NEAR EAST UNIVERSITY
INSTITUTE OF GRADUATE STUDIES
DEPARTMENT OF CIVIL ENGINEERING

EVALUATION OF TRAFFIC CONGESTION AT INTERSECTIONS IN MOGADISHU CITY A CASE STUDY OF MAKA –AL MUKARAMA ROAD

M.Sc.THESIS

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Nicosia

February, 2023

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Approval

We certify that we have read the thesis submitted by **Ilham Yahya AMIR** titled **"EVALUATION OF TRAFFIC CONGESTION AT INTERSECTIONS IN MOGADISHU CITY A CASE STUDY OF MAKA –AL MUKARAMA ROAD"** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Educational Sciences.

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Declaration

I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of the institute of graduate studies, Near East University. I also declare that asrequired by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Ilham Yahya AMIR

. .18/ .02./2023

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Ilham Yahya AMIR'

Abstract

EVALUATION OF TRAFFIC CONGESTION AT INTERSECTIONS IN MOGADISHU CITY A CASE STUDY OF MAKA –AL MUKARAMA ROAD

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The amount of traffic that goes through a certain intersection can be used to judge how well a road system works. In the neighborhood of any intersection during rush hour, traffic would be heavy. This research looked at four major crossroads in Mogadishu, the capital of Somalia, and how congested they were. The research was done over three different busy periods (morning: 8 a.m.–9 a.m.; noon or mid-day: 12 a.m.–13 p.m.; afternoon: 17 p.m.–18 p.m.). The data was analyzed using the SIDRA Intersection Software, with the level of service serving as the starting point for the evaluation under consideration at the moment and before and after optimizations being proposed based on the aforementioned parameters (average delay, degree of saturation, and level of service). The current assessment of both intersections has yielded a failing grade of F for the quality of service provided. The results of optimizing both crossings by adding two more lines revealed a decrease in average delays, degree of saturation, and level of service compared to the baseline in the majority of approaches.

Keywords*:* intersection, congestion, delay, level of service, SIDRA intersection

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List of Abbreviations

AVD: Average Delay

FUC: Fuel Consumption

HCM: Highway Capacity Manual

LOS: Level of Service

PCU: Passenger Car Unit

CO_2: Carbon dioxide

SIDRA: Signalized and Un-Signalized Intersection Design, and Research Aid

NCHRP: National Cooperative Highway Research Program

LT: Left Turn

TH: Through

RT: Right Turn

AM: Ante Meridiem

PM: Post Meridiem

TRRL: Transport and Road Research Laboratory

CHAPTER I

Introduction

A number of processes and components working together at once are what cause traffic congestion. More traffic jams will happen during peak commute times if more people use their own cars (Yahia, 2017). Mogadishu, Somalia's public transit system, frequently experiences delays and close vehicle spacing. Inadequate road network methods have contributed to large delays, increasing average delays (AVD), fuel consumption (FUC), and operating costs (OPC) in many cities throughout the world, especially in developing countries. Gridlock and lengthy wait times at intersections are common complaints from Malaysian motorists during peak commute times. In tandem with Malaysia's burgeoning economy, the demand for automobiles has skyrocketed in recent years (J. Kasipillai and P. Chan, 2008). These assessments would be carried out using the "micro-analysis traffic evaluation tool that employs lane-by-lane and vehicle drive cycle models" (SIDRA 5, Irtema et al. 2015). Networks of intersections that include both signalized and unsignalized roundabouts are compared. With the help of SIDRA Intersection 4, it was discovered that average delays decreased by 50% and travel speeds increased. In addition, the study found that traffic flow at intersections and roundabouts had greatly improved (Albrka et al. 2014).

Statement of the Problem

Mogadishu City's increased industry and urbanization have led to traffic congestion that restricts the movement of people and commodities that need to be delivered on time. Due to this, there are a number of problems brought on by the traffic congestion in Mogadishu City, including lengthy wait times for public transportation, delays at work and in schools, increased energy consumption, air and noise pollution, and delays in the delivery of goods and services.

These problems have a significant influence on people's productivity and health, as well as on business losses, longer delivery delays, and an increase in traffic accidents. As a result, many nations now place a high focus on minimizing traffic congestion.

The Aim and Objectives of the Study

Aim of the Study

The overall goal of this research is to assess the causes and impact of traffic congestion, quantify performance and the level of service at the selected intersections in Mogadishu city.

Specific Objectives of the Study

- ✓ To analyze the traffic volume and the vehicle type that cause high congestion during the peak hour periods at selected intersections.
- ✓ To determine the highest congestion approach for both intersections according to the peak hour periods,
- ✓ Using SIDRA intersection software to evaluate the level of service (LOS) and performance of the intersections.
- ✓ To analyze before and after optimization for both intersections with the parameters: average delay and degree of saturation.
- ✓ To install a traffic light system at a selected intersection according to the volume of traffic flow.

Scope of the Study

In this study, we used the SIDRA software to analyze the performance of a number of intersections with different legs at different times of day (peak hours in the morning, afternoon, and evening). The system used to control traffic is called SIDRA.

CHAPTER II

Literature review

Population and economic growth have increased the need for reliable modes of transportation. As a result, there will be a rise in traffic, which means higher costs for everyone. Congestion relief relies on infrastructure and traffic management. In a number of global cities, transportation is a major problem. The country's Ministry of Transportation (2018) has highlighted issues with public transportation in Somalia's cities. Increases in fuel prices, congestion, and collisions on the roads.

