commission, 2008). Road traffic accident in Ethiopia is a serious problem. The death rate presently stands near 6.5 per 1000 people (World Bank 2021). To curb the problem, strong mitigation and strategies are expected to deal with the challenges so as to reduce its impact at list by 50% at the end of 2050. In this regard, considering the importance of public safety, the Ethiopian government has requested the World Bank and its Global Road Safety Forum to review the road safety

management capacity of the country. This review was used for the development of national level 10 years strategy for road safety. Despite all public and private intervention the challenges of road traffic accident still increasing from time to time. This indicate studies made on the road safety sector at the national level are not sufficient to address the challenges (Ethiopia Ministry of Transport, 2011). The recent road safety record of Addis Ababa-Adama expressway is also alarming the critical of the situation and calling for an integral effort of all relevant stakeholders to reverse the trend. Road traffic accident data collected from Ethiopia Toll Road Enterprise indicated that, on average, about 1,646 road crashes were reported in the past three years that leads around 205 human injury (Ethiopian toll road enterprise road traffic accident data).

There have been no previous assessment made on traffic accident black spot using QGIS and no research has been conducted to identify which factor have significant contribution for most traffic accident injury. Because of this, the road segment needs to be considered for an in-depth investigation due to its highest rate of traffic accident record during the past three year period of time. This research will conducted to identify which major causes of road traffic accident injury, to extract knowledge on type of injury and possible relationship of cause of traffic accident and other factor (Day of the Week, Collision Types, Types of Vehicles and Geometric condition, whether condition, surface condition) specifically focusing on Addis-Adama expressway and to identify the most venerable segments of the road.

Road traffic safety audit planning is a life basic requirement in all public and private sector. Road safety information is essentials for addressing road and traffic safety needs. Informed decision-making of road safety issues is based on the registered vehicle crash data. The accident's information was collected from the Ethiopian toll road enterprise safety department. The collected data then is used to analyze and identify hot spot segment on study area, then the pattern of accidents can be identified by applying engineering studies (Karl-Olov Hedman 2001). Results of the analysis are used to implement the required improvements and road planning. This paper is a step forward in the procedure of identification and analysis of black spots using QGIS 3.16. QGIS 3.16 is used for the identification and analysis using heat map plugin and information query tool respectively. The other method for identification of the most vulnerable segments is the method of Prioritization by carrying out road inventory survey.

Quantum geographic information systems tools are utilized for advancing safety planning.

Applications of QGIS in the management of accident analysis and traffic safety were introduced in 2002. QGIS is an open source Geographic Information System that supports most geospatial vector and raster file types and database formats. The program offers standard GIS functionality, with a variety of mapping features and data editing. Several GIS-based accident information systems are devoted to managing and tackling traffic flow. These QGIS-aided systems aim to decrease the number of accidents by identifying the hazardous locations which can be achieved by using the spatial data analysis and statistical analysis methods provided in QGIS software. QGIS software includes a variety of analysis tools such as density, proximity, cluster, pattern, spatial query analysis in addition to the ability to build customized models using the model builder technique.

Identifying accidents hotspots is a major part of most safety analysis studies, where locations with the highest proportions of total accidents are identified. There are two main categories for identifying hotspots, observed accidents rate and expected accident rates. However, hotspots can be identified efficiently by using methods that incorporating both categories because accidents are considered random events and they can change in time and locations.

1.2 Statement of the problem

Ethiopia has one of the lowest road densities in Africa with highest road traffic accident. According to the data obtained from Ethiopian Roads Authority (ERA, 2016), the classified road network consists of only about 42,429 km of roads, comprising a population of about 100 million, Ethiopia's road density is 40.3 km/1000 sq.km or about 0.56 km per 1000 population, a road network of the lowest density when compared with the Africa's average of over 50 Km/1000 sq. Km (ERA, 2003).

Addis Ababa-Adama Expressway is one of the first expressway in Ethiopia, However there are several project to be on the evaluation of the profitability of the 16 expressways included into the Ethiopian National Master plan in the base scenario (Go-Ahead Scenario) has been conducted under the hypothesis that these expressways would be managed as toll road (Ethiopian Transport minister, 2022) .

Ethiopian Road Authority is responsible for all public roads construction in Ethiopia, they proposed the new and improved quality of road in safety and operating cost at Oromia region called Addis Ababa– Adama Expressway, which is the first modern road for Ethiopia and East Africa and officially opened in September 2014. The new six-lane, the 3.75 m-wide road for

each lane and 2.5 m wide shoulder was constructed along a different route but was placed adjacent to and 3.5 km from the west side of the old Addis Ababa Adama road. The new road is 20 km shorter than the old Addis Ababa Adama road, while the route is fenced on either side for protection from pedestrians and animals. The project was completed at an estimated cost of 11.2 billion birr and has a capacity more than 26,500 vehicles per day. Its facilities such as traffic cameras and variable message signs (VMS) enables effective traffic management and incident management control along with safe operations at the new complex road (Source: Ethiopian Toll Roads Enterprise Road safety department).

This road has technologically advanced safety management system aiming to reduce traffic accident with the support of 3 time routine patrolling, equip with rapid response ambulance, 18 tone wrecker, heavy vehicle wrecker, 36 tone Crain and weekly base education for traffic driver at the gate and bus transport terminal, installation of international standard road safety facility alongside the expressway. Despite the mentioned efforts by Ethiopian toll road enterprise traffic accidents occurred frequently.

The table below shows that the accident is increasing from time to time. If the accident rate is increased by this rate the road will be frustrate the driver and it will cause more casualty. As a result the driver will divert to the existing road, because of this the toll road administer could loss substantial amount of income. At the same time newly constructed and future planned expressway listed in table 1.1 could estimate to face many causality. Hence, this problem started to alarm the need for undertaking coordinated effort to curb the problem.

Table 1.2 Severity of traffic accident in AAE

Year	Type of Accident severity in number			Total register number of accident	Total property damage(birr)
	Fatality	Serious injury	Light injury		
2019/2020	11	42	151	538	6,242,536.97
2020/2021	16	52	164	524	7,359,208.17
2021/2022	24	67	135	588	9,826,947.76
Total	51	161	450	1,636	23,428,692.9

(Source: Ethiopian toll roads enterprise traffic data report from July 2019 up to July 2022)

This paper is written to show the road traffic accident characteristics and the procedures for investigating of the traffic accident prone black spot locations where there are high concentration of road accident with fatality on three-lane two carriageway expressway have been defined with an effective use of QGIS. This research is therefore motivated by the research

gap of previous similar work done by Debela D. et al. (2016), hence this paper will demonstrate the gap and help researcher to enhance an initiation for more study in this topic and this study can be used by other scholar and broad the knowledge in Ethiopia.

1.3 Objective of the study

1.3.1 General objective

The general objective of this research is to assess black spot zones and examine possible cause of the road accident.

1.3.2 Specific objective

The specific objectives of this study are to:

- Identify traffic accident black spot in the study area (from July 2019 to July 2022).
- Describe the major factors that contribute to traffic accidents injury at the black spot area.
- Prepare a map of black spot in the study area.

1.4 Research Question

In this research project topic mainly focused on secondary data, In addition I will attempt to conduct these interviews shortly after secondary data collection. Hence I will focus my effort to answer the following question.

1. What are the major factor that contribute to traffic accident?
2. Which of the major factors contribute for the most traffic accident injury?
3. Where are the most vulnerable segments of black spot along the study area?

1.5 Significance

Road traffic Accident related injury has been increasing from time to time however; no due attention is given to identify the root cause of the problem and its solutions at the black spot area. So, the findings of the study benefits different stakeholder involves public and private road administration. In this regards, the following are the major benefits of the study. Primarily, the findings of the study help Ethiopian Toll Roads Enterprise (specifically road safety and monitoring department and communication department.) can use this research output to make decision to use the road in professional manner, traffic police officer/department to concentrate causes and possible measures for accidents to be taken, driver to learn from different mistakes that has done and for researchers for those who are doing on similar topic possible. Hence, Ethiopian Toll Roads Enterprises can be benefited to gain useful information about which

segment of the road and in which direction of the road most accident related injury record and identify road traffic accident black spots, trend, cause of crash and thematic information on Addis Ababa Adama Expressway, this in turn, could help to develop appropriate countermeasures that could reduce the likelihoods of occurrence of road traffic accidents injury at black spot area. In addition to that the study will provide General information regards to most cause of crash, most frequent crash time in terms of date of the week and month in expressway and it will be helpful more accurately identified and remedial measure reduce the seriousness of the existing problem further as an input for the extended expressways (Modjo Hawassa expressway) or newly/under constructed expressways (Like Adama – Awash Expressway) in different parts of Ethiopian regions for elimination of road traffic accident by calibrating the output of this study. The findings of the study can also be an input for Governmental policy makers can use this research improve the quality of decision-making in other toll roads safety planning. Because of this It provide valuable information for policy maker, transport authority, road engineer and other concerned stakeholder to take appropriate action to minimize road safety problem. Lastly the study will benefits to other researcher can use this research will also give information to those who are interested in conducting research on traffic accidents. For this reason this research may add to an available literature and may encourage further research on the topic.

1.6 Scope of the Study

Addis - Adama Toll Motorway is located in the southeast of Addis Ababa, connecting two important cities of Ethiopia—Addis Ababa & Adama. This project started from Tulu Dimtu, 13 km southeast of Addis Ababa. Along the east of existing Addis Ababa To Adama Road to southeast, the expressway passes the Dukem, Debre Zeit, towns of Modjo and so on, extending southward through the south of Adama city to the east and connected the existing Adama To Awash Road.

The construction of Addis-Adama Toll Motorway is to adopt the Chinese highway engineering standard and specifications, i.e. two-way and six-lane expressway with the design speed of 120km/h and 100 km/h, roadbed width of 31.0 meters, route length of 78.1km and interchange connecting line about 10km long.

The study road has length of around 76 kilometers staring from Tulu dimtu toll station. The

research also basis its assessment on the data collected for the period of three years from July 2019 up to July 2022. The study mainly focuses on investigate black spot and/or sections along the route with high number of traffic accident and assess determinant of traffic accident on the study area. It also proposes countermeasures for those sections/ black spots identified during the study period.

CHAPTER II. REVIEW OF LITERATURE

2.1 Review of Theoretical literature

2.1.1 Concept of road traffic accident

As the number of motor vehicles and vehicle mile of travel increases, exposure of population to traffic accidents also proportionally increases. Road traffic accident is an accident with lenient participation of road users in road transport (public roads, paths and squares), its regulation is an important area of traffic civil law (WHO, 2002).

According to (Webster's Dictionary, 1976) the term "traffic" can mean movement of people and vehicles on along roads and streets, or air craft's in the sky. However, the actual meaning of traffic usually sights and road markings which are to function in regulating, warning, guiding, and directing traffic. The term traffic control refers not only to road, rail, sea and air transportation but also the traffic of shoppers in a supermarket, the flow of paper in large offices and the movement of component on an assembly line (WHO, 2008).

Accident is defined as anything which happens by misfortune, anything occurring unexpectedly and undersigned (Odugbemi, 2010). Road traffic accident is a collision or similar incident involving a moving people transportation, resulting in property damage, personal injury or death (Astrom, 2006). An "accident is a sudden phenomenon or happening which is resulted in an unexpected, unlikely, by chance or probability." and sometimes an "accident" is defined as "the sudden happening of events that comes up with personal injury, vehicle damage or property damage" (Encyclopedia Britannica Vol. 18). Therefore, the definition given to road traffic

accidents event at the vehicular road. Road traffic interact with people, environment and road conditions that affects road user safety and it depends on performance and interaction of the human, environment and road conditions. (Encyclopedia Britannica Vol. 18.). Road traffic accident is an unfortunate phenomenon that occurs as a result of the road use by human or

operation of vehicles including bicycles and other locomotive on the free highways or expressway. Accidents may be lethal, resulting in deaths of the road users (passengers, drivers or pedestrians), or minor when it is not severe enough as to cause substantial hardship to the road user and his family (Sarin, 2000).

Road accidents are an outcome of the interplay of various factors, some of which are the length of road network, vehicle population, human population and adherence/enforcement of road safety regulations etc. Road accident causes injuries, fatalities, disabilities and hospitalization with severe socio economic costs across the country. Consequently, road safety has become an issue of concern both at national and international level. The United Nations has rightly proclaimed 2011-20 as the Decade of Action on Road Safety (Geethabai, et al. 2016).

According to (Marzooqi, 2010), Road Traffic Accident is any vehicle accident occurring in a rural highway or national road or expressway. It includes collision between vehicles and animals, vehicles and pedestrians or vehicles and stuck obstacles. Single vehicle accidents, which involve a single vehicle, which means without other road user, are also enclosed. In a similar manner (Ajit et.al, 2004), have mentioned that Accident is an occasion, occurring without deliberate, unpredictably and in careless manner under unforeseen circumstances. Seemingly, (Segni, 2007) have also outlined that an accident is a rare, random, multi-factor event always preceded by a situation in which one or more road users have failed to handle event successfully with the road environment. Far from the above arguments, (Alister et.al, 2011) stated that accident involves personal injury occurring on the public highway (including footways) involving at least one road vehicle or a vehicle in collision with a pedestrian and which becomes registered at police office within 30 days.

In this regard, Road Traffic Accident can be defined as an accident that occurred on a way or street open to public traffic; resulted in one or more persons being injured, and at least one stirring vehicle was intricate. Therefore, RTA is a smash between two or several vehicles, vehicle with objects, between vehicles and pedestrians between vehicles and animals. The manifestations of RTA are irregular and random in space and time. Nevertheless, road safety and road incident diminish are related to many other fields of activity such as education, motorist or vehicle driver training, public health, police enforcement, road traffic policing, the court system, the National Health Service and Vehicle manufacturing and engineering (Alemayehu tabour 2009). The most shocking and emerging reality of RTA is that, it will continue affecting

the survival of several lives across the world. Consequently, (UN, 2009), remains pessimistic in road traffic accident cases where it projected that, road traffic related injuries will be the fifth leading cause of death globally by 2030. Because of this, the current trend in motorization world continues increasing in the same or similar manner for the coming decade.

2.1.2 Dynamics of Road traffic accident

2.1.2.1 Globally:- Road traffic accidents-the leading cause of death by injury and fifth leading cause of death by injury and the ninth-leading cause of all fatality globally now make up a surprisingly significant portion of the worldwide burden to current and future insufficient fund health sector. According to (WHO, 2021) report An estimated 1.35 million people are killed in road crash each year, 3,700 people single day and as 50 million are minor and serious injured, occupying 30 percent to 70 percent of orthopedic beds in developing countries hospitals. And if the present trends continue, road traffic injuries are predicted to be the third leading contributor to the global burden to the health sector mostly underdeveloped country by 2030. Road traffic accident injuries are preventable, but reliable data are important to understand the ways in which road safety interventions and technology can be successful transferred from developed nations where they have proven effective preventing RTA related injuries. Awareness of the consequences of road traffic injuries is fail to provide information to the public and effective action by policy makers (Luzitu S, 2016). What needed is in corporation of comprehensive road safety programs international planning particularly developing countries. In developed countries, road traffic death rates have decreased since the 1960s because of successful interventions such as seat belt safety laws, enforcement of speed limits, traffic warnings sign about the dangers of mixing alcohol consumption with driving, and public awareness advertisement using mass public media. For example, road traffic fatalities increase by 5 percent in the EU and by 2 percent in US from 2020 to 2021. But traffic fatalities increased in developing countries during the same period by 21 percent in Africa and 14 percent in south area with in the same periods. More than one half of all road traffic deaths globally occur among people ages between 15-44 their most productive age group accounts for 60 percent of all daily lost because of road traffic accidents. The costs and consequences of these losses are significant. Three-quarters of all poor families who lost a member to road traffic death reported a decrease in their standard of living and 61 percent reported they had to borrow money to cover expenses following their loss (UN, 2021).

Road traffic injuries cost 1 percent to 2 percent of the GNP of developing countries, or twice the total amount of development aid received worldwide by developing countries. As in developed countries, driver impairment component of road traffic accidents in developing countries. Driving at excess speeds, while under the influence of alcohol or drugs, while sleepy or tired, when visibility is composed, or without protective gear for all vehicle occupants are major factors in crashes, deaths and serious injuries (World Bank, 2012).

Road traffic accidents are one of the significant causes or disability, injury and death in the

world. India has the highest road traffic accident rate globally with over 25,000 deaths annually, beating second economic power house china. Every daily, nearly 71 lives are lost due to road accidents second most populated country India. More than 35% of the deaths are caused by trucks and three-wheelers. Most accidents occur in the afternoons and peak hours (especially in the evening) considered an 'unsafe' or dangerous time to be in the road. In 67% of these accidents there is head injury. Most drivers do not wear seat belts or those on two-motorist do not wear a helmet though it is compulsory in many country, the rules are broken all the time (WHO, 2021).

2.1.2.2 Road Traffic Accident in Africa:- Road traffic accidents kill more people around the world than epidemic disease, and are the leading cause of death for adult and youth aged 5 to 29 especially in particularly at developing countries (WHO, 2020).

The (Global Status Report Road Safety, 2022) has found that the risk of dying as a result of road traffic injury is highest in African region. The African continent recorded an average of 21 out of 100,000 populations dying as a result of road crash every year. The severity of road traffic crashes is likely to be much higher in Africa than any were else, because many vulnerable road users are involved, poor transport safety monitoring such as lack of seat belts, mobile phoning while driving, and poor infrastructure.