Definition of Traffic Congestion

A universal definition of traffic congestion does not exist. Getting everyone on the same page becomes more difficult as we get closer to the point where the supply of road space is at its maximum capacity. This is because traffic congestion is both a real phenomenon and a perception created by users of the road system's capabilities. When there are more cars on the road than the infrastructure can handle, the traffic moves at a painfully slow pace. In this case, the economy, people's quality of life and productivity, the environment, and the added costs and reduced service areas for workers, suppliers, or customers can all suffer (NCHRP report 463, 2011). Wallis and Lupton (2013) stated that there are three definitions of congestion:

Economists agree that road interactions between vehicles are what ultimately cause congestion. Because of this, all major thoroughfares experiencing high volumes of traffic are clogged. Road users experience congestion when speeds fall below what they consider safe. When there are too many cars for a given road, we say that traffic is "congested."

Causes of Traffic Congestion

Congestion on the roads is caused by a number of factors. Schrank et al. (2013) identify three causes of traffic jams: There are a lot of people and things on the move at once; supply is growing slowly, and many trips are getting pushed back because of unforeseen circumstances. The occurrence of accidents, vehicle breakdowns, poorly timed traffic signals, and even inclement weather all contribute to the wide variety of traffic congestion issues that drivers face.

The following is a summary of the major causes of traffic congestion, according to a separate study by Mekonnen (2015): There was car damage and illegal parking. Congestion in the transportation system is largely due to the following factors, as outlined by Mahmud et al. (2012):

Narrow Roads

Because of illegal possession on the roads, traffic is getting worse, which makes drivers wait longer. Consequently, expanding the road by their right-of-way can help reduce traffic. In addition, there will be no need for costly land acquisition, so the time and resources saved will add up.

Illegal Parking

Illegal parking has been a daily source of traffic congestion. Drivers illegally parking their vehicles there frequently contribute to congestion on major highways and highway segments.

An increasing population

Rising city populations are bad news for people who plan transportation and could be a big reason why traffic is getting worse in all major cities.

The higher purchasing power of the public

As city residents' disposable incomes rise, they are more likely to choose private transportation, but the city's highways can't handle the increase in traffic that this causes. As a result, traffic jams involving motor vehicles have increased dramatically.

Improper planning of city development

The Development Plan lays out the city's vision for the future. The problem with that approach is that it doesn't work. Due to the lack of a coherent construction strategy, a lot of snatched highway-side property goes unnoticed.

Improper lane management

Traffic management is difficult and requires careful attention to lanes. It's not uncommon for drivers to attempt to pass on a single-lane road. This is the primary reason why city streets typically lack lane separators.

Measuring Traffic Congestion

Congestion can be measured in a number of ways, and each one has its own pros and cons, depending on what is being looked into. Several things that show how slow things are can be used to figure out how bad the traffic is. According to Aftabuzzaman (2007), there are four main types of measures for gauging traffic congestion: fundamental measures, proportional measures, service-level measures, and indices. Among the most fundamental metrics, delay estimation is essential. Time lost due to traffic congestion is expressed as a percentage increase over the normal travel time. Full roadway length (volume- or population-weighted) and segment delays are both examples of congestion measures, as stated by Lomax et al. (1997). Travel time or uncertainty ratios are commonly used as a measure of traffic congestion. Numerous ratio measures based on travel rates were developed by Lomax et al. (1997).Level of service is another metric that can be used to assess traffic congestion (LOS). The Highway Capacity Manual from 1985 was the first time the LOS idea was mentioned. It sets up an operational range. Vehicle density, volume-to-capacity ratio, average speed, and intersection delay all play a role in determining LOS for various facilities. LOS grades go from A+ to D+ to E+ to F+, with A being the best possible grade. Users can set their own speeds and make their own moves within the flow of traffic without significantly impacting the flow's overall efficiency. LOS F represents the most congested and pushed-along flow, also known as forced flow or breakdown flow. In the end, the most useful metrics for gauging congestion are congestion indices like travel time indexes and others.

According to NCHRP Report 463 (2011), congestion impacts can be broken down further into user and non-user impacts. Time-related metrics, volumetric indices, delay metrics, and overall system throughput (LOS) metrics are just some of the ways that the effects of traffic congestion can be quantified. Time-based measures include the velocity, duration, and rate of a trip. Examples of volumetric measurements include traffic volume and vehicle miles traveled (lane miles). Accurate measurements are required for congestion indices like the congestion index, the road congestion index, and the excess delay metric. Measurements of LOS include not only congestion but also corner LOS, lane miles at or during LOS vehicle hours, and LOS vehicle hours themselves. LOS There isn't just the time spent traveling that you have to consider. Congestion has consequences for people who aren't using it, such as increased transportation costs, logistics and JIT processing costs, market size accessibility, and business commute times. In Table 1, you can see the ratio of volume to capacity and the LOS analysis.