According to (WHO, 2023) poor reporting system also masked the magnitude of the problem in Africa. Sub Saharan Africa fatality rate is 27 per 100,000 inhabitant. That is three times higher than most European which is 9 and well above the global average 18.

Road traffic accidents in Africa are expected to rapidly increase over the next four decades, becoming a major public health problem across the continent. Currently, road traffic accident worldwide is estimated to claim the lives of 1.35 million people per year and injure an additional 20-50 million. By 2050 the international futures forecasting with the model anticipates that global traffic deaths will surpass 3 million people per year. This forecast shows that Africa will be particularly hard hit and will account for over 1 million of these deaths, or 35 percent of the global total. To put this in perspective, by 2050, traffic accidents in Africa will kill almost the same number of people annually as now die from malaria in sub Saharan Africa. And, for every 20 Africans who die in 2050, one will be killed in a traffic accident. However, despite the significant numbers of Africans being injured or killed in this way, road traffic accidents do not receive the same coverage as other public health issues such as chronic diseases. African countries

experience a dramatic increment in the number of vehicles on the road. Very often, such increases in road traffic accident are not matched by adequate improvements in infrastructure and road safety regulation. This results in lag between private expenditure on vehicles and the public expenditure necessary to accommodate increased motorization (African Futures Brief, 2019).

Different Author Who investigate about Africa road traffic accident including Ethiopia.

Table 2.1 Road traffic accident in Africa

Author	Date	Objective	Methodology	Finding
Godwin Boating	January, 2021	To measure road trauma in Africa through a case study of Ghana.	Descriptive analysis	African drivers as having a danger-prone driving culture
KD Konlan	August, 2022	To determine factors associated with motorcycle-related Road traffic accident in Africa.	Convergent synthesis	Behavioral factors associated with RTA were alcohol use, smoking, use of illicit drugs, tiredness of rider, poor knowledge on traffic regulations are the main factor for motor related RTA.
Birhanu Teshome and MekonnenTadesse	April, 2021	Identify the potential factor associated with number of human death by RTA In Oromia, Ethiopia.	Count regression model	Vehicle service for long year, driving on weight road, driving in the afternoon, driving residential place are the main contribute for RTA.

(Source: Journal article of Africa, 2021/2022)

2.1.2.3. Road Traffic Accident in Ethiopia: - The 2011 traffic accident report of the Ministry of Transport National Road Safety Council indicated that next to pedestrians (51%), passengers' accident ranks second, accounting 46% of fatality. Of the total traffic accidents, 93% of the cases were associated with human factors, 5% accounted for vehicle factors, and 2% were associated with road related problems. Similarly, the Ethiopian Federal Police report of (2011) stated that road accident level of the country is one of the worst in the world, as expressed by per 10,000 vehicles. Moreover, the report stated that majority of road accidents were concentrated in Addis Ababa, which is the capital city of Ethiopia, and Oromia region, accounting 58 percent of all fatalities and two-third of all injuries.

The summary report of the Federal Police Commission also shows that 82% of the accidents occur on straight and level roads with good surface, while 83% of all the accidents were occurred on good asphalt roads. During the last five years, the ratio of people who injured as a result of traffic accidents (fatal, serious and light) includes 48% pedestrians, 45% passengers and 7% drivers. This all facts show that majority of traffic accidents have been caused by poor driving skill or negligence towards traffic rules and regulations. This conclusion can be further supported

with report prepared by Minister of Transport on pilot radar control program, which was conducted in East Shewa Zone of Ethiopia, indicating majority of drivers do not respect the speed limit rule of the road. The graph below shows that speed violation in some cities and towns

is sometimes up to three times higher than the posted legal limit (Minister of Transport, Febraury, 2011).

2.1.3 Concepts of traffic accident black spot

There is no universally accepted definition for black spot. Black spot areas in road traffic accident are defined in different ways by different scholars. In highway traffic safety, "black spots" are defined as unit road section that show dense accident rates (Deepthi et al. 2010). From the perspective of (Rokytova, 2000) black spots are defined as locations that are generally classified after an assessment of the level of risk and the likelihood of a crash occurring at a particular section. In another words, accident black spot in Norway national highway agency is defined as any place with a maximum length of 100 meters, where at least four injury accidents

have been testified to the police in a four year period (Elvic, et al. 2005). Thus, a black spot in the UK may well have only five injury accidents within three years, whereas a city in Bangladesh may have black spot defined as having more than 10 injury accidents in a year (Geurts and Wets 2003). In most developed states, black spots are defined as the locations where there are 12 accidents within 3 years per kilometers (Guo, Gao et al. 2003). In Czech Republic, the black spot criterion is that junctions or 250 m long road segment that are considered as black spots on condition that at least 3 road accidents with injuries occurred within year or at least 3 road accidents with injuries of the same type occurred within 3 years or at least 5 road accidents of the same type occurred within a year (Rokytova 2000). Study on single carriage trunk road (Walmsley, et al. 1998) revealed that the criterion used to describe road sections for accident analysis are age of road inauguration, carriageway width, curbs, hard strips, and speed of the road section. However, (Elvic, et al. 2005) identified black spots on national highways in Norway have heavy traffic but do not have particularly high accident rates when compared with places which are not classified as accident black spots. Ranking of black-spots were done with various alternatives. (Jonnessen at.al 2006) show three alternative methods of ranking black spots.

1. **Frequency of Accidents:** The frequency of accidents is one of the most commonly used methods of ranking road black spots. This method involves analyzing the number of accidents that have occurred on a particular road over a given period. Roads with a higher frequency of accidents are ranked higher on the black spot list.
2. **Severity of Accidents:** The severity of accidents is another method of ranking road black spots. This method involves analyzing the severity of accidents that have occurred on a particular road. Accidents resulting in fatalities or serious injuries are ranked higher on the black spot list.
3. **Public Perception:** Another method of ranking road black spots is by public perception. This method involves gathering feedback from the public, including drivers, passengers, and pedestrians. Public feedback is used to identify roads that are perceived to be dangerous, and these roads are ranked higher on the black spot list. This method is often used in combination with the frequency and severity methods to provide a more comprehensive ranking.

2.1.4 Criteria for selection of black spot

Different country can use expected time coverage for black spot analysis in respect to amount of road accident exist repeatedly with the specified frequency and relative severity at specified period. As a result; accident data for the most recent 1 to 3-year period is normally used and is generally sufficient. 2 or 3 year analysis periods are more appropriate at locations with low traffic density, where a single year period may not provide sufficient information for location with low traffic volume. Accident data should only be used when there are no major changes in facility characteristics or land cover. Simple methods for selecting unsafe locations, where the number of crashes or the crash rate per unit exposure exceeds a given threshold, are routine and straightforward (Taylor, Bonsall et al. 2000). From statistical point of view, it is favorable to have as many road accidents as possible. If accidents from more than one year are added, the result would be more accidents (Kent Sjölander and et.al, December 2001).

Various criteria for selection of road traffic black spot area using crash data are listed below (Ministry of road transport &highway of India, June 2017).

1. **Historical crash data:** The number of crashes that have occurred at the black spot over a set period of time, preferably at least three years, should be analyzed.
2. **Severity of crashes:** The types of crashes that have occurred at the location should be considered, as well as the severity of the injuries sustained by those involved. This can be determined by analyzing police reports, medical records, and insurance claims.
3. **Geographical and traffic characteristics:** The road's physical characteristics, including the width, shape, access points, speed limit, and traffic flow, should be analyzed to identify possible causes of crashes.
4. **Contributing factors:** Other factors that may contribute to crashes, such as weather conditions, visibility problems, driver behavior, and road maintenance, should be assessed.
5. **Comparative analysis:** The black spot should be compared to other similar locations in terms of crash rates and contributing factors to determine if there are common factors that lead to black spot crashes.
6. **Potential solutions:** Possible solutions to alleviate the issue should be considered and analyzed, such as improving road design, adding safety features, or implementing traffic calming measures.

7. **Cost-benefit analysis:** The cost of implementing potential solutions should be weighed against the potential benefits and effectiveness in reducing crashes at the black spot.

2.1.5 Concept notes of QGIS

QGIS is an application which can be highly customized and open source system. It is possible to adapt the graphical user interface (menus, toolboxes, docks...), extends behavior through various mechanism, and create specific custom feature with plugins and new processing algorithms. Geographic or spatial data usage plays an important role on many field of study. Many data used in life directly or indirectly have spatial information. Usage of spatial data required selection and manipulation of them correctly. In this step, QGIS has an important role. QGIS is a tool which provides collection, storage, manipulation, query, analyzing and visualization of the spatial data (Lloyd, 2010).

Geographic location gives information about road traffic accidents with their coordinates. Occurrence of accidents at the same place or nearby places could be the indicator of causes of accidents. For this reason, traffic accidents should be analyzed with their coordinates. With the help of spatial analysis tools, high RTA occurrence areas could be clearly identified. QGIS is a very important and comprehensive management tool for road traffic safety. Since 1990's, QGIS technologies have been used more frequently for such studies due to the availability of open source QGIS with user-friendly interfaces. In the traffic safety analysis, QGIS can visualize the locations of accidents and store the attributes of accidents like time of the accident, number of injuries, number of fatalities, characteristic of the roads that accidents occur, land-use characteristic, etc. QGIS is explanatory in order to find the reason behind the occurrence of accidents since it relates the locations with many attributes. Recently, many studies related with traffic safety analysis have been performed with the help of QGIS. The type of analysis, applicable for accident analysis, include intersection analysis, segment analysis, cluster analysis, density analysis, pattern analysis, proximity analysis, spatial query analysis and spatial accident analysis modeling techniques. Kim et.al (1996) described the traffic safety QGIS prototype which performed spatial analysis of traffic accidents that is developed for Honolulu, Hawaii. Different type of spatial analysis methods based on point, segments and zones analyses had been developed. Affum et.al (1998) introduced a Safety Evaluation Method for a Local Area Traffic Management (LATM), which was also a QGIS-based program for analyzing accident patterns

over time. Hirasawa et.al (2003) proposed a traffic accident analysis system based on QGIS, which was linked with digital maps showing accident locations, and also provided vital information on road structure and road furniture, and weather forecast information. In order to identify black spot (accident related with roads or criminal activity at the highway for example, vehicle thefts or car chase) on roads, network based spatial analysis can be used. Software package Spatial Analysis on a Network (SANET), can be used within the ArcGIS software. Network KDE, can be used for identifying traffic accident hot spot segments on a network. Different from KDE measure the bandwidth based on Euclidian distance, network KDE provides measurement of bandwidth based on a network distances. (Okabe et al., 2006)

QGIS tools have the ability to do spatial analysis; but there are many other software packages performing spatial statistical analysis. In some situations, scholars needing more than a QGIS program, couple different analyses to QGIS fully or loosely. Loose coupling means exporting data from the QGIS package to use in a statistical spatial analysis framework. Close coupling involves calling a spatial analysis routine from within QGIS (Bailey et.al, 1995).

2.1.6. Severity index

A widely used statistics for the description of relative crash severity is the severity index (SI), Severity indexes can be calculated using various factors such as the impact on human life or health, the degree of damage or loss caused to property, or the extent of disruption to critical systems or processes.. Crash severity index is used for assessing the level of severity between accident variables. This approach is widely used for analysis of relative severity of crashes. This analysis fill the gap created on accident frequency, which expresses only the number of accidents registered on the expressway. Unlike accident frequency, crash severity index provide the severity of each crash relative to accidents registered during a specific time.

2.1.7. Spatial analysis tools

In this section, spatial techniques in GIS used to analyze road traffic accidents are presented. Spatial analysis is used to geographically specify the locations where the crashes occurred, and to assess specific patterns of distribution through map visualization.

2.1.7.1 Moran's I statistic: - Moran's I is a statistical tool that measures the spatial dependence of the accident location (Moran, 1948). MI also evaluates if the spatial pattern clusters are dispersed or random and also determines the level of concentration. According to Erdogan (2009), MI provides a single value of the spatial correlation and checking the clustering of the spatial pattern. Heavy locations of the proximity between the two points are often defined as the inverse of the distance between them. The attribute similarity severity index of two points is defined as the difference between each value and the value of the global average. Pirdavani et al. (2014) developed crash prediction models using geographically weighted regression. It was carried out by computing Moran's I for dependent and selected explanatory variables. The result revealed the necessity of considering spatial correlation when developing crash prediction models.

2.1.7.2 Getis-Ord:- Getis-Ord Statistics are a family of statistics that has a number of attributes that make them attractive to measure the dependence of spatially distributed variables, especially when they are used in conjunction with MI. They deepen the knowledge about the processes that lead to spatial dependency and improve the detection of local 'pockets' dependence that may not appear when using global statistics (Getis & Ord, 1992). The Getis-Ord statistic is used to identify hot spots of traffic accidents. A high value of the Getis-Ord statistic represents a group of high index value (hot spots), while a low value represents a low value of the index group. The hot spot analysis calculates Getis-Ord statistic for each feature in the data set.

2.1.7.3 Kernel density: - Kernel Density Estimation (KDE) is a spatial data analysis of ArcGIS program. Budiharto and Saido (2012) measured Kernel Density for determining the risk spread of the accidents. The spread of risk can be defined as the area around the cluster where such risk may increase due to an accident. An analysis using KDE tool produces a raster output.

2.2. Review of Empirical Literature

2.2.1 Limitation of previous researcher

Road traffic accidents are increasingly being recognized as a growing major issue, particularly in developing countries. They provide significant social and economic losses. Hence recently the numbers of studies uses Geographical Information Systems for analyzing accidents. Furthermore using GIS for traffic accident analysis not saturated.

Presently, while considering investigating road traffic accident black spot area, there are many research gap related identifying major cause of road traffic accident injury on black spot area on the far fewer research work. The majority of research only limited to the temporal classification. However the present study has not been unable to mention a specific research toward practical application of cause of crash (alcohol, sleeping while driving, etc) , crash type(overturn, crush with fixed object and other) geometric condition type, road surface condition (dry or wet), road conditions (raveling surface, alligator crack, pot hole surface or other) whether condition (sunny, rainy, frost and foggy), vehicle classification, vehicle ownership (private, governmental, NGO or company plate), years of manufacturing of the vehicle, driver gender, age, license level, Driver education level, driving experience, direction (travelling direction away or toward) and type of road (intersection or road segment because factors related to the accidents that occurred at junctions were different from factors on the road segment.). Even though the research reveals the strong relationship between road traffic accident, times interval and traffic volume. However the practical application of mentioned models are limited because of the complex numerical solution require. As a result the relationship of traffic accident, time interval and traffic volume actually have a limited effect on the identification of a real cause of the road traffic accident subsequently it's difficult to make appropriate mitigation action taken by the concerned institution and policy maker.

CHAPTER III METHOD AND MATERIAL

3.1 Description of Study area

3.1.1 Location

The Addis Ababa Adama expressway is located in Central part of Ethiopia in Oromia Regional State and starts from Tulu Dimtu station, 13 kilometers south-east of Addis Ababa City. The mainline of the expressway follows 2 Kilometer on Outer Ring Road of Unisa, Maseltgna roads of Addis Ababa. The Expressway proceeds in a southeast direction, passing to the east of Dukem Town, Bishoftu City, and Modjo Towns crossing the existing Addis Ababa, Adama at approximately 62 Km to bypass Adama to southern side. The expressway terminates to the east of Adama, connecting with the newly ongoing constricted Adama, Awash expressway road. Its geographic coordinate between 8°51'44" North, 38°49'40" Easting and 8°32'38" North, 39°18'38" Easting. The expressway covers a total length of 76.3 kilometers (Addis Abeba, Adama expressway as built document, 2014).

Daily traffic accident data that was collected through the Ethiopian Toll Road Enterprises is used for the study. Overall, the data covers a period of three and half years (January 2018 to May 2022), all traffic accident related collected data

The purpose of this study was to investigating road traffic accident using QGIS software. This chapter details the research methodology employed in the study. The main source of data for this study would be a secondary data utilized from Ethiopian toll roads enterprise, road safety department.