Table 1

Volume to Capacity Ratio and LOS Evaluation

LOS	Description	Volume/ Capacity
A	Stooped over, in a state of free-flowing maneuverability, The amount of time lost due to a slowed-down intersection is minimal.	0.00-0.60
B	Restricted maneuverability and stoppages aren't a big deal for most people.	0.61-0.70
C	Consistent performance with a few more limitations on mid-block lane changes in comparison to LOS B. Drivers will feel significant stress while on the road.	0.71-0.80
D	Small increases in volume lead to significant delays and	0.81-0.90

	low average speeds in unstable operations.	
E	Operations with significant delays at intersections and low speeds.	0.91-1.10
F	Congested intersections, long delays, and poor signal progression have resulted in extremely low speeds.	In excess of 1.0

Source: Joshua and Iyiola (2009)

Table 2

Congestion and the Average Capacity to Volume Ratio

No.	Average traffic volume/capacity Ratio	Technical interpretations
I	Less than 0.6	No congestion
Ii	0.6 to 0.8	Slight congestion
Iii	0.8 to 1.0	Congestion
Iv	1.0 to 1.2	Severe congestion
V	Greater than 1.2	Extreme congestion

Impacts of Traffic Congestion

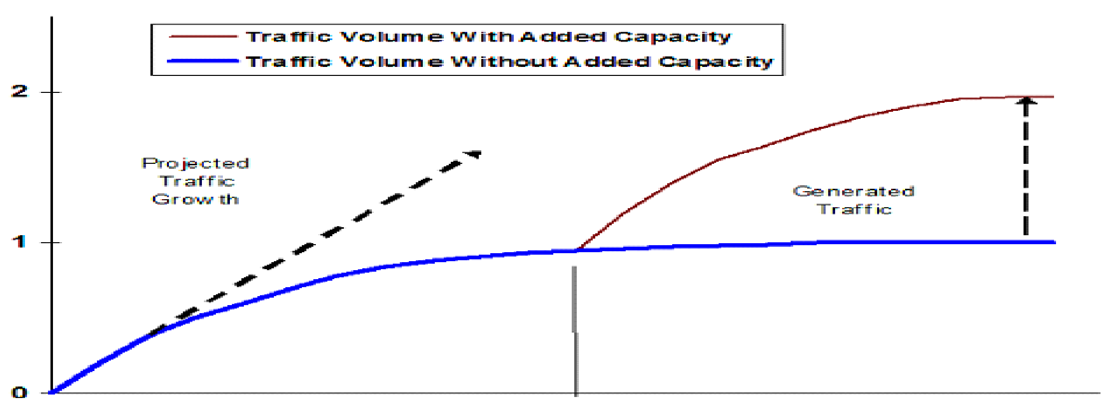
Congestion is bad for cities and their people in many ways, like making transportation more expensive and making commutes longer. Congestion's knock-on effects on things like environmental quality and human well-being are just a few of the many that should be kept in mind. Design and safety considerations also extend to pedestrians and people whose homes are located close to the edges of roads. In 2012, a group led by Mahmud and others published a study confirming the hypothesis. The effects of traffic congestion can be examined from three perspectives: the economy, public health, and the environment. Congestion costs the economy dearly in four main ways, as detailed below (Mahmud 1 et al., 2012): Having fewer people working on the project means less money spent on transportation, less money spent on gas, and less money spent on maintenance and other expenses. Different social effects of congestion have been identified. Not only does it have an adverse effect on the environment, but it also has repercussions for people who use the road but aren't in a car, such as pedestrians, cyclists, and property owners (European Conference of Ministers of Transport, 2007).

Measures to Reduce Traffic Congestion

Because of the above reasons, it is important to take steps to manage traffic flow and reduce the number of traffic jams. Traffic management strategies can help lessen some of the bad things that have already been mentioned. According to Joshua and Iyiola (2009), there are three distinct goals of traffic management: Improving quality of life and public safety through the practice of reserving a portion of a roadway for pedestrian use or increasing the carrying capacity of a vehicle to carry as many people as possible Additional traffic may be induced by adding lanes or grade-separated intersections, meaning that increasing road capacity may not help alleviate congestion. Growth in traffic occurs when roads are not congested, but as congestion rises, growth stutters and eventually stops. Without a change in the power dynamic, traffic volumes will continue to increase (Grant-Muller and Laird, 2007). Figure 1 illustrates the relationship between road capacity and the volume of traffic it can safely accommodate.

Figure 1

Traffic Volume and Roadway Capacity



Source: (Grant-Muller and Laird, 2007)

Haregewein's (2007) research shows that the following are the most effective ways to reduce traffic congestion: Possible solutions include making work schedules more flexible, changing the start and end times of the workday, making sure parking is well managed, making sure there are enough parking spots, and hiring trained traffic police. Improving and enlarging the parking system.

Overview of Intersection

When two or more roads intersect, this is called an intersection. One of its primary functions is to enable drivers to make directional changes. Numerous traffic signs, road markings, and traffic lights were used to keep traffic moving in the right direction and prevent accidents. As of 2017 (Wang, Wang, Song, & Raghavan). Intersections are composite road units due to the high volume of traffic movements that are affected by signalization and visibility (Ferreira & Couto, 2013). The role of intersections in urban transportation is crucial. The effectiveness of a city's traffic system depends on the size of its intersections. Gao and Wang et al. (2017); Zhu et al. (2016) There are a number of different replication models that can be used to analyze traffic patterns at the intersection (Fan et al., 2014). Oversaturation, especially at choke points where traffic backs up and the network becomes congested, has been a major issue at urban intersections (Sun et al., 2015). When city intersections don't work as they should, traffic flows less efficiently and produces fewer results. In 2018, research led by Yao et al. Certain crossroads have traffic signals, and others do not.