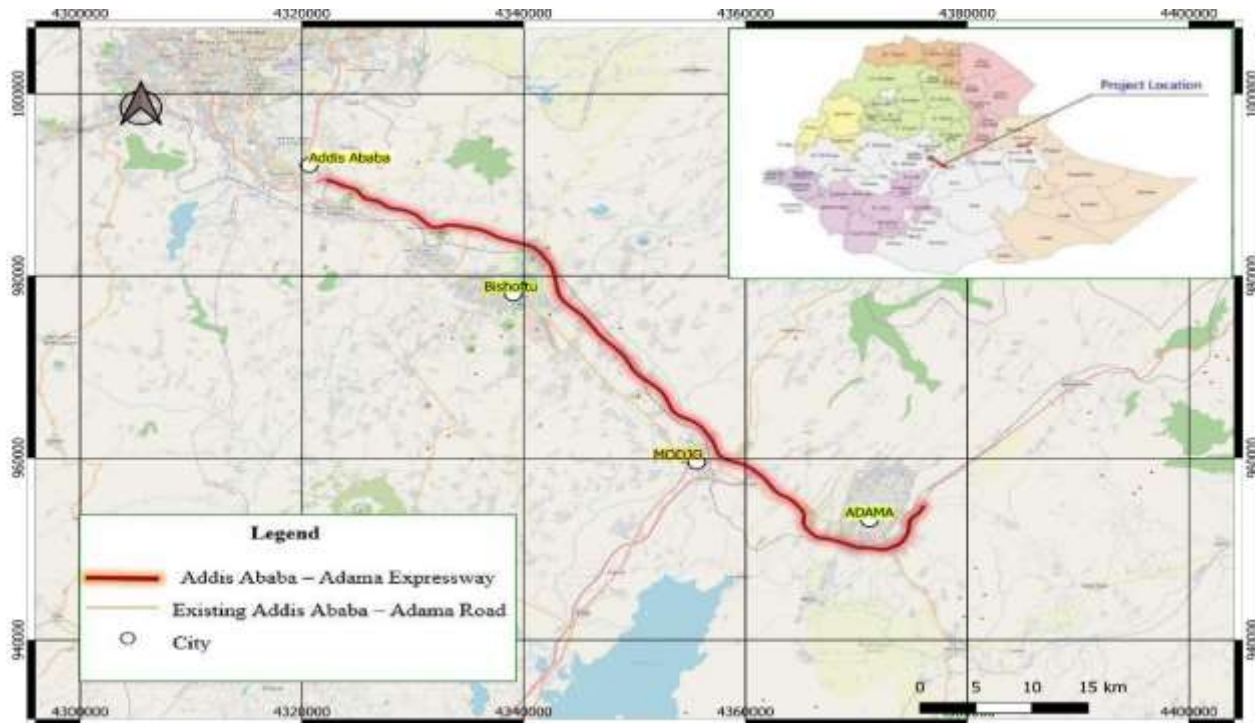


Figure 1:- Study area of Addis Ababa, Adama Expressway (source: Addis Ababa, Adama toll road As-built document)

3.2 Data type, source and material

The study project required secondary data for determining the accident black spots along the Addis Ababa Adama expressway.

The accident data or the secondary data was collected from reports maintained by the road safety departments, Ethiopian toll roads enterprise along the Addis Ababa Adama expressway. It comprised of three years of accident records vis. July 2019 up to July 2022. Three year data were used instead of one year to even out random variations. Apart from this, three years is a suitable balance between having a long period for getting many road accidents and a short period so that the spot is not changed too much. The data provided by Ethiopian toll roads enterprise consisted of crash data, crash time, week of a day, crash type, cause of crash, type of accident, chainages, direction, geometrical condition, surface condition, whether condition, plate number, years of car manufacture, make in country, vehicle ownership, age, sex, marital status, license level, driving experience, driver education level and driver relationship. The coordinates of all accident locations were acquired using a chainages from the secondary data (Road safety department daily patrolling three time within 24 hours 76 km of Addis Ababa Adama expressway, hence during accident the road safety officer recorded accident location from the

chainages leveled at curved stone of the median). It had accuracy of 3-5 meter within a 20 meter interval chainages. The following issues were observed in collection of secondary data:

Availability of data: Some of the locations register in chainages have a corresponding coordinate value from as built data regarding its location

Accuracy of data: With high accuracy QGIS data collection capabilities of GPS from as built data and easily understood accident location reporting by road safety department of respective zones (road safety department on Addis Ababa Adama expressway have three sub department each patrolling up to 30 km per day within 24 hour), effective mapping of all the accidents was possible with little deviation of <10 meter from actual spot.

3.2.1 Software and material used

In order to achieve the objectives of the study, the following hardware and software were also utilized.

A) Hardware

- Laptop with a monitor display of 1024x768 pixels, memory 8GB RAM, Core i7
- Handheld GPS receiver. Used for sample point collection and data verification.

B) Software : The following software package used for study were:

- Excel office: used for data management, data entry in to QGIS
- Microsoft office: package used to wright the thesis, undertake statistical analysis, develop data spread sheet, manage data base and print the final result.
- SPSS: statistical analysis and chart and graphs representation.
- Google Earth: used as a complimentary in order to check the data
- Quantum GIS 3.16: used for secondary data manipulation including neighborhood analysis and map algebra.
- Expert GPS: To export hand held GPS data to excel sheet.

3.3 Data and methodology

3.3.1 Data

Traffic accident data acquire from Ethiopian Toll Roads Enterprise

Table 3.1 Data and their source

No.	Data	Source	Purpose
01	Addis Ababa- Adama Toll Road plan and profile	Ethiopian Roads Administrator	To extract road plan

No.	Data	Source	Purpose
02	Google Earth	Open source	for verification of the acquired data (open source)
03	Traffic accident data	Ethiopian Toll Roads Enterprise	To acquire traffic accident data
04	Road traffic accident location	Field collected using hand held GPS	To show spatial patterns road accident

3.4 Source and Type of Data

To meet the objective of this research, different kinds of data were collected from both primary and secondary data source.

3.4.1 The primary data

The primary data source was include field data that was collected with the use of Global position system (GPS) using hand held GPS and exported using Expert GPS to excel format. Furthermore, cross check using Google earth field data field observation.

3.4.2 Secondary data

The secondary data source involves Traffic data is required to undertake analysis of road safety problems for roads under consideration. These data is helpful in determining the type of measures that is applicable at the site. Besides, the result of traffic counts and compositions is used as one of the inputs or to develop criteria in delineating the road under study. Since the expressway registers the volume of traffic digitally, there is no need to undertake field traffic count.

3.4.4 Secondary Data Collection

3.4.4.1 Accident Records: Crashes were recorded by the Ethiopian toll roads Enterprise safety officer on daily basis. This study was based on a secondary data obtained from Ethiopian Toll Roads Enterprise Addis Ababa –Adama expressway branch office for three years period from June, 2019 – June, 2022.

3.4.4.2 Traffic data: Road traffic accident data on expressway have been gathered and recorded by the traffic patrol assigned by Ethiopian Toll Road Enterprises. As a result, the raw data used for this research is obtained from the Traffic Safety and Security Department of Ethiopia Toll Road Enterprises. To achieve the study objective, traffic data was obtained from Ethiopian toll roads Enterprise safety officer on daily basis in order to determine the rate of traffic crash within

three years period from 2019-2022. Though road geometry has an effect on occurrence of road accident, the study road under consideration is high standard. As a result, in this study do not include data on geometrical design. Therefore, the study used the data as recorded by the enterprise to draw logical conclusion. To organize the data for various analyses and investigations, road traffic accident database was established using excel and used for the study. Data collected from the enterprises shows that, around 1392 road crashes were registered on the expressway during the study period. All accidents were properly identified and registered. Furthermore, to determine the location of accident spot, each accident location was measured by the enterprise up to the accidents spot using available measurements.

A. Traffic Accident Data

All road sections are found on mainline, toll entrance and exit point. To acquire reliable data, a road traffic accident form was designed. The form has the following major characteristics and these features are used for capturing data.

- Temporal variation (Day time, Daily of a week, hourly of day and monthly) of accident
- Sex of a driver
- Maritime status of driver
- Age of a driver
- Vehicle type
- Injury type
- Location of accident
- Cause of accident
- Surface type
- Geometric condition
- Plate type
- Direction of flow

B. Traffic flow data

Under this study area road traffic data is required to undertake analysis of road safety related problems. These data is helpful in determining the type of measures that is applicable at the site. Besides, the result of traffic counts and compositions is used as one of the inputs or standard to develop criteria in delineating the road under study.

Vehicle classification

Vehicle is defined as carriage, chariot, bicycle, motor vehicle, semi-trailer and trailer operated on a road, a vehicle type refers to the classification or category of a motorized vehicle based on its form, function, and purpose. Examples of vehicle types include cars, trucks, motorcycles, bicycles, buses, trains, boats, airplanes, and helicopters. (Council of Addis Ababa City Government, 1998). In case the study classified vehicles into seven groups. This are small automobile, pickup (up to 5 seat cars) classified as V_1 , minibus (5L, dolphin, high roof) classified as V_2 , medium bus (sets up to 30 passenger) and mini truck (ISUZU truck) classified as V_3 , Large bus (sets more than 30 passenger) and Dump truck with 14 kunal carrying capacity (SINO truck or FSR) classified as V_4 , Heavy track (Low bed or high bed)classified as V_5 , V_6 , V_7 depends on number axil load. Detail parameter listed below on table 3.2.

Table 3.2 Vehicular classification

Vehicles Category	Classification Parameters				Character description of vehicles
	I-Axle number	II-Tire number	III-Height of vehicles head(m)	IV-Axle distance (m)	
V_1	2	4	<1.3	<2.4	Small automobiles Cars, Jeep, L/Rover, taxi Pick up
V_2	2	4	≥ 1.3	≥ 2.4	Minibus
V_3	2	6	—	—	Medium Bus, ISUZU
V_4	3	—	—	—	Big size Bus Medium Truck
V_5	4	—	—	—	Heavy Truck Trailers
V_6	5	—	—	—	Heavy Truck Trailers
V_7	≥ 6	—	—	—	Heavy Truck trailers

(Source: Ethiopian toll road enterprise, ICT and monitoring department)

3.9 3.5 The study research approach

Both qualitative and quantitative research technique is used to systematically investigate the facts behind traffic accidents and to discover and analyze events, behaviors, or facts to draw logical conclusion that help to draft applicable rules, laws and theories for the area. As it is documented in different literatures, there are three main types of research approaches. These are:

1. **Explanatory research:** this type of research that seeks to explain a certain phenomenon by identifying the underlying factors that contribute to it. It aims to give a more detailed

understanding of the subject matter and provide valuable insights into the reasons behind certain trends or behaviors. This type of research usually involves studies that use a mix of qualitative and quantitative methods in gathering data, such as surveys, interviews, experiments, and case studies. The findings of explanatory research often provide explanations, theories, and suggestions for further research on the subject matter.

2. **Constrictive research:** this type of research that is conducted with a defined and specific set of objectives. It is carried out in order to provide solutions to specific problems, and to achieve these objectives in a precise manner. The research is designed to constrain the scope of study to a particular set of variables, which are then analyzed within a structured framework.
3. **Empirical Research:** is a research method that involves collecting data through observation and experimentation. It is also known as experimental research. Empirical research aims to discover and test theories or hypotheses by generating data that can be analyzed and interpreted. It's based on systematic and objective observation, experimentation, or measurement to create knowledge. It often involves quantitative (numerical) data collection and analysis, using statistical methods and it is important because it helps to establish evidence-based practices, policies and decisions. It also helps to identify new areas of concern and explore the relationships between variables.

In this particular study, the intention of the research is to design appropriate techniques that help to solve the problem of road traffic crash that have been created on Addis Ababa-Adama expressway. As a result, this study can be categorized partly as empirical research, since it uses empirical technique to show the level of traffic crash in Addis Ababa-Adama Expressway.

3.10 3.6 Model selection for Analysis

Different models uses different data set to effectively perform analysis and draw logical conclusion. Researches made on this area indicated that Binary Logistic Regression requires dummy variables to run the model. Ordinal Logistic Regression requires ordered polytomous data to run the model and execute the data. On the other hand, Binary Logistic regression requires nominal dichotomous data to function properly. Given the nature and properties of identified black spot area outcome from the result (which is analysis from collected Ethiopian Road Tall Enterprise data) which has nominal and dichotomous in nature, the study preferred the use of Binary Logistic regression model. The main benefit of using this model is

that it gives cumulative standardize predicting the likelihood of road traffic accident injury.

3.11 3.7 Variables Definition

Depending on the objective of the study and the type of data collected from the enterprise, the study identified the following independent and dependent variables to be used for research under consideration.

3.7.1 Independent variable

- Crash time (0:00-6:00 , 6:01 – 12:00, 12:01 - 18:00 , 18:01 – 24:00)
- Weeks of a day (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday)
- Crush type (Collusion with animal, Collusion with fixed object, Collusion with parking vehicle, Collusion with tree, Overturning, out of road and others)
- Cause of crash (Vehicle technical problem, Driver uses of substance, Flat tire, Driver sleep while driving, Over speed, Road condition, Animal interaction)
- Direction (To Addis Ababa and To Adama)
- Geometric condition (Horizontal curve, Uphill, downhill and straight)
- Vehicle condition ($V_1, V_2, V_3, V_4, V_5, V_6, V_7$)
- Age (Child, youth, Adult, senior/old and unidentified)
- Sex (male and female)
- Maritime status (Married, single and divorced)
- Education (Primary school, secondary school, high school and degree or above)
- Weather (Clear sky, Sunny, cloudy, rainy and heavy wind)

3.7.2 Independent variable

In line with the objective of this research, the dependent variable is road traffic accident at the black spot segment. This variable can be express interims of variable it contribute a road traffic accident injury or not.

3.12 Method of Analysis

3.8.1 Descriptive analysis

Descriptive analysis is a statistical technique that is used to describe and summarize data. It consists of various methods and techniques that are used for summarizing and describing the basic features of the data. Descriptive analysis helps in identifying patterns and trends in the

data and provides insights that enable better decision-making.

Descriptive analysis includes the identification of the mean, median, mode, range, and standard deviation of the data. It also involves graphical representation of the data using tools such as histograms, bar charts, pie charts, and scatterplots. Descriptive analysis can be performed on quantitative data such as numerical measurements and qualitative data such as categorical variables or attributes..

3.8.2 Empirical Analysis

Empirical analysis is a type of research that is based on data and observation. it involves using data to test a hypothesis or answer questions. Empirical analysis involves collected data through various methods such as field survey using hand held GPS, secondary data from Ethiopian Toll road enterprise road safety department report and the road traffic accident of Addis Ababa Adama expressway data within study period analysis using statistical techniques to identify patterns and relationships. The results of the analysis are used to draw conclusion and make predictions.

Empirical analysis is important because it provides the relationships between road traffic accident injuries and temporal variation, maritime status, cause of accident, age, sex and other variable.

3.8.2.1 Binary logistic Regression: The logistic regression model estimates the relationship between the dependent variable and the independent variables using the logistic function, which transforms the linear relationship between the independent variables and the dependent variable into a range between 0 and 1. This allows us to interpret the output of the logistic regression model as the probability of the dependent variable being in one of the binary categories.

The logistic regression model returns estimates of the coefficients of the independent variables, which represent the change in log odds of the dependent variable for a one-unit increase in the independent variable. These coefficients are used to calculate the odds ratio, which measures the change in the odds of the dependent variable for a one-unit increase in the independent variable.

On the basis of the nature of the data is dichotomous, the research used binary logistic Regression model used to model the relationship between binary categorical dependent variable and more independent variable. Binary logistic regression is a statistical method used to predict the probability of a categorical dependent variable based on one or more independent variables.

In binary logistic regression, the dependent variable is usually dichotomous or binary, meaning it can only take two possible values (e.g. success/failure, yes/no, 1/0). The independent variables can be continuous, categorical, or a combination of both.

In this study assess if a particular road traffic accident at the black spot area lead to injury/ no injury of Addis Ababa –Adama expressway road user based on age, maritime status, cause of accident, surface condition, geometric condition, education, temporal variation, weather condition, carriage way and sex. According to Leblanc and Fitzgerald (2000) suggest a minimum of 30 observation per interdependent variable, hence in this study uses 218 road traffic accident data at the black spot area section.

3.9.2. Statistical Analysis

3.9.2.1 Accident Severity: Accident severity refers to the level or extent of harm or damage resulting from an accident. It is often measured by the severity of injuries, property damage or loss of life that occur as a result of the accident. Severity can range from slight injuries or damage to severe injuries and lethal accidents. The severity of an accident can be influenced by several factors including the speed of impact, type of collision, condition of the vehicles or infrastructure, use of safety features, and pre-existing medical conditions of the victims.

This study utilized QGIS 3.16 which is an Open Source Geographic Information System for analysis. The digitized map of Addis Ababa, Adama expressway obtained from GPS was imported in QGIS 3.16 and saved as “roads” layer. It was ensured that imported GPS coordinate and data frame of QGIS 3.16 have the same „projected co-ordinate” system. The co-ordinate system adopted for the present study is WGS 1980 UCS. The 3 and half years (2018-2022) accidents were geocoded by giving X and Y coordinates to each location. For every geocoded point, an Identity (ID) in a form of whole number is automatically created on QGIS 3.16. Every accident location was also attributed with detailed information severity of the accident. This Studies were performed with considering severity of accident incident in analysis for determination of high clustering. The severities of accidents were considered in analysis and produce heat map by QGIS 3.16 using a tool so called KDE (one of the most common methods for hot spots analysis is preparation of crash maps based on Kernel Density Estimation) is used to create density map of an input point vector layer. It was utilized to calculate density of accidents within a required search bandwidth. In this study I intended to use weighing system was adopted by Belgium government as a part of their official methodology for hot spot

detection.

Studies were performed with and without considering severity of accident incident in analysis for determination of high clustering. For the analysis without taking severity in consideration, ID of each accident should be taken as “1”. This will provide equal weight to each accident irrespective of its severity. Some researchers also suggested that, without weighted data, it is very hard to establish whether the observed clustering is true or not. To identify unsafe locations, crashes should be weighted according to severity.

It is a belief that more severe accidents should have greater weights. There is no universally defined optimum accident severity weighing system. The severities of accidents were considered in analysis as per Belgium system. This weighing system was adopted by Belgium government as a part of their official methodology for hot spot detection. As per this system, individual weights of 100, 50 and 2 is provided for fatal accident, serious accident and for slight accident type accidents respectively. Severity index for each location can be calculated as per Equation 1:

$$SI = 18F + 8SE + 3SL + PD \dots \dots \dots \text{eq 1}$$

Where:

SI = Severity index

F= total number of fatal accidents

SE= total number of serious accidents

SL= total number of slight accident and property damage only accidents

PD = Property damage

Heat map in QGIS 3.16 is a tool based on KDE (one of the most common methods for hot spots analysis is preparation of crash maps based on Kernel Density Estimation) is used to create density map of an input point vector layer. It was utilized to calculate density of accidents within a required search bandwidth.

After identifying severity index above the model can be divided by a suitable value, the number of accidents. The relative severity value is the $R_j = S_j / A_j$, which means severity per accident.

The average value of severity per accident was estimated with:

$$R_{ave} = \sum_{i=1}^n S_j / \sum_{i=1}^n A_j \dots \dots \dots \text{eq 2}$$

The Variant δ^2 of the severity value is estimated with:

$$\delta^2 = 1/n \sum_{i=0}^n (R_j - R_{ave})^2 \dots \dots \dots \text{eq 3}$$

On the basis of the above severity computation, the location of black spot found if: $R_j > R_c$,

$$R_c = R_{ave} + k\alpha\sqrt{\delta^2} - 0.5/L_j \dots \dots \dots \text{eq 4}$$

k_{α} is a constant that is chosen for the significance test. It is determined from a normal distribution and selected to give a certain significance level:

$\alpha = 0,1\%$ gives $k_{\alpha} = 2.576$ $\alpha = 5\%$ gives $k_{\alpha} = 1.645$ $\alpha = 10\%$ gives $k_{\alpha} = 1.282$, Where L_j is 1 km and $k_{\alpha} = 1.282$ for more information (source: Road improvement and traffic safety project manual, Ankara, 2001)

3.10. Road traffic accident black spot identification flow diagram

The process of identifying the black spot area and identifying the major factor contribute to traffic injury at the black spot area using empirical analysis illustrated in the following figure.

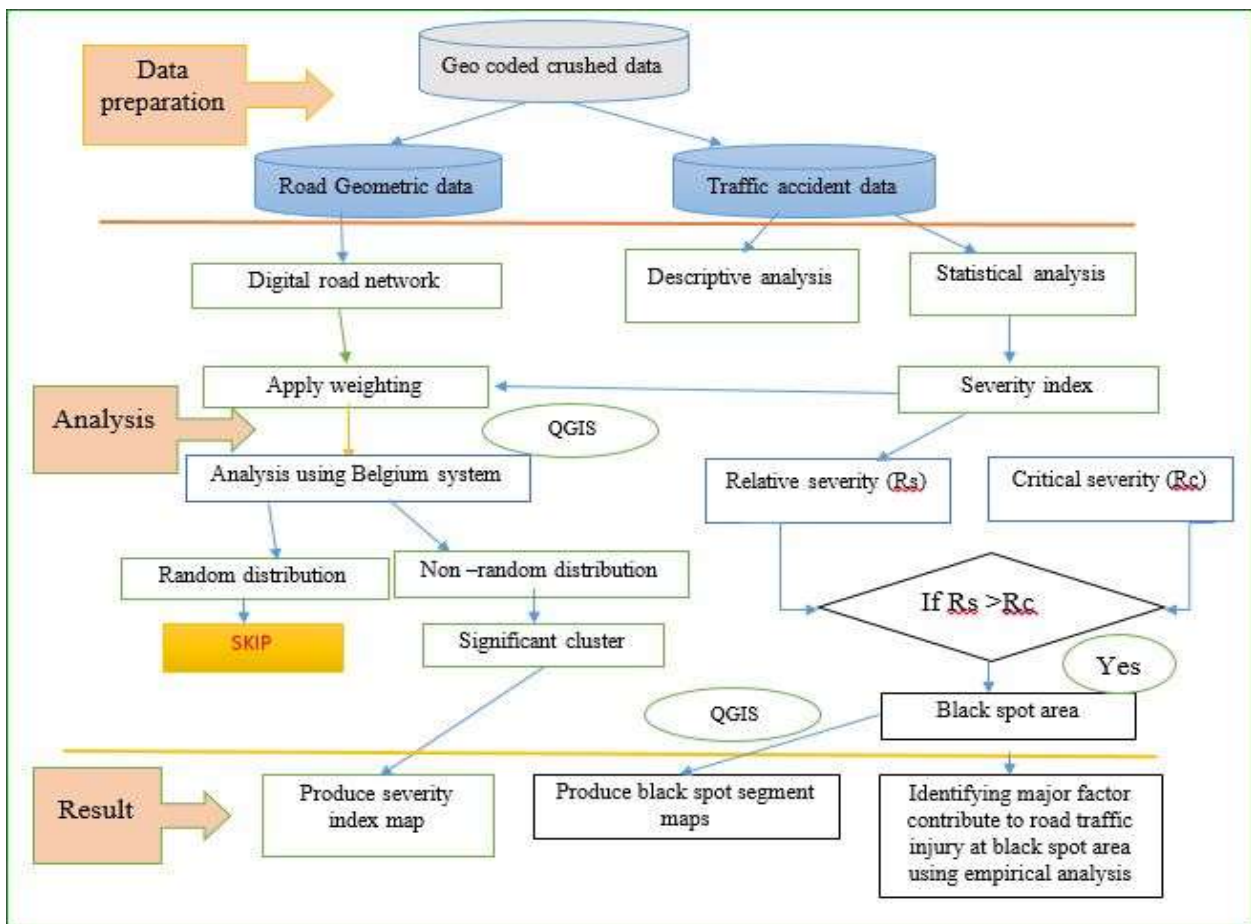


Figure 3.2 Process of identifying black spot area and major factor contributor to road traffic injury

3.11. Model testing

In order to check the appropriateness of the variables and validate the applicability of the model the reliability analysis test was made and cronbach's alpha measured and the value more than 0.7, cronbach's alpha a measure of internal consistency reliability in research. It is used to assess the reliability of a scale or test that consists of multiple measures or items. Alpha

measures the extent to which all the items in a scale or test are measuring the same construct or attribute. An alpha coefficient of 0.7 or above is usually considered acceptable but the reliability value varies according to the situation and variables. Meanwhile after checking appropriateness of the model only eleven variable used for the analysis of study in this paper.

Table 3.3 cronbach's alpha coefficient indicates it's above 0.7 indicating the variables can be used for further analysis.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.701	.824	11

Table 3.4: correlation coefficients between multiple variables.

Correlation Matrix

	Type of injury	geometric condition	Road Surface condition	Age	Education	Light Condition	Sex	Weather condition	Carriage way	Marital	Cause of crash
Type of injury	1.000	.073	.947	.699	.066	.286	.329	.699	1.000	.340	.092
geometric condition	.073	1.000	.101	.099	.484	.019	.055	.099	.073	.017	.615
Road Surface condition	.947	.101	1.000	.685	.077	.298	.274	.685	.947	.287	.091
Age	.699	.099	.685	1.000	.099	.197	.201	1.000	.699	.219	.165
Education	.066	.484	.077	.099	1.000	.043	.104	.099	.066	.031	.569
Light Condition	.286	.019	.298	.197	.043	1.000	-.026	.197	.286	-.046	.096
Sex	.329	.055	.274	.201	.104	-.026	1.000	.201	.329	.946	.033
Weather condition	.699	.099	.685	1.000	.099	.197	.201	1.000	.699	.219	.165
Carriage way	1.000	.073	.947	.699	.066	.286	.329	.699	1.000	.340	.092
Marital	.340	.017	.287	.219	.031	-.046	.946	.219	.340	1.000	-.022
Cause of crash	.092	.615	.091	.165	.569	.096	.033	.165	.092	-.022	1.000

The above table shows to explore the relationship between different variables in a dataset and can help identify patterns or trends. The correlation coefficient is a statistical measure that indicates the strength and direction of the relationship between two variables. Hence the table below shows determine which variables are strongly correlated and which are not, and to help build predictive models.

CHAPTER IV RESULT AND DISCUSSION

4.1 General characteristics of road traffic accident in Addis Ababa, Adama expressway.

In order to identify black spots and develop model of accident on Addis Ababa, Adama expressway, it is important to look for the characteristics of the total road accidents registered on the study area. In this case, the RTA database for the Addis Ababa, Adama Expressway include all accidents reported by the Traffic management and road safety and security department along 76 km long road for the period 01/07/2019 up to 01/ 07/2022. Accordingly, a total of 1,392 traffic crashes were reported during the stated period. From which of those crashes over 662 accidents were registered in the expressway cause injury. Out of these accidents human injuries, 51 were fatal, 161 and 450 were serious and slight injuries respectively and 23,428,692.9 ETB for property damage. To have better understanding, it is important to see the road accident distribution in relation road segment. Accordingly, accident frequency analysis is made to identify the characteristics of the road accidents and identify which variable is affecting road traffic related injury. Accident frequency provides rough estimation for exhibiting road traffic injury contributing factor. However, it can't give answer to which measure is severely contributing for road crash relative to the other variables. In order to differentiate the level of severity of crash across the road, there are options of using road accident severity index. The following figures and tables provide descriptions on the level of accidents using normal distribution.

4.1.1 Temporal variation of Road traffic accident

4.1.1.1 Hourly Temporal variation of road traffic accident: The occurrence of road traffic accident can vary within the 24 hours of a day. The environmental factors like the availability of light, the density of vehicles and the like have a greater impact in the variation of road traffic accident distribution within a day. A total of 1,392 road traffic crashes occurred in Addis Ababa, Adama expressway in three years. As indicate Table 4.1 below specifies the alteration of distribution of road traffic accident occurrence in Addis Ababa, Adama expressway in terms of the variation of time. Hence large number of accident was recorded between 0:00-6:00 on date time within three years traffic data.

Table 4.1.1 temporal variation of road traffic accident by hour of Addis Ababa, Adama expressway.

Time interval (US military time format)	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
0:00 – 6:00	245	182	112	539	38.72%
6:00 – 12:00	119	135	147	401	28.8%
12:00 – 18:00	68	117	148	333	23.9%
18:00 – 24:00	106	12	89	207	14.87%
Total	538	446	496	1392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.1.2 Traffic accident due to effect of time of day: Analysis made on the effect of brightness towards traffic accident indicated that huge number of road accidents was registered during day time accounting 62.93 percent of the total. This may indicate from table 4.2 .it directly related to number of traffic volume in other work the higher traffic volume at day time the higher traffic accident recorded meanwhile during night is a vise versa. As a result, the level of accident is low during night time.

Table 4.1.2 temporal variation traffic accident frequency by times of a day

Time of a day	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
Date time	346	270	260	876	62.93%
Night time	102	177	237	516	37.07%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.1.3 Weekly temporal variation of road traffic accident: There is a discrepancy in the frequency of road traffic accidents between different days of the week, similar to the fluctuation in the distribution of road traffic accidents within 24 hours of a day. Hence subject of result of the analysis, among the week of a day large number of accident was record on Wednesday with percentage of 15.61. The lowest number of accident was register on Tuesday with a percentage of 13.45 showed in in the table 4.3.

Table 4.1.3 temporal variation traffic accident frequency by weeks of a day

weekly interval	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
Monday	82	36	80	198	14.11%
Tuesday	64	59	64	187	13.45%
Wednesday	70	64	83	217	15.61%
Thursday	73	73	58	204	14.67%
Friday	73	58	57	188	13.52%
Saturday	71	70	56	197	14.17%
Sunday	68	62	72	202	14.51%
	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.1.3 Monthly temporal variation of road traffic accident: There is a discrepancy in the frequency of road traffic accidents between different days of the week, similar to the fluctuation in the distribution of road traffic accidents within 30 days of a month. The accident data base for Addis Ababa-Adama expressway include all accidents reported by the Road and Traffic Safety Management Team around 76 km long road for the period July 01, 2019 to July 01, 2022. Accordingly, a total of 1392 traffic crashes were reported during the stated period. Out of these accidents human injuries is accounted for 662 and 1076 property damage. Of the total human injuries, 51 were fatal, 69 and 204 were serious and slight injuries respectively. From table 4.13 August month is the highest number of crash recorded which account 11.71% and December month is the lowest number of crash recorded and recorded a percentage of 6.46.

Table 4.1.4 temporal variation traffic accident frequency by month.

Month	No. of Crash	No. of Vehicle Involved	Type of Crash						
			Fatal	Serious	Light	Fatal Crash	Serious Crash	Light Crash	Property Damage
July	121	139	5	11	41	5	6	16	94
August	163	178	6	8	36	6	5	21	121
September	115	134	6	21	41	5	5	17	81
October	107	136	6	13	38	5	5	16	80

Month	No. of Crash	No. of Vehicle Involved	Type of Crash						
			Fatal	Serious	Light	Fatal Crash	Serious Crash	Light Crash	Property Damage
November	99	116	4	20	39	3	7	15	73
December	90	106	2	9	26	2	5	13	69
January	119	140	10	8	19	6	2	11	99
February	128	152	3	7	20	3	3	13	108
March	114	136	5	18	25	4	6	12	91
April	125	145	6	14	31	6	3	14	101
May	114	134	3	6	42	3	3	21	86
June	119	138	8	20	37	6	7	17	88
Total	1392	1636	51	161	450	40	75	201	1076

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.2 Drivers Characteristics and Road Traffic Accidents

4.1.2.1 Drivers Age: Peoples are the primary causes of road traffic accident. Numerous research studies concludes that the age of drivers have direct relationship with occurrence of road traffic accident scenes. This is due to the fact that, the age of drivers affects their driving behavior, concentration, sense of responsibility and patience. According to data the highest number accident age category between 24 -64 years. Hence 88.76% of accident occurrence due to younger driver the age from 24 up to 64.

Table 4.1.5: Drivers age and road traffic accident in Addis Ababa, Adama

Driver age in years (in accordance Canada statistic agency)	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
Children (0 – 14 years)	0	0	0	0	0 %
Youth (14 – 24 years)	9	50	32	91	6.54%
Adult (24 – 64 years)	432	358	446	1,236	88.79%
Senior/old (64 and above years)	0	21	8	29	2.08%
Unidentified	7	18	11	36	2.59%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.2.2 Drivers sex: The occurrence of road traffic accident in Addis Ababa Adama expressway shows a great variation in terms of driver sex. As shown in Table 4.2.2 .Accordingly the data the highest number of driver are male which account 94.18% and 5.82% are female respectively.

Table 4.1.6: Drivers gender frequency

Driver gender	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
Male	390	428	493	1311	94.18%
Female	58	19	4	81	5.82%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.2.3 Marital status: Data on marital status were obtained from Addis Ababa Adama expressway shows in Table 4.2.3 Married driver account 58.19% and 41.45%, 0.36% are Single driver and Divorced respectively.

Table 4.1.7: Drivers marital status frequency

Marital status	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
Married	245	232	333	810	58.19%
Single	202	212	163	577	41.45%
Divorced	1	3	1	5	0.36%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.3 Road traffic accident Distribution in terms of vehicle type

Types of vehicle had their impact on accident severity. The study area had seven categories of vehicle. Accident data collected in this data indicated the major traffic accident caused by V₁ types of vehicle with a percentage of 40.30 and least traffic accident caused by V₆ with a percentage of 1.08.

Table 4.1.8: Traffic accident frequency to classification of vehicle type

Vehicle type	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
V ₁	194	163	204	561	40.30%
V ₂	38	46	55	139	3.95%
V ₃	103	135	108	346	24.86%
V ₄	53	36	71	160	11.49%
V ₅	6	8	3	17	1.22%
V ₆	2	8	5	15	1.08%
V ₇	52	51	51	154	11.06%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.4 Crash type variable

In terms of collision types, majority of accidents that were registered on road users resulted from collision vehicle to vehicle, car overthrow and collision vehicles with static objects. As indicated in Table 4.1.9 below, collisions due to collusion with fixed object accounted for about 40.1 percent of the total accident that are registered during three years.

Table 4.1.9: Traffic accident frequency related crash type

Crash type	Accident Year			Frequency	Percentage
	2019/2020	2020/2021	2021/2022		
Collusion with animal	2	5	4	11	0.79%
Collusion with fixed object	202	156	200	558	40.1%
Collusion with vehicle	7	3	42	52	0.36%
Collusion with tress	3	0	2	5	3.74%
Overturning	2	5	4	11	0.79%
Out of road	16	13	9	38	2.73%
Others	139	183	202	514	39.92%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.5 Cause of crash and related variable

Traffic accidents usually happen spontaneously over time due to external and internal factors. In line with this fact, the distribution of traffic accidents are analyzed for the Addis Ababa – Adama expressway and the result of the analysis clearly identified that among the total seven causes of accident that are; Driving behaviors (problem with over speeding account the highest among types of crash and animal interference while driving account the lost with 40.88% and 0.36% of the total accidents (Table 4.1.10) respectively.

Table 4.1.10: Cause of traffic crash related frequency

Crash type	Accident Year			Frequency	Percentage
	2019/2020	2020/2021	2021/2022		
Vehicle technical problem	87	117	89	293	21.05%
Driver using substance	76	6	45	127	9.12%
Flat tire	87	83	76	246	17.67%
Driver sleep while driving	62	28	14	104	7.47%
Over speeding	120	203	246	569	40.88%
Road construction	16	9	23	48	3.45%
Animal	0	1	4	5	0.36%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.6 Weather condition

Table 4.1.11 shows that variety of weather conditions can lead to road traffic accidents. Accordingly the study area rainy accounts a percentage of 37.14 which was the highest weather condition that contribute to road traffic accident and it cause reduce visibility and slick road lead to more accident. Meanwhile the list possible cause for traffic accident by weather condition are heavy windy which account 0.79 percentage.