Signalized intersection

Signalized intersections use lights, signs, and other traffic control devices to make sure cars go in the right direction and keep people safe. In contrast to their signalized counterparts, non-signalized intersections behave very differently. The drivers' groups mostly control the flow of traffic at these junctions (Yao et al., 2018).

Non-signalized intersection

Without a traffic light, cars can ignore the signs telling them how to move and keep going through the intersection. If this behavior persists, it could cause an increase in traffic accidents and collisions. "(Fan et al., 2014)".

Level of Service (LOS)

A facility or road system has a capacity for the maximum number of vehicles or road users it can safely handle in a given time period and at a given level of service (facility capacity). Ability is often used as a synonym for capacity to talk about how capable someone is. This metric is concerned with service quality (LOS) as opposed to sheer volume (capacity). It's possible that there's always a lot of foot traffic there. However, day-to-day traffic levels can shift significantly depending on the hour. A significant indicator of a road's level of service (LOS) is the number of vehicles using it each hour. It's essentially a phenomenon that decides on a given set of operating conditions for a given facility type. It may be used to specify a type of service in some contexts. The available service level can be calculated with the help of the tools provided in the Highway Capacity Manual. The quality of traffic flow can be rated from A to F, with a being the best possible situation for drivers to feel safe and comfortable maintaining or exceeding the speed limit. Meanwhile, F denotes a level of traffic flow that severely limits both driver liberty and comfort. The standard of care is established in accordance with the MOE (a measure of effectiveness). Travel time, traffic density, and delay time are the three main factors that make up the MOE. How long it takes to get somewhere is a key indicator of quality. Thus, the efficiency and swiftness of travel define the quality of a facility's service (LOS). The term "density" is used to describe the average volume of traffic on a given stretch of road. As a result, drivers have less room to maneuver within the flow of traffic. The HCM includes a wide variety of delay measures with well-defined definitions and applications as measures of effectiveness (MOEs). To wit: Marfani et al. (2018).

Table 3

Standard Level of Service (Highway Capacity Manual, 2000)

Level of service	Average Control Delay (Sec/ Veh)	General description (Signalized intersection)
B	10.1- 20.0	Stable flow(slight delays)
C	20.1-35.0	Stable flow (acceptable delays)
D	35.1-55.0	Approaching unstable flow (tolerable delay, occasionallywait through more than one signal cycle before proceeding)
E	55.1-80.0	Unstable flow (intolerable delay)
F	>80.0	Forced flow (jammed)

Aspects of LOS that need to be considered

Getting the LOS from a road with different traffic characteristics and volumes is possible. The following factors influence LOS (level of service): time and speed of travel; the extent to which traffic is impeded or halted; the ability to set one's own speed; drivers' convenience and comfort; and costs of operation. (Marfani et al., 2018).

Overview of the SIDRA Software

There are currently a plethora of software programs and online resources for traffic modeling. When it comes to managing traffic, however, only one suite of programs stands out from the pack. There is a wide range of potential uses for traffic procedure software. Although traditional methods of highway capacity analysis are frequently employed, there is now software that can offer an alternative. However, other chapters employ simulations to examine the influence of controlling strategies for managing traffic flow as well as the effect of geometric patterns. The improvement of control devices is facilitated by the in-built optimization features of other apparatuses. Numerous programs such as SIDRA, TRANSYT-7F, PASSER IV, HCS2000, and PASSER IV are just a few of the many options. System capacity, timing, LOS, and execution can all be evaluated with the help of SIDRA, which is also used to create intersections and networks of intersections. SIDRA is a crucial analytical package for signalized intersections such as four-way stops, five-way stops, and roundabouts with up to eight legs. By adding up all the lanes, including the ones for turning and networking, and improving the phase separations and cycle lengths, SIDRA provides a useful illustration of how traffic flow is organized. SIDRA is the go-to software for calculating capacity-based MOEs, and it can be used to analyze any stage of a road intersection. SIDRA may be the most effective MOE based on the data from the intersections.

CHAPTER III

Study Area and Methodology

Banadir and Zoobe were chosen as the study's two major intersections in Mogadishu city. These two crossroads are two of the busiest in all of Mogadishu. The intersection was selected using data from aerial surveys, geometric analyses, and traffic studies. In this chapter, we covered in depth the processes involved in data selection, collection, and analysis.

Area of the Study

The capital of Somalia, Mogadishu, is situated in the Horn of Africa, not far from the Red Sea. Somali is the official language, and Sunni Muslimism is the dominant religion. A total of 2,497,000 people will call the Mogadishu metropolitan area home in 2022, representing a year-over-year growth of 4.56 percent. (Integrated Land Data for the Government of Mogadishu, 2022). Two of the many intersections in the study area are rapidly deteriorating as a result of heavy traffic.

Description of Benadir Intersection

The first crowded area in the area is this intersection. It has four legs: the SOBE approach. The SEYBIYANO approach, the DIGFER approach, the MADINA-hospital approach.