Table 4.1.11: Traffic accident frequency related weather condition

Weather condition	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
Clear at night	104	59	137	300	21.55%
Sunny	127	170	139	436	31.32%

Rainy	192	172	153	517	37.14%
Cloudy	23	40	65	128	9.19%
Heavy windy	2	6	3	11	0.79%
	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.7 Geometric condition

Road's geometric condition is found as the major contributing variable for the occurrence of road traffic accident at Addis Ababa Adama Expressway, since it is directly related to the speed of the vehicle and technical problem of the vehicle. Table 4.1.12 shows various geometric condition can lead to road traffic accident. Downhill contribute 34.27% with a highest contribute factor for traffic accident and Horizontal curve contribute 11.49% with the lowest road traffic accident.

Table 4.1.12: Traffic accident frequency related geometric condition

Geometric condition	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
Horizontal curve	41	75	44	160	11.49%
Up hill	63	84	153	300	21.55%
Down hill	141	207	129	477	34.27%
Straight	203	81	171	455	32.68%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

4.1.7 Road surface condition

As stated by David et al. (2005), the condition of road weather strongly affects the occurrence of road traffic accident. Similarly, road traffic accident is found to vary according to weather (Figure 4.10). The road condition due to differences in moisture is classified as dry or wet road. Out of the total 1,392 road traffic accident records in the last three years along study area 1,103 (79.23%) have occurred on dry roads while 289 (20.77%) on wet roads along Addis Ababa Adama expressway. This may be due to the short wet season (little number of rainy days) in a year, the dry season or dry weather which shields the extensive number of days in a year in the study area therefore produces greater number of road crashes.

Table 4.1.13: Traffic accident frequency related surface condition

Surface condition	Accident Year			Total	Percentage
	2019/2020	2020/2021	2021/2022		
Dry	349	370	384	1,103	79.23%
Wet	99	77	113	289	20.77%
Total	448	447	497	1,392	100%

(Source: Ethiopian toll roads Enterprise, Addis Ababa, Adama branch office.)

3.13 4.7 Spatial variation of Road traffic Accident

In case of analysis using KDE, since there is no index associated with statistical significance, hot spots were categorized using equal intervals. In this study, the categorization was done in three categories i.e. slight injury, sever injury and fetal based on their associated accident densities..

4.7.1 Spatial distribution of road traffic accident severity between Jun-07-2019 and Jun-7-2022

According to criteria set, all place exhibit severities of accidents were considered in analysis as per Belgium system. This weighing system was adopted by Belgium government as a part of their official methodology for hot spot detection. As per this system, individual weights of 18, 8 and 3 is provided for fatal accident, serious accident and for slight accident type accidents respectively.

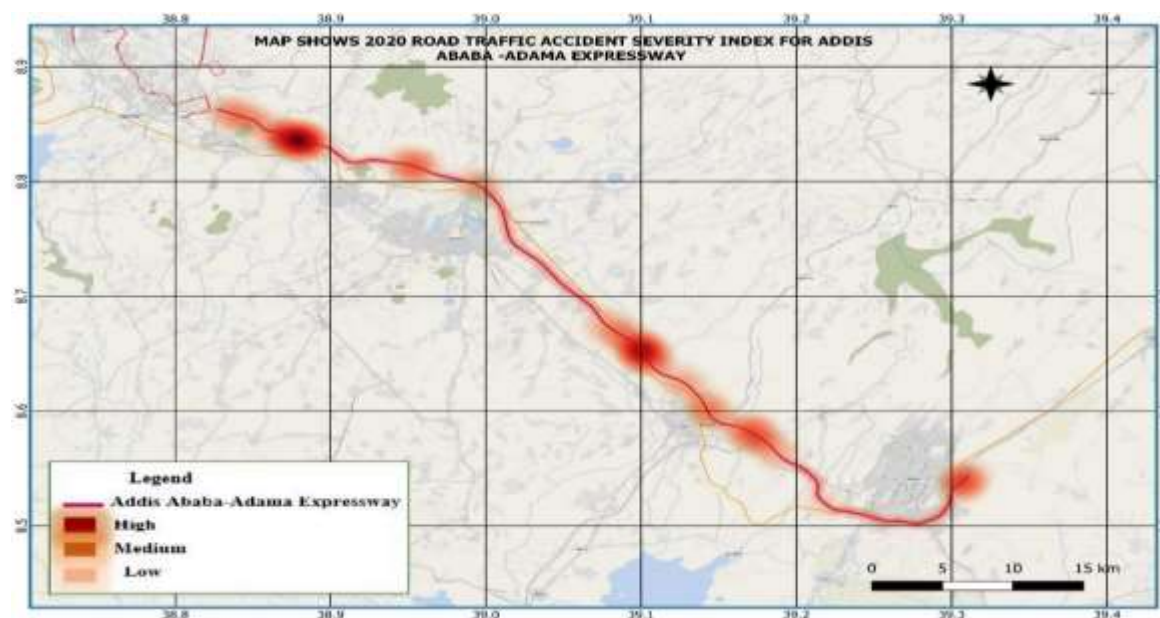


Figure 4.1 spatial distribution of road traffic accident severity index in 2020

The above figure illustrate that's high severity rate of traffic accident at km 8+000 and km 47+000 segment of the study area and medium severity rate of traffic accident at km 13+000, km 56+000 and 78+000 segment of the study area. Furthermore, km 2+500, km 16+000 and km 52+000 shows

low severity index.

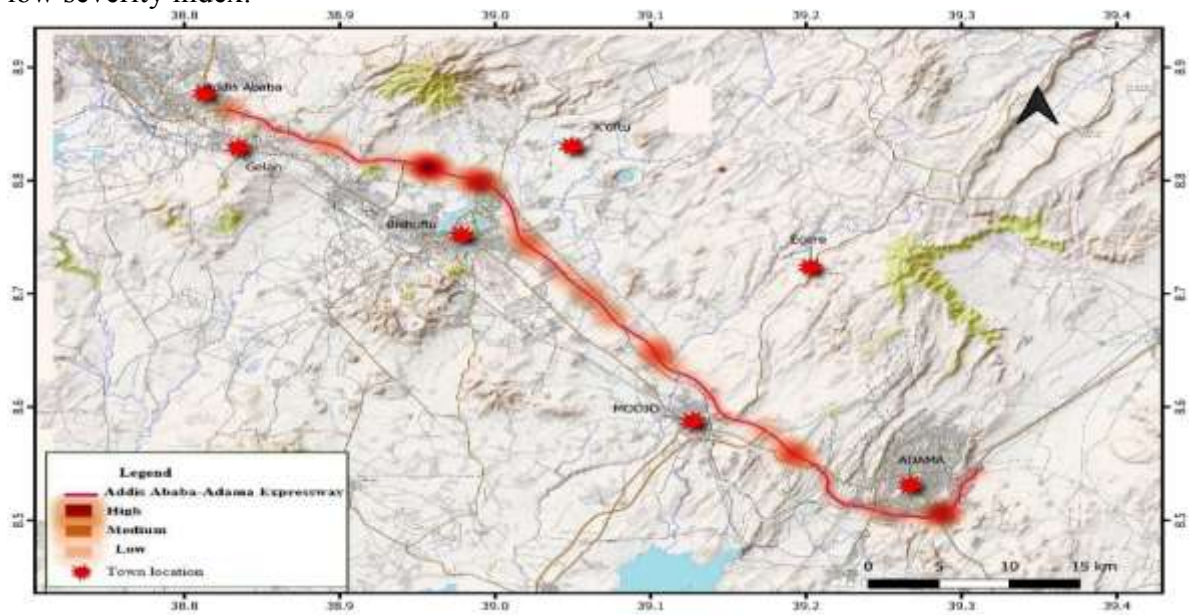


Figure 4.2 spatial distribution of road traffic accident severity index in 2021

The above figure shows points are high-value areas with high-risk conditions. Because of this, we were able to identify statistically significant clusters of high-priority crash points that dramatically varied from the pattern in this case. This in turn high severity index at km 17+000 and km 24+000 segment of the study area. In addition medium severity index at 29+000, 45+000, 60+000 and 72+000 segment of the study area. Lastly low severity index at km 41+000, 42+000, 2+500 and 10+000 segment of Addis Ababa- Adama expressway

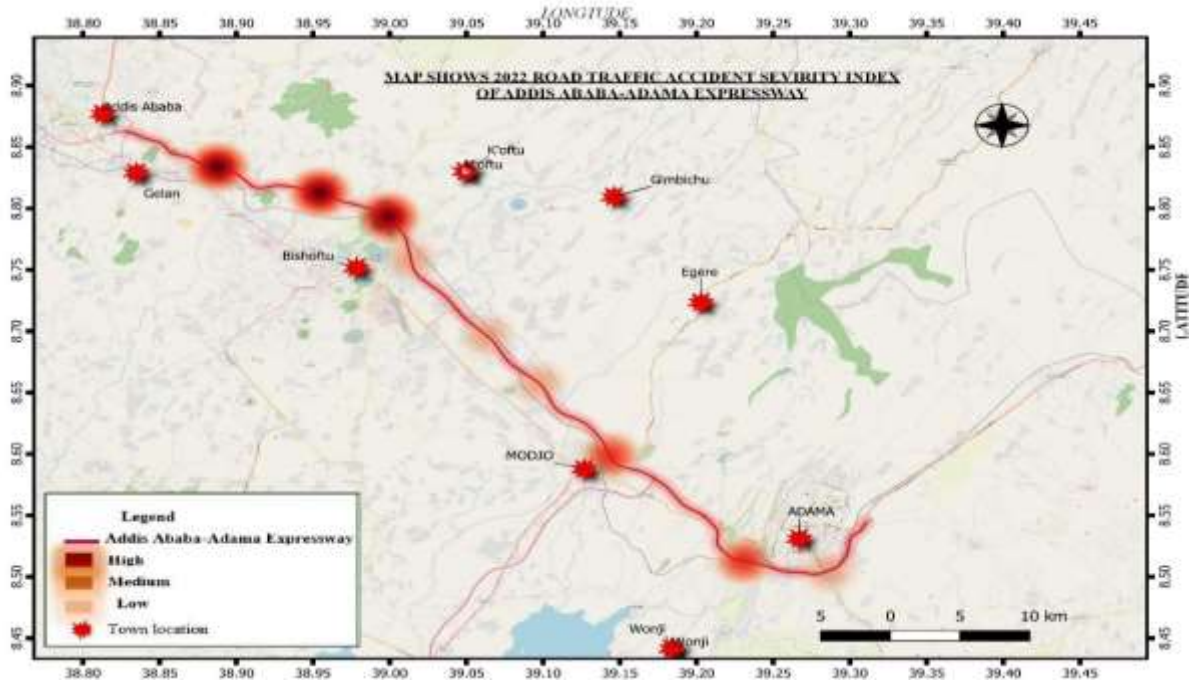


Figure 4.2 spatial distribution of road traffic accident severity index in 2021

The above figure demonstrate location are high-value areas with high-road traffic accident risk segments of the road. This include high severity index at km 12+000, km 17+000 and km 20+000. At the time medium severity index located at km 52+000 and km 64+000. Lastly low severity index at km 27+000, 36+000, 42+000, and 67+000 segment of Addis Ababa-Adama Expressway.

3.14 4.7 Road traffic Accident hot spot location and contribution factor determination

4.7.1 Descriptive analysis of independent variable

In this study descriptive statistic method used to summarized and describe data using qualitative measure

4.7.2 Empirical Analysis

To test Measuring of the influence of road traffic injury variable by other independent variable using multiple logistic regression. The Multinomial logistic regression model results of Addis Ababa-Adama Expressway injury severity are presented in table 4.18. In the model, injury severity (fatal, serious and light injuries) and property damage are the dependent variable, with property damage used as the reference category. Cause-effect analysis results of variables using multinomial logistic model on Addis Ababa - Adama Expressway shows that Day of the Week and direction have significant effect on traffic accident at P value of 0.05. The remaining parameters that were considered in the study were removed from the relationship as they are found insignificant and have no effect for the occurrence of traffic accident on the Expressway.

Table: 4.1.14: case process summary highlighting the case includes in the analysis.

Un weighted Cases	N	Percent
Selected Cases Included in Analysis	218	100
Missing Cases	0	0
Total	218	100.0
Unselected Cases	0	.0
Total	218	100.0

Table 4.1.15: model able to predict the correct category

Observed			Predicted		
			Type of injury		Percentage Correct
			no injury	injury	
Step 1	Road traffic accident	no injury	53	14	79.1
		Injury	9	142	94.0
	Overall Percentage				89.4

Observed: - This indicates the number of 0's and 1's that are observed in the dependent variable.

Predicted – These are the predicted values of the dependent variable based on the full logistic regression model. This table shows how many cases are correctly predicted (53 traffic accident are observed to be no injury indeed have no injury and are incorrectly predicted 14 traffic accident no injury personal actually should have injured and this means percentage of correct 79.1 percent. Likewise for injury personal on black spot segment along Addis Ababa Adama expressway correctly predicted 142 traffic accident indeed to be injured and incorrectly predict to be 9 traffic accident are to be no injury and this mean the percentage of correct are 94 percent.

Specificity: (Also known as true negative rate) refer to percentage of cases observed to fall into non target (or reference) category. (In this study those road traffic accident not contributed the cause of injury on road user on black spot segment). The specificity for this study are 79.1 %.

Sensitivity: (Also called true positive rate) refer to percentage of cause observed to fall in the target group (in this study those road traffic accident lead to road injury on Addis Ababa-Adama expressway road user on the black spot segment) correctly predict by the model fall in to a leading factor for the road traffic accident injury. The sensitivity for the study are 94%.

Overall Percentage: This gives the percent of cases for which the dependent variables was correctly predicted given the model. So chat it can compare to classification table (see appendix 2) in block 0. To see how much improvement there is when the predictor variable are include in the model. The model (independent variable predicting dependent variable) correctly classified 89.4 percentage of case overall. In other word this is the rate of correct classification if the study always predict that the independent variable would determine the road traffic accident injury. Specifically, it presents information on the degree to which the observed injury are predicted by the study model.

In general, the accuracy rate was very good, at 89.4 %. The model exhibit good sensitivity and good specificity, among registered traffic accident could lead to injury 94% were correctly predicted, so that the study classification are appropriate.

Table 4.1.16 relationship between the predictor and the outcome.

Variables in the Equation									
		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1 ^a	Cause crash	.040	.165	.059	1	.807	1.041	.754	1.437

Variables in the Equation								
		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)
								Lower Upper
Step 1	Direction	-3.408	.720	22.402	1	.000	.033	.008 .136
	Geometric condition	.146	.256	.326	1	.568	1.158	.700 1.914
	Surface condition	4.270	1.008	17.934	1	.000	71.539	9.913 516.262
	Light condition	-.651	.573	1.291	1	.256	.522	.170 1.603
	Age(1)	-2.239	.732	9.348	1	.002	.107	.025 .448
	Sex	-2.165	2.971	.531	1	.466	.115	.000 38.793
	Maritime stat	2.069	2.940	.495	1	.481	7.918	.025 2516.262
	Education	-.826	.345	5.732	1	.017	.438	.223 .861
	Constant	4.025	1.189	11.450	1	.001	55.970	

a. Variable(s) entered on step 1: Cause of crash, Direction, geometric condition, Surface condition, Light condition, Age, Sex, maritime status and Education.

The above empirical analysis results of the study show the various relationships between road traffic accident and its factors. It also identified the key variable that play critical roles in the determination of road traffic accident injury. The result indicates most of independent variables has no significant factor for the cause of road traffic accident injury on an expressway.

Meanwhile, the findings of the model clearly indicates that some factors plays significant role in the determination of road traffic accident injury. The above table shows which independent variable significantly affect the outcome or not, have a significant affecting the model where a p value are less than 0.05. To enhance the level of accuracy, the coefficients of all independent variables are examined for their significance and those variables with higher significant relationship with road traffic accident is used for developing an equation that help to predict road traffic accident. Accordingly, variables like that of direction the carriageway, education, Surface condition and ages are identified as independent variable to assess the level of traffic accident on the expressway.

B: value indicates the value for regression equation for predicting the dependent variable from the independent variable. They are in log-odds unit. On the above fining, the model that will help determine the level of accident can be expressed using the following road traffic injury predicting equation.

$$\log(p/1-p) = \beta_0 + \beta_1 D + \beta_2 SC + \beta_3 A + \beta_4 E$$

Where p is the probability of being in honors composition. The logistic regression equation then, $\log(p/1-p) = 4.025 - 3.408 \times \text{Direction of carriageway} + 4.270 \times \text{surface condition} - 2.239 \times \text{Age} - 0.826 \times \text{education}$
S.E. – These are the standard errors associated with the coefficients. The standard error is used for testing whether the parameter is significantly different from 0; by dividing the parameter estimate by the standard error you obtain a t -value. The standard errors can also be used to form a confidence interval for the parameter.

df – This column lists the degrees of freedom for each of the tests of the coefficients. It represents the number of variables or parameters in a statistical model that can be adjusted or estimated freely. The degree of freedom is used to describe the distribution of test statistics and to calculate confidence intervals and p -values in statistical inference. The study shows degree of freedom equals to one this means that we have only one parameter to estimate the variance of the sample mean, and therefore our estimates will have greater uncertainty than if we had more degrees of freedom.