Description of Zoobe Intersection

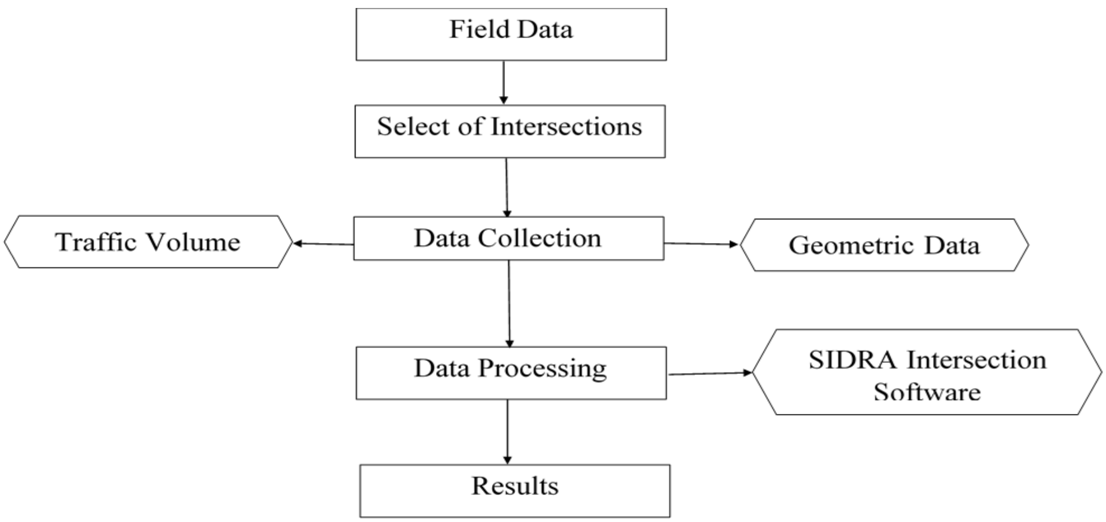
The second-most crowded region in the area is this intersection. It has three legs: the KM4 approach, the BANADIR approach, and the BULAXUBEY approach.

Data Collection Methodology

The information was collected at the start of the day, at midday, and at the end of the day, when traffic is typically at its highest. There is a wide range of recorded unit sizes, so this is deemed to be a good option. There was no data collection during times of extreme weather or during any unusual patterns of movement (like those that might follow a car accident). Figure 2 shows the method that was chosen to measure traffic congestion in order to reach the goals listed above.

Figure 2

Outline of the Study



Traffic Volume Studies

Traffic volume studies must be done in order to understand the types, numbers, and flow of vehicles in a certain area. With this information, you can figure out when large vehicles and people are most likely to be on the road at the same time, which can help you avoid traffic jams. The length of the sampling period depends on the type of count and how the data is going to be used. An intersection count, for instance, might be performed during peak traffic times. In such a scenario, it might be necessary to manually tally the flow of traffic at regular intervals of 10 minutes.

Manual Count Method

It is common practice to have a person manually log traffic data as part of the data collection process. Due to the time and work needed, this kind of data collection can be too expensive for most people to do.If you want to count cars without resorting to a machine, you'll need to rely on a person (or people) with a counter. This counter is able to record both the types of vehicles passing through and their directional changes at intersections.

Manual counting is the standard practice for intervals shorter than a day. Standard intervals for hand counting are 5, 10, and 15 seconds. Manual counts can be recorded using tally sheets, mechanical counting boards, or electronic counting boards. Rather than use a mechanical or electronic counting board, the city conducted a manual traffic census with the help of a tally sheet.

Vehicle Classification Counts

Vehicle classification counts are essential for traffic data collection. It is helpful to know the number of vehicles and the types of vehicles present on a given roadway in order to gain insight into how vehicles move, how they affect traffic, and what design standards should be used. However, there are other methods for gathering vehicle data, each of which varies in accuracy depending on the circumstances. Highway user income and computing power forecasts based on vehicle classification data can be used to establish geometry and the highway's overall layout. A classification count must be performed if a large number of heavy trucks are present or if the mix of vehicles at the incident site is suspected of being a contributing factor in the accident problem.

Figure 3

Vehicle Classification

CLASSIFICATION NAME	CLASSIFICATION TYPE
PASSENGER CARS	
RICKSHAW	
MINI TRUCK	
BUS	
TRUCKS	

The Direction of Vehicle Flow Count

The number of pedestrians, bicyclists, and motorists heading toward an intersection is tallied using the turning movement count, also known as the intersection count. The main objective is to gather information about passing vehicles in order to map out the circulation patterns nearby. The Turning Movement Count is used to calculate the number of turns a moving vehicle makes in three different directions: left, tight, and straight. Possible blunders in the estimation The number of turns varies based on factors such as the layout of the roads involved, the volume of traffic, the timing of the lights, and the types of vehicles on the road. Turning Movement Count Services are an effective tool for reducing delays caused by traffic at crossroads and other junctions. Transportation planning using ready-to-interpret footage analytics and traffic count services can't happen without turn count data. The primary purpose of the manual traffic counts was to collect data on the volume and composition of traffic.

Time Period for Data Recording

The three main types of peak times were figured out, and the volume was measured every 10 minutes. Morning peak period: 8:00 a.m. to 9:00 a.m.; noon peak period: 12:00 p.m. to 1:00 p.m.; and evening peak period: 7:00 p.m. to 8:00 p.m.

Field Measurement

Field measurements were taken of the geometric characteristics of the chosen crossroads. The primary components of an intersection design are the legs, crosswalks, sidewalks, and lanes. Depending on the design, turning motions are directed and handled differently. Intersections require careful planning to accommodate pedestrians, drivers, truckers, and public transit users. The practitioner must work with an interdisciplinary group to address not only intersection layout but also accessibility, traffic control and equipment placement, traffic operations, lighting (both pedestrian- and safety-scaled), and urban design. Leg-alignment, lane width, crosswalks, number of lanes, median, treatment, and channelization method for turning movements were all measured at each approach to the chosen intersection.

Calculating Peak Hour Volume and Planning Hourly Volume It's well-known that your area experiences peak traffic between the hours of 8:00 a.m. and 9:00 a.m., 12:00 p.m. and 1:00 p.m., and 5:00 p.m. and 7:00 p.m. (5:00 p.m. to 6:00 p Finding the peak hour volume, the peak hour factor (PHF), and the actual or design flow rate is today's homework assignment. To do this, you need to locate the intersection and acquire a click-counter. Right turns, left turns, and straight-through travel are all recorded for every 5-, 10-, and 15-minute interval.

Table 4

Sample of Calculation Peak Hour Factor and Design Hourly Volume

TIME	Volume (PCU)
8:00 - 8:10 AM	580
8:10 - 8:20 AM	655
8:20 – 8: 30 AM	732
8:30 - 8:40 AM	976
8:40 - 8:50 AM	813
8:50 – 9:00 AM	762

Total volume during peak hours = (580+655+732+976+813+762) = 4518Volume during peak 10 min = 976

$$\text{PHF}= \frac{Volume\ during\ peak\ hours}{6{*}volume\ during\ peak\ 15\ \text{min}\ during\ peakhours}$$

Optimum Cycle Time

Researchers have pondered the optimal length of a traffic signal cycle for decades. By plugging the values into the equation, you can obtain the solution. The length of a cycle indicates how often one motion is prioritized relative to others. There has been extensive application of the TRRL model. The TRRL formula for the minimum delay cycle length was formulated under the assumption that the effective green times of the phases fell within the range of their respective flow ratio values. To wit: Webster and coworkers, 1966.

$$C_o = \frac{1.5L+5}{1-Y}$$

Where:

C_o**:** The optimal cycle length (sec)

L: The total lost time (sec)

Y: The sum of the critical flow ratio of all phases.

Lost time= 4sec, all red time in one cycle= 1sec in one cycle, amber=3sec in one cycle

SIDRA Intersection Input Data

The SIDRA Intersection technical software allows for the modeling of intersections with light, medium, and heavy vehicle traffic as well as pedestrian traffic. The primary goal of the program is to regulate the effectiveness of existing and future intersections by simulating various scenarios. Due to weather and traffic fluctuations, the software requires a number of inputs at each intersection.

The following input data were assumed in order to make a more precise prediction and analysis: In the SIDRA intersection movement class entry, only standard movement classes were assumed; the SIDRA standard capacity model was selected as the intersection capacity model; this approach was selected for the intersection level of service analysis based on the SIDRA intersection LOS; the environmental factor was set to -1.0; and the size factors were set as follows: The peak flow factor, expressed in a variety of percentages, was used to rank the various categories of movers. At the time, projections predicted a 2% annual increase across all types of movement; however, new information on gap acceptance - For all movement classes, a minimum gap acceptance rate of 2.6 vehicles per minute was used; 40 kilometers per hour was selected as the cruise speed for the approach and exit phases; An analysis was performed using the target level of service for the worst lane over a 10-year design life; LOS D was selected as the target level of service for the peak hour demand at the site; the pump fuel price was set at 29 shillings per liter; the fuel resource cost factor was set at 0.5; and the ratio of running costs to fuel.

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CHAPTER IV

Results and Discussion

Congestion on the roads of Mogadishu City's major cities has become a big problem. It hurts the city's economy, changes how people travel and how land is used, and makes hundreds of drivers very uncomfortable. For many people, the idea of simply widening roads to accommodate more cars is unrealistic and undesirable. With SIDRA intersection software, which will be shown in this chapter, the performance and quality of service at intersections have been looked at and rated.

Traffic Volume Analysis

Data on traffic volumes for directional analysis is only collected during peak hours. In order to better comprehend the two-way traffic flow, the following two intersections were studied: The crossroads of Banadir and Zoobe.Analysis of Traffic Flow at Banadir Intersection.

Banadir Hospital, one of the city's largest, is located at this intersection, which has four entry legs on both approaches and heavy traffic during the morning, midday, and afternoon rush hours. Figure 4 shows that the most traffic at Banadir Intersection happens when people are going to or coming from Madina and in the morning.