Exp(B) – These are the odds ratios for the predictors. They are the exponentiation of the coefficients. So that odd ratios equals to zero means the probability of falling into the non-target group, where odd ration greater than one indicates that the occurrence of the event is more likely to occur in one group compared to the other. On the other hand odd ration less than one indicates the probability events occurring decreased. In this study only considering statistically significant value, it's believe to say Addis Ababa Adama expressway road surface condition are 17. 539 times as likely to contribute the occurrence of road traffic personal injury, meanwhile the odds of the direction of carriageway for the occurrence of traffic accident injury while driving compare to non-injury 0.33 times less likely to occur, on other hand age group and education leads to road traffic injury 0.107 times and 0.438 times less likely to occur in the group respectively.

4.2.1. Black Spot Identification and Recommended Counter Measures

Using the criteria developed in chapter three, around 76 road sections were demarcated for severity of accident and black spots analysis within 1km interval. On the basis of the criteria, road sections which have relative severity value greater than severity critical value is considered as black spot and used for further treatment. Hence, out of the 76 road sections define for black spot analysis, eleven (11) road segment were fulfilled the criteria and identified for further treatment.

According to black spot identification criterion, the following road stations had the highest relative severity value compare to its critical severity value. This implies that these road sections are the most risky area and dangerous road for users.

A) Segment 8+000 - 8+999

According to Appendix 2A number of road traffic accident 27 and severity value of 175 have been recorded within a study period. Sunday contribute the highest percentage of accident with 19 percent of a total accident at this segment and 68 percent of accident happen toward Adama. From total injury 5 fetal, 9 serious and 3 light injury.

B) 15+000 - 15+999

According to Appendix 2A number of road traffic accident 40 and severity value of 196 have been recorded within a study period. Sunday contribute the highest percentage of accident with 19 percent of a total accident at this segment and 68 percent of accident happen toward Adama. From total injury 3 fetal, 11 serious and 10 light injury.

C) 18+000 - 18+999

According to Appendix 2A number of road traffic accident 16 and severity value of 85 have been recorded within a study period. Sunday contribute the highest percentage of accident with 28.57 percent of a total accident at this segment and 87.5 percent of accident happen toward Addis Ababa. From total injury 1 fetal, 5 serious and 7 light injury.

D) 20+000 - 20+999

According to Appendix 2A number of road traffic accident 18 and severity value of 88 have been recorded within a study period. Sunday contribute the highest percentage of accident with 20 percent of a total accident at this segment and 65 percent of accident happen toward Adama. From total injury 2 fetal, 5 serious and 3 light injury.

E) 26+000 - 26+999

According to Appendix 2A number of road traffic accident 12 and severity value of 61 have been recorded within a study period. Sunday contribute the highest percentage of accident with 41.67 percent of a total accident at this segment and equal percentage of road traffic accident record in both carriageway. From total injury 2 fetal, 2 serious and 3 light injury.

F) 32+000 - 32+999

According to Appendix 2A number of road traffic accident 10 and severity value of 98 have been recorded within a study period. Wednesday contribute the highest percentage of accident with

54.54 percent of a total accident at this segment and 72.72 percent of accident happen toward Adama. From total injury 1 fetal, 5 serious and 12 light injury.

G) 37+000 - 37+999

According to Appendix 2A number of road traffic accident 15 and severity value of 76 have been recorded within a study period. Saturday contribute the highest percentage of accident with 27.27 percent of a total accident at this segment and 63.63 percent of accident happen toward Adama. From total injury 2 fetal and 11 light injury.

H) 45+000 - 45+999

According to Appendix 2A number of road traffic accident 15 and severity value of 94 have been recorded within a study period. Wednesday contribute the highest percentage of accident with 42.85 percent of a total accident at this segment and 85.71 percent of accident happen toward Adama. From total injury 3 fetal, 3 serious and 6 light injury.

I) 58+000 - 58+999

According to Appendix 2A number of road traffic accident 13 and severity value of 68 have been recorded within a study period. Sunday and Friday each contribute the highest percentage of accident with 23.1 percent of a total accident at this segment and 69.23 percent of accident happen toward Adama. From total injury 4 serious and 10 light injury.

J) 63+000 - 63+999

According to Appendix 2A number of road traffic accident 9 and severity value of 79 have been recorded within a study period. Friday contribute the highest percentage of accident with 28.57 percent of a total accident at this segment and 87.71 percent of accident happen toward Adama. From total injury 1 fetal, 5 serious and 6 light injury.

K) 77+000 - 78+000

According to Appendix 2A number of road traffic accident 40 and severity value of 196 have been recorded within a study period. Saturday and Tuesday each contribute the highest percentage of accident with 23.1 percent of a total accident at this segment and 76.92 percent of accident happen toward Adama. From total injury 4 fetal and 4 serious injury.

3.15 4.8 Road traffic accident black spot In Addis Ababa Adama expressway

4.8.1 Spatial distribution of road traffic accident black spot between 2020/2022.

According to criteria set, segments that exhibit relative severity value greater than severity critical value is considered as black spot. Accordingly, as shown in table 4.4.1 and figure 4.4. Place were

identified road traffic accident black spot along Addis Ababa Adama expressway in year between 01/07/2019 and 01/ 07/2022.

Table 4.1.17 Road traffic accident black spot in study area between 2019/2020 – 2021/2022

Year	Road traffic accident segments	Relative severity	Critical severity
2020 -2022	8+000 - 8+999	6.48	4.81
	15+000 - 15+999	4.9	4.81
	18+000 - 18+999	5.31	4.81
	20+000 - 20+000	4.89	4.81
	26+000 - 26+000	5.08	4.81
	32+000 - 32+999	9.8	4.81
	38+000 - 38+999	5.1	4.81
	45+000 - 45+999	6.26	4.81
	58+000 - 58+999	5.231	4.81
	63+000 - 63+999	8.78	4.81
	77+000 - 78+000	9.1	4.81

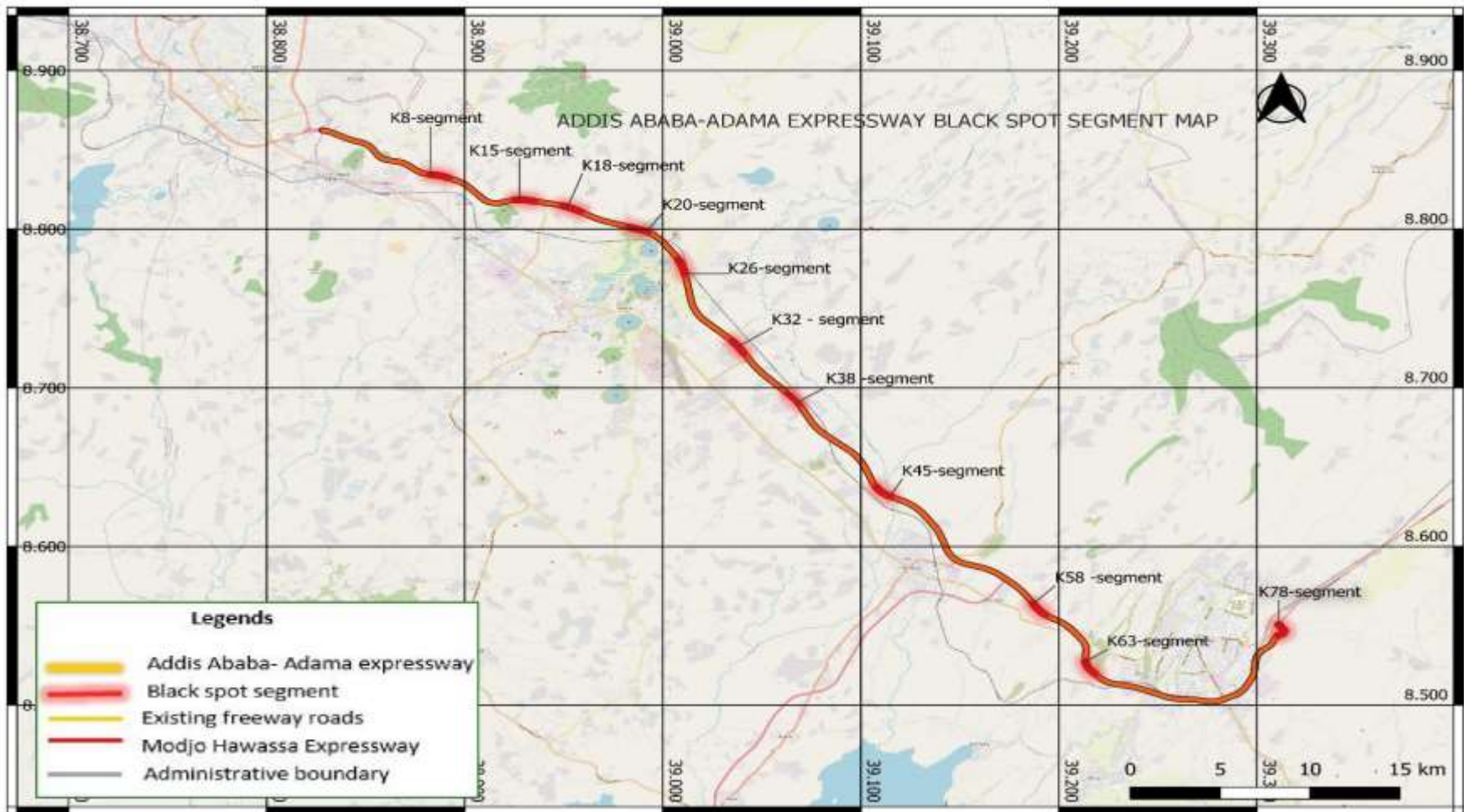


Figure 4.4: Eleven road traffic accident black spot segment of Addis Ababa-Adama expressway

CHAPTER V CONCLUSION AND RECOMMENDATION

3.16 5.1 Conclusion

A road traffic accident refers to any collision or incident involving a vehicle or vehicles on a road or highway. It is also known as a car accident, motor vehicle accident, or traffic collision. Road traffic accident can range from minor car collision to more serious accidents resulting in injuries or fatalities. The situation of road traffic accident at the national level is getting worse. Despite small number of vehicles operating in the country, the level of accident recorded each day made the country one of the top in the world. Similar experience is started to be registered on the newly developed Addis Ababa - Adama Expressway.

The Expressway is the focus of this study and all the data used in the study is collected from traffic accidents registered on this road and accounted for 100% of the total accidents. The data was collected for 2020/2022 period of the expressway, i.e. accident registered during three years. Both qualitative and quantitative methods are used to analyze the data and interpret results.

The results obtained throughout the assessment of the data, the extent and numbers of road traffic accidents showed an increasing trend during the study period.

The average number of road traffic accidents in Addis Ababa-Adama expressway increase yearly an average of 47.5 percent for death, 25.9 percent for serious injury, 25.7 percent in property damage and decrease in 9.08 percent in light injury.

The result of the study shows that accident is higher in Wednesday of the week with 15.61 percent and Tuesday shared lowest with 13.45 percentage. The monthly trends shows August was more traffic accident and December shares the lowest traffic accident with 6.46 percentage. August has their own impact related with seasoned of the year, because at the beginning of august, the rains are the most intense.

The unique characteristic of the road traffic an average of 1847 traffic flow registered which is at the pick hour between 1:00 -2:00 which is concede with an higher traffic accident registered between 00:00 to 6:00 hourly distributions with a 38.72 percentage. The large portion of accident register during day time with 62.93 percentage due to large percentages of density of traffic volume and thus high over speed that prevailed registered during daytime.

On the other hand During 2020/2022, the result shows almost all with an accounts of 94.18 percentage road traffic accident registered by male gender. Particularly 88.79 percentage of road

traffic accident Adult age group from all registered road traffic accident. In terms of maritime status more than half of road traffic accident caused by married car user.

The level of accident on the expressway using aV₁ types of vehicle accounted for the largest of all, which is accounting around 40.3 percent of the total accidents. In terms of crash type collision to the fixed object has the worst records in Addis Ababa-Adama Expressway with 40.1 percentage. Looking at cause of accident as factor of accident, overs peed a prime cause of road traffic accident which report with 40.88 percentage. On the other hand rainy weather condition has been the most contributor factor for road accident with 37.14 percentage.

However most of the road traffic accident occurrence on dry surface condition with 79.25 percentages this telling as most of a calendar years are summer and frequent accident happen throughout the study period. Meanwhile the most occurrence place of road traffic accident in terms of geometric condition are downhill with 34.27 percentage.

Furthermore, the study was carried out to identify black spot area in Addis Ababa –Adama expressway. Seventy sex (76) segment were identified for the analysis of black spot and the accident black spot exhibit relative severity value greater than severity critical value and found that eleven hazardous segments of the road consider as a black spot area in Addis Ababa Adama expressway from July 7 2019 to July 7 2022. out of seventy sex segment eleven section consider black spot are from 8+000 to 8+999, 15+000 to 15+999, 20+000 to 20+999, 26+000 to 26+999, 32+000 to 32+999, 38+000 to 38+999, 45+000 to 45+999, 58+000 to 58+999, 63+000 to 63+999 and 77+000 to 78+000 are consistent road traffic accident black spots which exist consistently as road traffic accident black Spots with in study period and identifying map places of spatial distribution of road traffic accident severity in Addis Ababa –Adama Expressway and black spot area, tries to use the application of QGIS.

Using the Quantum Geographic information system (QGIS) is useful in displaying of road traffic accident severity location on the map and can be utilized effectively for the analysis, prioritization and representation of black spots. At the same time, a QGIS can be effectively used to identify accident black spots on roads in Addis Ababa-Adama Expressway. In this situation, it is very important to identify and forecast the cause of accidents.

In addition to identifying road traffic accident black spot segment, the study produce a relationship probable effect and Couse of injury using binomial logistic regression model and the result shows Direction of carriageway, Age of driver, Education level of driver and Road

surface condition contribute the occurrence of road traffic accident injury where there P-value are less than 0.05. The previous study conducted by (Debele Dame 2016) in this study area produces otherwise. The difference might be due to limited study period which is one and half year data, in addition the difference period of times.

In general, It's clear that road accidents have been a serious problem in our everyday life. This study identified road traffic accidents are randomly distributed alongside Addis Ababa-Adama expressway in terms of space and time. The magnitude has shown an increasing trend in the study period. The accident hot spot areas exhibit relative severity value greater than severity critical value. Identifying map places of black spots, tries to use the application of QGIS, examine the temporal and spatial trends, identify causes of accident using engineering measurements for each road segment, analyze the occurrence of road traffic accidents with respect to temporal variation, drivers characteristic, driver behavior, Geographical condition, weather type, cause and types of crash. Furthermore develop accident prediction models was developed through investigating factors contributing to the occurrence of accident and that enlarge the severity of accidents on Addis Ababa – Adama Expressway using survey data obtained from Traffic Safety and Security Department of Ethiopia Toll Road Enterprises. Finally, I believe that this study contributes much for those to understand the general characteristics of road traffic accidents in Addis Ababa-Adama Expressway and inspire other stakeholders to conduct further studies in the field.

3.17 5.2 Recommendation

Based on the above findings, the following recommendations are recommended. This recommendation will help the Ethiopia Toll Road Enterprises, Government policy makers and road user to alarming the problem and give attention working on to minimize this severity of road traffic injury crashes on Addis Ababa, Adama Expressway.

- The finding of the study reveals that the prevalence of injury crashes were high, even if several road furniture and additional modern safety measure, the enterprise administrator and the stakeholder should be take attention.
- The finding of the study revealed that accident frequency is high at the exit main gates (particularly at Tulu-dimtu and Adama East). As a result, Ethiopian Toll Road Enterprise should work on road safety campaign at main station, implements additional modern technical road safety measure and prepare road safety at identified black spot area through this study.

- During the study most frequent accident record during August and most of the time easily morning, hence the enterprise should give due attention in road safety campaign to promote aware creation at bus station (towns alongside side Addis Adama -Adama expressway), entrance toll gate and identified black spot area.
- Driver behavior (over speeding, unethical driving and sleeping/fatigue) and Vehicle factor were the worst accident cause on Addis Ababa – Adama Expressway. Therefore, it is important to advocate extra awareness creation for drivers at the nation level and ensure ethical behavior among those using the road, which may include enhancing personal driving capacity through participating different government and non-governmental initiatives towards the transport sectors. In addition, Ethiopian toll road enterprise should completed service station construction (currently Ethiopian toll road enterprise on progress to complete the construction of service station at km 29+500 alongside the study) to ensure the maintenance of car regularly.
- The study area shows high level of fatality as compare to 76 km short road segment with modern high speed highway. Unethical driving (over speed) is the worst causes of death on this road. As a result, it is advisable to use speed control technology like vehicle traffic reinforcement CCTV camera alongside of the road.
- Since most of the accident happen at the end and start point of entrance and exit point it's important to construct speed reducing ramp (escape lane).

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
3	3+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	3+100-200		1														0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	3+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	3+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	3+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	3+500-600												2				0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	3+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	3+700-800	1	1	3													1	1	3	0	32	0	0	2.702	-2.702	7.300804	4.81
	3+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	3+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	3+00-999	1	2	3	1	8	0	0	0	3	3	0	0	2	8	8	1	2	5	12	58	19	3.05263	2.702	0.350632	0.1229425	4.81
4	4+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	4+100-200													3			0	0	3	0	9	0	0	2.702	-2.702	7.300804	4.81
	4+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	4+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	4+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	4+500-600						1	2	0								1	2	0	0	31	0	0	2.702	-2.702	7.300804	4.81
	4+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	4+700-800			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	4+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	4+900-999		1	1													0	1	1	0	11	0	0	2.702	-2.702	7.300804	4.81
	4+000-999	0	1	2	0	4	1	2	0	4	7	0	0	3	6	8	1	3	5	10	64	19	3.36842	2.702	0.666421	0.444117	4.81
	5+00-100			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	5+100-200			1					1								0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chanage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
5	5+200-300												2	1			0	2	1	0	19	0	0	2.702	-2.702	7.300804	4.81
	5+300-400											0		1			0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	5+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	5+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	5+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	5+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	5+800-900			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	5+900-999			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	5+000-999	0	0	4	2	5	0	0	1	2	2	0	2	2	4	6	0	2	7	8	45	13	3.46154	2.702	0.759538	0.5768987	4.81
6	6+00-100			2													0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	6+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	6+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	6+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	6+400-500								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	6+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	6+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	6+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	6+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	6+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	6+00-999	0	0	2	2	8	0	0	1	5	6	0	0	0	7	7	0	0	3	14	23	21	1.09524	2.702	-1.60676	2.5816838	4.81
	7+00-100			1										1			0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	7+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	7+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	7+300-400	2	1	6					2				1	2			2	2	10	0	76	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chanage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
7	7+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	7+500-600		1	1													0	1	1	0	11	0	0	2.702	-2.702	7.300804	4.81
	7+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	7+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	7+800-900		1	2					1								0	1	3	0	17	0	0	2.702	-2.702	7.300804	4.81
	7+900-999			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	7+00-999	2	3	11	8	18	0	0	3	14	15	0	1	3	6	7	2	4	17	28	141	40	3.525	2.702	0.823	0.677329	4.81
8	8+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	8+100-200											1	1	0			1	1	0	0	23	0	0	2.702	-2.702	7.300804	4.81
	8+200-300											2	7	3			2	7	3	0	95	0	0	2.702	-2.702	7.300804	4.81
	8+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	8+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	8+500-600						1	0	0								1	0	0	0	15	0	0	2.702	-2.702	7.300804	4.81
	8+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	8+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	8+800-900	1	1	0													1	1	0	0	23	0	0	2.702	-2.702	7.300804	4.81
	8+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	8+00-999	1	1	0	4	6	1	0	0	6	9	3	8	3	9	12	5	9	3	19	175	27	6.48148	2.702	3.779481	14.28448	4.81
9	9+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	9+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	9+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	9+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	9+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	9+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	9+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	9+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	9+800-900								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	9+900-999								1					2			0	0	3	0	9	0	0	2.702	-2.702	7.300804	4.81
	9+00-999	0	0	0	2	4	0	2	0	2	4	0	2	0	3	6	0	4	0	7	39	14	2.78571	2.702	0.083714	0.0070081	4.81
10	10+00-100				1					1							0	0	0	2	2	0	0	2.702	-2.702	7.300804	4.81
	10+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	10+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	10+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	10+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	10+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	10+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	10+700-800												1	4			0	1	4	0	20	0	0	2.702	-2.702	7.300804	4.81
	10+800-900														12		0	0	0	12	12	0	0	2.702	-2.702	7.300804	4.81
	10+900-999				9					7			1	14			0	1	14	16	66	0	0	2.702	-2.702	7.300804	4.81
	10+00-999	0	0	0	10	8	0	0	0	8	8	0	2	18	12	15	0	2	18	30	100	31	3.22581	2.702	0.523806	0.2743732	4.81
11	11+00-100			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	11+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	11+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	11+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	11+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	11+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	11+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	11+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	11+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	11+900-999			1	2					3					5		0	0	1	10	13	0	0	2.702	-2.702	7.300804	4.81
	11+00-100	0	0	2	2	3	0	0	0	3	3	0	0	0	5	7	0	0	2	10	16	13	1.23077	2.702	-1.47123	2.16452	4.81
12	12+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	12+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	12+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	12+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	12+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	12+500-600								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	12+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	12+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	12+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	12+900-999				5					4					4		0	0	0	13	13	0	0	2.702	-2.702	7.300804	4.81
	12+000-999	0	0	0	5	6	0	0	1	4	5	0	0	0	4	5	0	0	1	13	16	16	1	2.702	-1.702	2.896804	4.81
13	13+00-100								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	13+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	13+200-300			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	13+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	13+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	13+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	13+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	13+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	13+800-900								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	13+900-999				2					4					5		0	0	0	11	11	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ2	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	13+00-999	0	0	1	2	13	0	0	2	4	6	0	0	0	5	7	0	0	3	11	20	26	0.76923	2.702	-1.93277	3.7355969	4.81
14	14+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	14+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	14+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	14+300-400			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	14+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	14+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	14+600-700								1					1			0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	14+700-800								2								0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	14+800-900												1				0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	14+900-999				7					9					11		0	0	0	27	27	0	0	2.702	-2.702	7.300804	4.81
	14+00-999	0	0	1	7	5	0	0	3	9	10	0	1	1	11	9	0	1	5	27	50	24	2.08333	2.702	-0.61867	0.3827484	4.81
15	15+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	15+100-200		1	1													0	1	1	0	11	0	0	2.702	-2.702	7.300804	4.81
	15+200-300												1				0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	15+300-400								3					1			0	0	4	0	12	0	0	2.702	-2.702	7.300804	4.81
	15+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	15+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	15+600-700											1	0	0			1	0	0	0	15	0	0	2.702	-2.702	7.300804	4.81
	15+700-800		1	1													0	1	1	0	11	0	0	2.702	-2.702	7.300804	4.81
	15+800-900						2	8	4								2	8	4	0	106	0	0	2.702	-2.702	7.300804	4.81
	15+900-999				8					14					10		0	0	0	32	32	0	0	2.702	-2.702	7.300804	4.81
	15+00-999	0	2	2	8	11	2	8	7	14	14	1	1	1	11	15	3	11	10	33	196	40	4.9	2.702	2.198	4.831204	4.81
	16+00-100								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ2	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
16	16+100-200		1									1	0	0			1	1	0	0	23	0	2	2.702	-0.702	0.492804	4.81
	16+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	16+300-400			5					1								0	0	6	0	18	0	0	2.702	-2.702	7.300804	4.81
	16+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	16+500-600												1				0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	16+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	16+700-800								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	16+800-900													3			0	0	3	0	9	0	0	2.702	-2.702	7.300804	4.81
	16+900-999				9					4					7		0	0	0	20	20	0	0	2.702	-2.702	7.300804	4.81
	16+00-999	0	1	5	9	14	0	0	3	4	13	1	0	4	7	23	1	1	12	20	79	50	1.58	2.702	-1.122	1.258884	4.81
17	17+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	17+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	17+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	17+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	17+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	17+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	17+600-700							1	2								0	1	2	0	14	0	0	2.702	-2.702	7.300804	4.81
	17+700-800								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	17+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	17+900-999				4					1					1		0	0	0	6	6	0	0	2.702	-2.702	7.300804	4.81
	17+00-999	0	0	0	4	2	0	1	3	1	3	0	0	0	1	4	0	1	3	6	23	9	2.55556	2.702	-0.14644	0.021446	4.81
	18+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	18+100-200								2								0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	18+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
18	18+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	18+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	18+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	18+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	18+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	18+800-900				2			4	5	3					4		0	4	5	9	56	0	0	2.702	-2.702	7.300804	4.81
	18+900-999	0					1	1	0								1	1	0	0	23	0	0	2.702	-2.702	7.300804	4.81
	18+00-999	0	0	0	2	5	1	5	7	3	6	0	0	0	4	5	1	5	7	9	85	16	5.3125	2.702	2.6105	6.8147103	4.81
19	19+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	19+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	19+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	19+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	19+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	19+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	19+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	19+700-800							1	2								0	1	2	0	14	0	0	2.702	-2.702	7.300804	4.81
	19+800-900	1	1	0													1	1	0	0	23	0	0	2.702	-2.702	7.300804	4.81
	19+900-999				1					4					4		0	0	0	9	9	0	0	2.702	-2.702	7.300804	4.81
	19+00-999	1	1	0	1	7	0	1	2	4	9	0	0	0	4	4	1	2	2	9	46	20	2.3	2.702	-0.402	0.161604	4.81
	20+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	20+100-200			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	20+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	20+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	20+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
20	20+500-600								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	20+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	20+700-800											2	5	1			2	5	1	0	73	0	0	2.702	-2.702	7.300804	4.81
	20+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	20+900-999				2					4					3		0	0	0	9	9	0	0	2.702	-2.702	7.300804	4.81
	20+00-999	0	0	1	2	5	0	0	1	4	5	2	5	1	3	8	2	5	3	9	88	18	4.88889	2.702	2.186889	4.782483	4.81
21	21+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	21+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	21+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	21+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	21+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	21+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	21+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	21+700-800								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	21+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	21+900-999			1	3					3					3		0	0	1	9	12	0	0	2.702	-2.702	7.300804	4.81
	21+00-999	0	0	1	3	10	0	0	1	3	5	0	0	0	3	3	0	0	2	9	15	18	0.83333	2.702	-1.86867	3.4919151	4.81
22	22+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	22+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	22+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	22+300-400			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	22+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	22+500-600			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	22+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chanage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	22+700-800													2			0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	22+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	22+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	22+900-999				2					8					4					14	14	0	0	2.702	-2.702	7.300804	4.81
	22+00-100		0	2	2	8	0	0	0	8	4	0	0	2	4	7	0	0	4	14	26	19	1.36842	2.702	-1.33358	1.7784328	4.81
23	23+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	23+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	23+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	23+300-400						1	0	2								1	0	2	0	21	0	0	2.702	-2.702	7.300804	4.81
	23+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	23+500-600			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	23+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	23+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	23+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	23+900-999				4					3					3		0	0	0	10	10	0	0	2.702	-2.702	7.300804	4.81
	23+00-999	0	0	1	4	4	1	0	2	3	5	0	0	0	3	5	1	0	3	10	34	14	2.42857	2.702	-0.27343	0.0747632	4.81
24	24+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	24+100-200		1														0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	24+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	24+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	24+400-500													1			0	0	0	1	1	0	0	2.702	-2.702	7.300804	4.81
	24+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	24+600-700						1	0	1								1	0	1	0	18	0	0	2.702	-2.702	7.300804	4.81
	24+700-800			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ2	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	24+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	24+900-999				9					11					7		0	0	0	27	27	0	0	2.702	-2.702	7.300804	4.81
		0	1	1	9	5	1	0	1	11	11	0	0	0	8	10	1	1	2	28	57	26	2.19231	2.702	-0.50969	0.2597862	4.81
25	25+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	25+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	25+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	25+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	25+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	25+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	25+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	25+700-800			2					1								0	0	3	0	9	0	0	2.702	-2.702	7.300804	4.81
	25+800-900								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	25+900-999				2					2					4		0	0	0	8	8	0	0	2.702	-2.702	7.300804	4.81
	25+00-999	0	0	2	2	4	0	0	2	2	5	0	0	0	4	4	0	0	4	8	20	13	1.53846	2.702	-1.16354	1.3538218	4.81
26	26+00-100												1				0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	26+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	26+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	26+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	26+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	26+500-600			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	26+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	26+700-800						2	1	2								2	1	2	0	44	0	0	2.702	-2.702	7.300804	4.81
	26+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	26+900-999									4					2		0	0	0	6	6	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ2	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	26+00-999	0	0	1	0	3	2	1	2	4	5	0	1	0	2	4	2	2	3	6	61	12	5.08333	2.702	2.381333	5.6707484	4.81
27	27+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	27+100-200			1					2			1	0	1			1	0	4	0	27	0	0	2.702	-2.702	7.300804	4.81
	27+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	27+300-400													1			0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	27+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	27+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	27+600-700											1	2				0	1	2	0	14	0	0	2.702	-2.702	7.300804	4.81
	27+700-800			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	27+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	27+900-999									2					3		0	0	0	5	5	0	0	2.702	-2.702	7.300804	4.81
	27+00-999	0	0	2	0	4	0	0	2	2	4	1	1	4	3	6	1	1	8	5	52	14	3.71429	2.702	1.012286	1.0247224	4.81
28	28+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	28+100-200		1	1					2			1		1			1	1	4	0	35	0	0	2.702	-2.702	7.300804	4.81
	28+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	28+300-400													1			0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	28+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	28+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	28+600-700											2	1				0	2	1	0	19	0	0	2.702	-2.702	7.300804	4.81
	28+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	28+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	28+900-999									5					7		0	0	0	12	12	0	0	2.702	-2.702	7.300804	4.81
	28+00-999	0	1	1	0	6	0	0	2	5	7	1	2	3	7	8	1	3	6	12	69	21	3.28571	2.702	0.583714	0.3407224	4.81
	29+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
29	29+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	29+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	29+300-400			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	29+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	29+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	29+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	29+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	29+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	29+900-999				4			2		2				1	5		0	2	1	11	30	0	0	2.702	-2.702	7.300804	4.81
	29+00-999		0	1	4	8	0	2	0	2	7	0	0	1	5	8	0	2	2	11	33	23	1.43478	2.702	-1.26722	1.6058399	4.81
30	30+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	30+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	30+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	30+300-400											1	0	0			1	0	0	0	15	0	0	2.702	-2.702	7.300804	4.81
	30+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	30+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	30+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	30+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	30+800-900								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	30+900-999									3					5		0	0	0	8	8	0	0	2.702	-2.702	7.300804	4.81
	30+00-999	0	0	0	0	2	0	0	1	3	5	1	0	0	5	5	1	0	1	8	26	12	2.16667	2.702	-0.53533	0.2865818	4.81
	31+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	31+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	31+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
31	31+300-400									2							0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	31+400-500									2							0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	31+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	31+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	31+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	31+800-900			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	31+900-999				1					6					1		0	0	0	8	8	0	0	2.702	-2.702	7.300804	4.81
	31+00-999	0	0	1	1	2	0	0	4	6	9	0	0	0	1	6	0	0	5	8	23	17	1.35294	2.702	-1.34906	1.8199597	4.81
32	32+00-100		1	3													0	1	3	0	17	0	0	2.702	-2.702	7.300804	4.81
	32+100-200						1	4	7								1	4	7	0	68	0	0	2.702	-2.702	7.300804	4.81
	32+200-300													2			0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	32+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	32+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	32+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	32+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	32+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	32+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	32+900-999				2					2					3		0	0	0	7	7	0	0	2.702	-2.702	7.300804	4.81
	32+00-999	0	1	3	2	3	1	4	7	2	3	0	0	2	3	4	1	5	12	7	98	10	9.8	2.702	7.098	50.381604	4.81
	33+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	33+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	33+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	33+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	33+400-500												2				0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
33	33+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	33+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	33+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	33+800-900								8								0	0	8	0	24	0	0	2.702	-2.702	7.300804	4.81
	33+900-999				2					9					3		0	0	0	14	14	0	0	2.702	-2.702	7.300804	4.81
	33+00-999	0	0	0	2	8	0	0	8	9	3	0	0	2	3	11	0	0	10	14	44	22	2	2.702	-0.702	0.492804	4.81
34	34+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	34+100-200								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	34+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	34+300-400								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	34+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	34+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	34+600-700			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	34+700-800								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	34+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	34+900-999				1			1	1	4					3		0	1	1	8	19	0	0	2.702	-2.702	7.300804	4.81
	34+00-999		0	1	1	2	0	1	4	4	8	0	0	0	3	3	0	1	5	8	31	13	2.38462	2.702	-0.31738	0.100733	4.81
35	35+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	35+100-200	1	1	0													1	1	0	0	23	0	0	2.702	-2.702	7.300804	4.81
	35+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	35+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	35+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	35+500-600		1														0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	35+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	35+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	35+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	35+900-999				2					1							0	0	0	3	3	0	0	2.702	-2.702	7.300804	4.81
	35+00-999	1	2	0	2	5	0	0	0	1	1	0	0	0	3	6	1	2	0	6	37	12	3.08333	2.702	0.381333	0.1454151	4.81
36	36+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	36+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	36+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	36+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	36+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	36+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	36+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	36+700-800			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	36+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	36+900-999				2					1					7		0	0	0	10	10	0	0	2.702	-2.702	7.300804	4.81
	36+00-999	0	0	1	2	1	0	0	0	1	7	0	0	0	7	8	0	0	1	10	13	16	0.8125	2.702	-1.8895	3.5702103	4.81
37	37+00-100			3								1	0	0			1	0	3	0	24	0	0	2.702	-2.702	7.300804	4.81
	37+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	37+200-300								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	37+300-400											1	0	1			1	0	1	0	18	0	0	2.702	-2.702	7.300804	4.81
	37+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	37+500-600			6													0	0	6	0	18	0	0	2.702	-2.702	7.300804	4.81
	37+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	37+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	37+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chanage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	37+900-999				4					2					6		0	0	0	12	12	0	0	2.702	-2.702	7.300804	4.81
	37+00-999	0	0	9	4	5	0	0	1	3	3	2	0	1	6	7	2	0	11	13	76	15	5.06667	2.702	2.364667	5.5916484	4.81
38	38+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	38+100-200											1	0	0			1	0	0	0	15	0	0	2.702	-2.702	7.300804	4.81
	38+200-300						3	6	0								3	6	0	0	93	0	0	2.702	-2.702	7.300804	4.81
	38+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	38+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	38+500-600							1									0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	38+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	38+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	38+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	38+900-999		1	2	1					7					8		0	1	2	16	30	0	0	2.702	-2.702	7.300804	4.81
	38+00-999		1	2	1	10	3	7	0	7	10	1	0	0	8	12	4	8	2	16	146	32	4.5625	2.702	1.8605	3.4614603	4.81
39	39+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	39+100-200								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	39+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	39+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	39+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	39+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	39+600-700											3	0	0			3	0	0	0	45	0	0	2.702	-2.702	7.300804	4.81
	39+700-800								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	39+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	39+900-999				3					5					6		0	0	0	14	14	0	0	2.702	-2.702	7.300804	4.81
	39+00-999	0	0	0	3	5	0	0	2	5	8	3	0	0	6	7	3	0	2	14	65	20	3.25	2.702	0.548	0.300304	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
40	40+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	40+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	40+200-300								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	40+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	40+400-500												1				0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	40+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	40+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	40+700-800			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	40+800-900							1	2								0	1	2	0	14	0	0	2.702	-2.702	7.300804	4.81
	40+900-999				3					3					2		0	0	0	8	8	0	0	2.702	-2.702	7.300804	4.81
	40+00-999	0	0	1	3	5	0	1	3	3	5	0	0	1	2	3	0	1	5	8	31	13	2.38462	2.702	-0.31738	0.100733	4.81
41	41+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	41+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	41+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	41+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	41+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	41+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	41+600-700			1									1	0	0		1	0	1	0	18	0	0	2.702	-2.702	7.300804	4.81
	41+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	41+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	41+900-999		1	1	1					1					7		0	1	1	9	20	0	0	2.702	-2.702	7.300804	4.81
	41+00-100	0	1	2	1	8	0	0	0	1	1	1	0	0	7	10	1	1	2	9	38	19	2	2.702	-0.702	0.492804	4.81
	42+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	42+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
42	42+200-300													2			0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	42+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	42+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	42+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	42+600-700												1				0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	42+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	42+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	42+900-999									1					2		0	0	0	3	3	0	0	2.702	-2.702	7.300804	4.81
		0	0	0	0	2	0	0	0	1	2	0	0	3	2	3	0	0	3	3	12	7	1.71429	2.702	-0.98771	0.9755795	4.81
43	43+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	43+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	43+200-300								2								0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	43+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	43+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	43+500-600			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	43+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	43+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	43+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	43+900-999				4					2					5		0	0	0	11	11	0	0	2.702	-2.702	7.300804	4.81
	43+00-999	0	0	1	4	6	0	0	2	2	9	0	0	0	5	10	0	0	3	11	20	25	0.8	2.702	-1.902	3.617604	4.81
	44+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
44	44+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	44+00-999	0	0	0	1	6	0	0	0	6	4	0	0	0	8	8	0	0	0	15	15	18	0.83333	2.702	-1.86867	3.4919151	4.81
45	45+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	45+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	45+200-300	3	2	3										1			3	2	4	0	73	0	0	2.702	-2.702	7.300804	4.81
	45+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	45+400-500		1										1				0	1	1	0	11	0	0	2.702	-2.702	7.300804	4.81
	45+500-600								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	45+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	45+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	45+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	45+900-999				0					3					4		0	0	0	7	7	0	0	2.702	-2.702	7.300804	4.81
	45+00-999	3	3	3	0	4	0	0	1	3	6	0	0	2	4	5	3	3	6	7	94	15	6.26667	2.702	3.564667	12.706848	4.81
46	46+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	46+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	46+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	46+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	46+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	46+500-600		2	3													0	2	3	0	25	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	46+600-700									1							0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	46+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	46+800-900									1							0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	46+900-999				1						6				7		0	0	0	14	14	0	0	2.702	-2.702	7.300804	4.81
	46+00-999	0	2	3	1	3	0	0	2	6	8	0	0	0	7	9	0	2	5	14	45	20	2.25	2.702	-0.452	0.204304	4.81
47	47+00-100			5													0	0	5	0	15	0	0	2.702	-2.702	7.300804	4.81
	47+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	47+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	47+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	47+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	47+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	47+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	47+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	47+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	47+900-999				1					4					4		0	0	0	9	9	0	0	2.702	-2.702	7.300804	4.81
	47+00-999	0	0	5	1	3	0	0	0	4	4	0	0	0	4	5	0	0	5	9	24	12	2	2.702	-0.702	0.492804	4.81
48	48+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	48+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	48+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	48+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	48+400-500	1	1	0						1							1	1	1	0	26	0	0	2.702	-2.702	7.300804	4.81
	48+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	48+600-700													1			0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	48+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	48+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	48+900-999				5					6					7		0	0	0	18	18	0	0	2.702	-2.702	7.300804	4.81
	48+00-999	1	1	0	5	7	0	0	1	6	8	0	0	1	7	9	1	1	2	18	47	24	1.95833	2.702	-0.74367	0.5530401	4.81
49	49+00-100		1	7			1	0	0								1	1	7	0	44	0	0	2.702	-2.702	7.300804	4.81
	49+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	49+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	49+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	49+400-500			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	49+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	49+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	49+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	49+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	49+900-999				6					2					3		0	0	0	11	11	0	0	2.702	-2.702	7.300804	4.81
	49+00-999	0	1	8	6	13	1	0	0	2	5	0	0	0	3	3	1	1	8	11	58	21	2.7619	2.702	0.059905	0.0035886	4.81
50	50+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	50+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	50+200-300								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	50+300-400			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	50+400-500								4					1			0	0	4	1	13	0	0	2.702	-2.702	7.300804	4.81
	50+500-600							1	2								0	1	2	0	14	0	0	2.702	-2.702	7.300804	4.81
	50+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	50+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	50+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	50+900-999				0					4					2		0	0	0	6	6	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	50+00-999	0	0	1	0	4	0	1	7	4	7	0	0	0	3	3	0	1	8	7	39	14	2.78571	2.702	0.083714	0.0070081	4.81
51	51+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	51+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	51+200-300	1	1	1													1	1	1	0	26	0	0	2.702	-2.702	7.300804	4.81
	51+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	51+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	51+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	51+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	51+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	51+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	51+900-999				3					5					5		0	0	0	13	13	0	0	2.702	-2.702	7.300804	4.81
	51+00-999	1	1	1	3	8	0	0	0	5	5	0	0	0	5	6	1	1	1	13	39	19	2.05263	2.702	-0.64937	0.4216793	4.81
52	52+00-100			1				2	6								0	2	7	0	37	0	0	2.702	-2.702	7.300804	4.81
	52+100-200											2	5	10			2	5	10	0	100	0	0	2.702	-2.702	7.300804	4.81
	52+200-300							1									0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	52+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	52+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	52+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	52+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	52+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	52+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	52+900-999				11					6					16		0	0	0	33	33	0	0	2.702	-2.702	7.300804	4.81
	52+00-999	0	0	1	11	20	0	3	6	6	14	2	5	10	16	24	2	8	17	33	178	58	3.06897	2.702	0.366966	0.1346637	4.81
	53+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
53	53+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	53+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	53+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	53+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	53+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	53+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	53+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	53+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	53+900-999				3					2					6		0	0	0	11	11	0	0	2.702	-2.702	7.300804	4.81
	53+00-999	0	0	0	3	7	0	0	0	2	8	0	0	0	6	4	0	0	0	11	11	19	0.57895	2.702	-2.12305	4.5073525	4.81
54	54+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	54+100-200								2								0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	54+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	54+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	54+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	54+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	54+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	54+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	54+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	54+900-999				1					3					4		0	0	0	8	8	0	0	2.702	-2.702	7.300804	4.81
	54+00-999	0	0	0	1	1	0	0	2	3	5	0	0	0	4	3	0	0	2	8	14	9	1.55556	2.702	-1.14644	1.3143349	4.81
	55+00-100								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	55+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	55+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
55	55+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	55+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	55+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	55+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	55+700-800			1	1					6					2		0	0	1	9	12	0	0	2.702	-2.702	7.300804	4.81
	55+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	55+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	55+00-999	0	0	1	1	5	0	0	1	6	4	0	0	0	2	4	0	0	2	9	15	13	1.15385	2.702	-1.54815	2.3967803	4.81
56	56+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	56+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	56+200-300								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	56+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	56+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	56+500-600											1	1	0			1	1	0	0	23	0	0	2.702	-2.702	7.300804	4.81
	56+600-700		1	4													0	1	4	0	20	0	0	2.702	-2.702	7.300804	4.81
	56+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	56+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	56+900-999				1					3					2		0	0	0	6	6	0	0	2.702	-2.702	7.300804	4.81
	56+00-999	0	1	4	1	3	0	0	1	3	3	1	1	0	2	5	1	2	5	6	52	11	4.72727	2.702	2.025273	4.1017296	4.81
	57+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	57+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	57+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	57+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	57+400-500								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
57	57+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	57+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	57+700-800											1	1	0			1	1	0	0	23	0	0	2.702	-2.702	7.300804	4.81
	57+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	57+900-999				3					5				2			0	0	0	10	10	0	0	2.702	-2.702	7.300804	4.81
	57+00-100	0	0	0	3	3	0	0	1	5	7	1	1	0	2	3	1	1	1	10	36	13	2.76923	2.702	0.067231	0.00452	4.81
58	58+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	58+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	58+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	58+300-400												4	9			0	4	9	0	59	0	0	2.702	-2.702	7.300804	4.81
	58+400-500													1			0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	58+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	58+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	58+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	58+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	58+900-999				1					2					3		0	0	0	6	6	0	0	2.702	-2.702	7.300804	4.81
	58+00-999	0	0	0	1	6	0	0	0	2	2	0	4	10	3	5	0	4	10	6	68	13	5.23077	2.702	2.528769	6.3946738	4.81
59	59+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	59+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	59+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	59+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	59+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	59+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	59+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ2	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	59+700-800						1	0	0								1	0	0	0	15	0	0	2.702	-2.702	7.300804	4.81
	59+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	59+900-999									3					4		0	0	0	7	7	0	0	2.702	-2.702	7.300804	4.81
	59+00-999	0	0	0	0		1	0	0	3	5	0	0	0	4	4	1	0	0	7	22	9	2.44444	2.702	-0.25756	0.0663349	4.81
60	60+00-100			1					4					3			0	0	8	0	24	0	0	2.702	-2.702	7.300804	4.81
	60+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	60+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	60+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	60+400-500								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	60+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	60+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	60+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	60+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	60+900-999				7					11					10		0	0	0	28	28	0	0	2.702	-2.702	7.300804	4.81
	60+00-999	0	0	1	7	22	0	0	5	11	13	0	0	3	10	15	0	0	9	28	55	50	1.1	2.702	-1.602	2.566404	4.81
61	61+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	61+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	61+200-300			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	61+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	61+400-500							1									0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	61+500-600											1					1	0	0	0	15	0	0	2.702	-2.702	7.300804	4.81
	61+600-700			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	61+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	61+800-900						1	1	0				1	3			1	2	3	0	40	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	61+900-999				11					8					14		0	0	0	33	33	0	0	2.702	-2.702	7.300804	4.81
	61+00-100	0	0	2	11	8	1	2	0	8	6	1	1	3	14	8	2	3	5	33	102	22	4.63636	2.702	1.934364	3.7417627	4.81
62	62+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	62+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	62+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	62+300-400													1			0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	62+400-500												1				0	1	0	0	8	0	0	2.702	-2.702	7.300804	4.81
	62+500-600			2										1			0	0	3	0	9	0	0	2.702	-2.702	7.300804	4.81
	62+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	62+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	62+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	62+900-999				1					3					4		0	0	0	8	8	0	0	2.702	-2.702	7.300804	4.81
	62+00-999	0	0	2	1	4	0	0	0	3	5	0	1	2	4	11	0	1	4	8	28	20	1.4	2.702	-1.302	1.695204	4.81
63	63+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	63+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	63+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	63+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	63+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	63+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	63+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	63+700-800			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	63+800-900				2												0	0	0	2	2	0	0	2.702	-2.702	7.300804	4.81
	63+900-999									3		1	5	5	1		1	5	5	4	74	0	0	2.702	-2.702	7.300804	4.81
	63+00-999	0	0	1	2	2	0	0	0	3	5	1	5	5	1	2	1	5	6	6	79	9	8.77778	2.702	6.075778	36.915076	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
64	64+00-100			1			1		4				1	4			1	1	9	0	50	0	0	2.702	-2.702	7.300804	4.81
	64+100-200								1								0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	64+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	64+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	64+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	64+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	64+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	64+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	64+800-900								2					1			0	0	3	0	9	0	0	2.702	-2.702	7.300804	4.81
	64+900-999				5					10					11		0	0	0	26	26	0	0	2.702	-2.702	7.300804	4.81
	64+00-999	0	0	1	5	9	1	0	7	10	13	0	1	5	11	14	1	1	13	26	88	36	2.44444	2.702	-0.25756	0.0663349	4.81
65	65+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	65+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	65+200-300			1													0	0	1	0	3	0	0	2.702	-2.702	7.300804	4.81
	65+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	65+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	65+500-600								1					1			0	0	2	0	6	0	0	2.702	-2.702	7.300804	4.81
	65+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	65+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	65+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	65+900-999				2										1		0	0	0	3	3	0	0	2.702	-2.702	7.300804	4.81
	65+00-999	0	0	1	2	3	0	0	1	0	2	0	0	1	1	2	0	0	3	3	12	7	1.71429	2.702	-0.98771	0.9755795	4.81
	66+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	66+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
66	66+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	66+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	66+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	66+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	66+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	66+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	66+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	66+900-999				1					3					2		0	0	0	6	6	0	0	2.702	-2.702	7.300804	4.81
	66+00-999	0	0	0	1	4	0	0	0	3	5	0	0	0	2	3	0	0	0	6	6	12	0.5	2.702	-2.202	4.848804	4.81
67	67+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	67+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	67+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	67+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	67+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	67+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	67+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	67+700-800	1	2	1													1	2	1	0	34	0	0	2.702	-2.702	7.300804	4.81
	67+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	67+900-999				2										2		0	0	0	4	4	0	0	2.702	-2.702	7.300804	4.81
	67+00-999	1	2	1	2	3	0	0	0	0	2	0	0	0	2	5	1	2	1	4	38	10	3.8	2.702	1.098	1.205604	4.81
	68+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	68+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	68+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	68+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ2	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
68	68+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	68+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	68+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	68+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	68+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	68+900-999				2												0	0	0	2	2	0	0	2.702	-2.702	7.300804	4.81
	68+00-999	0	0	0	2	4	0	0	0	0	3	0	0	0	0	2	0	0	0	2	2	9	0.22222	2.702	-2.47978	6.1492978	4.81
69	69+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	69+00-999	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	0	0	2	2	3	0.66667	2.702	-2.03533	4.1425818	4.81
70	70+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chanage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	70+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	70+00-999	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0	2.702	-2.702	7.300804	4.81
71	71+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	71+900-999				1												0	0	0	1	1	0	0	2.702	-2.702	7.300804	4.81
	71+00-999	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	2.702	-1.702	2.896804	4.81
72	72+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	72+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	72+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	72+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	72+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	72+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	72+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	72+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
	72+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	72+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	72+00-999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
73	73+00-100																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+500-600																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	73+00-999	0	0	0	0	2	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	5	0	2.702	-2.702	7.300804	4.81
74	74+00-100																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+500-600																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	74+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																												
S/no	Chantage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ ₂	δ	Cs	
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI									
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81	
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81	
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81	
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81	
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81	
	2+500-600			9				2	2	23				2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81	
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81	
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81	
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81	
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81	
	74+00-999	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	2	0	2.702	-2.702	7.300804	4.81	
75	75+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	75+900-999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
76	76+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+700-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	76+00-999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	
	77+00-100																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81	