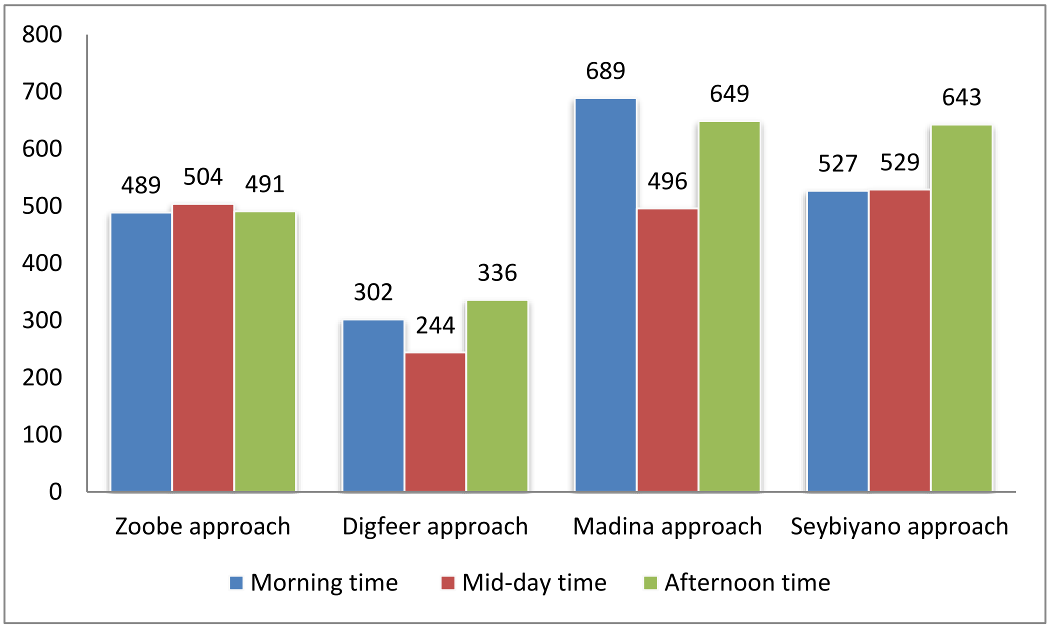
Table 5

Different Approaches of Traffic Volume at Banadir Intersection

Approaches	Morning time	Mid-day time	Afternoon time
Zoobe approach	489	504	491
Digfeer approach	302	244	336
Madina approach	689	496	649
Seybiyano approach	527	529	643

Figure 4

Banadir Intersection Traffic Volume analysis



Vehicle Analysis at Banadir Intersection According to the Peak Hour Periods

Figure 5, shows the type of the vehicle that causes the highest traffic congestion during all the peak hour periods is the rickshaw.

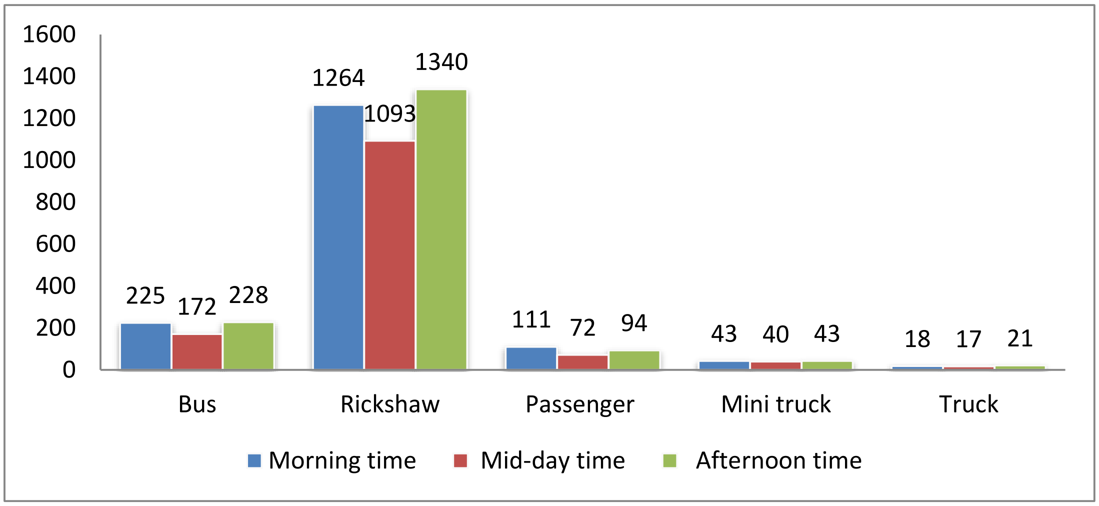
Table 6

Vehicle Analysis at Banadir Intersection

Vehicle type	Morning time	Mid-day time	Afternoon time
Bus	225	172	228
Rickshaw	1264	1093	1340
Passenger	111	72	94
Mini truck	43	40	43
Truck	18	17	21

Figure 5

Vehicle Analysis at Banadir intersection



Analysis of Traffic Flow at Zoobe Intersection

This intersection has three entry legs on both approaches and it has hightraffic volume towards the morning peak period, noon and afternoon peak periods. Figure 6, below shows that the traffic volume at the Bulaxubey approach has the highest traffic volume of all approaches at Zoobe Intersection and also shows that the highest traffic peak period is the afternoon time.