Addis Ababa-Adama expressway Black spot segment

Fatal crash Location 2007-2014 E.C																											
S/no	Chanage	2012					2013					2014					Total			T.PD	Sj	Aj	Rj	Ravg	δ_2	δ	Cs
		Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	Fa	SI	LI	PD	A	T.Fa	T.SI	T.SI								
2	2+00-100	1	1														1	1	0	0	0		0	2.70074	-2.70074	7.2939711	4.81
	2+100-200																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+200-300																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+300-400																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+400-500																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+500-600			9				2	2	23			2	2	26		0	4	13	0	0		0	2.702	-2.702	7.300804	4.81
	2+600-700																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+700-800																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+800-900																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+900-999																0	0	0	0	0		0	2.702	-2.702	7.300804	4.81
	2+00-999	1	1	9	13	33	0	2	2	23	12	0	2	2	26	18	1	5	13	62	156	63	2.47619	2.702	-0.22581	0.0509899	4.81
77	77+100-200																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+200-300																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+300-400																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+400-500																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+500-600																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+600-700																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+00-800																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+800-900																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+900-999																0	0	0	0	0	0	0	2.702	-2.702	7.300804	4.81
	77+00-999	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2.702	-2.702	7.300804	4.81
78	78+00-100	1			1	4				2	3	3	4	0	5	4	4	4	0	8	100	11	9.09091	2.702	6.388909	40.818159	4.81

110 240 660

-61

171

$\Sigma S_j = 3,673.0$

$\Sigma A_j = 1,360.0$

$C_s = 4.80446$

$1/n \Sigma \delta = 319.143$

4.19925

$\delta = 2.03$

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