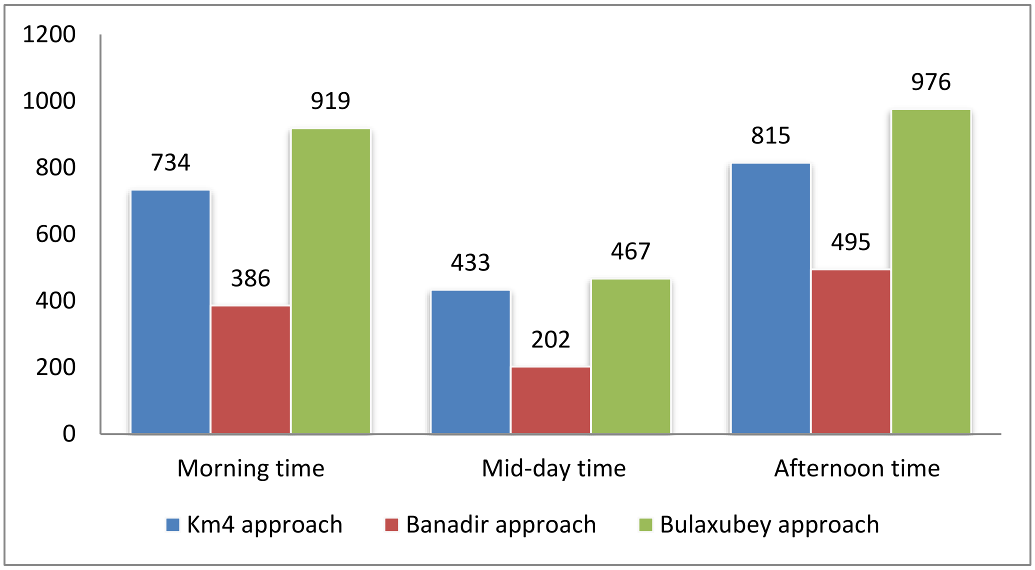
Table 7

Different Approaches of Traffic Volume at Zoobe Intersection

Approaches	Morning time	Mid-day time	Afternoon time
Km4 approach	734	433	815
Banadir approach	386	202	495
Bulaxubey approach	919	467	976

Figure 6

Zoobe intersection Traffic Volume analysis



Vehicle Analysis at Zoobe Intersection According to the Peak Hour Periods

Figure 7 shows the Rickshaw is the type of the vehicle that causes the highest traffic congestion during all the peak hour periods.

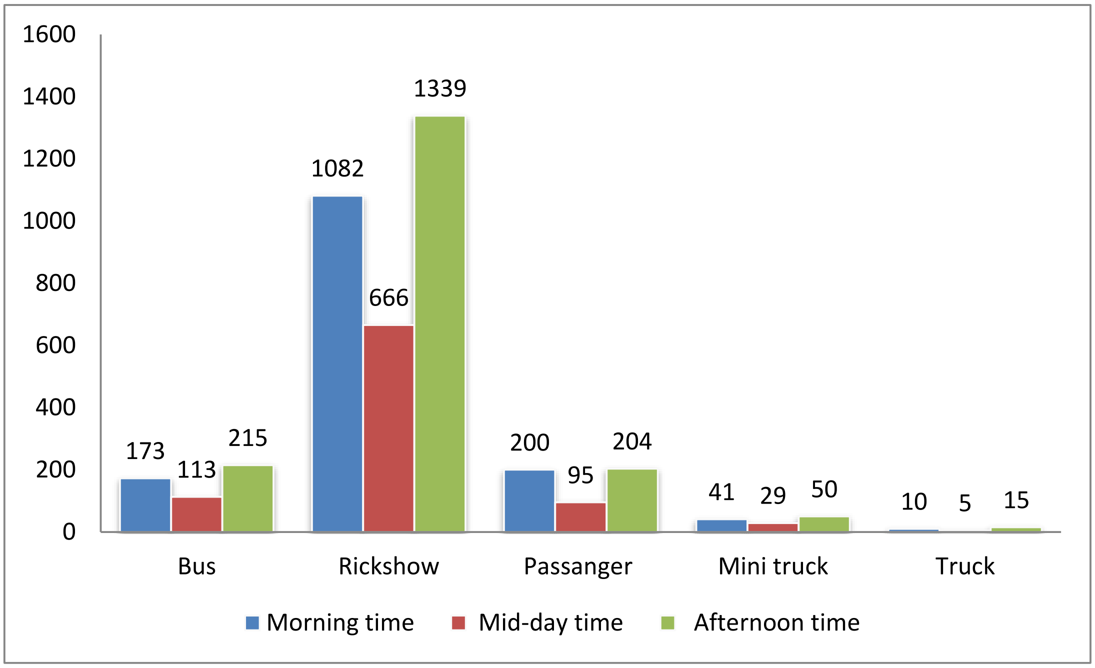
Table 8

Vehicle Analysis at Zoobe Intersection

Vehicle type	Morning time	Mid-day time	Afternoon time
Bus	173	113	215
Rickshaw	1082	666	1339
Passenger	200	95	204
Mini truck	41	29	50
Truck	10	5	15

Figure 7

Vehicle Analysis at Zoobe intersection



Intersection Level of Service

Congestion levels at intersections were determined by performing level of service analyses using SIDRA software. For determining the quality of service, the following information is required: roadway geometry, and traffic volume.

LOS and Delay Output Results for Both Intersections

In order to assess the level of service, SIDRA software and the HCM 2000 right hand rule are used. Intersections have almost LOS F, meaning that traffic is moving at extremely low speeds, there are often delays, and there are often large volumes. This means that most intersections are operating above their capacity.

Suggestions for Optimization

Intersection widening and capacity building projects should be prioritized to reduce congestion and roadblocks. Plans are in place to enhance service at these hubs. The proposed phase shifts at the intersections may be revised. Extra lanes and a dedicated left-turn lane were built as a direct response to the ever-increasing traffic congestion. To compare the results of the pre- and post-optimization phases of this study, we added two new lines at each intersection.

Banadir Intersection Before and After the Optimization

In figures 8, 9 presents before and after optimization of the following parameters: average delay, degree of saturation respectively, and it's clear that more amount of reduction are found after optimization or enhancement.

Table 9

Average Delay (sec) Analysis at Banadir Intersection

Average delay(sec)			
Approach	Periods	Before	After
Zoobe	Morning	193.7	54.8
	Mid-day	186.9	55
	Evening	218.4	56.4
Digfer	Morning	340.5	81.1
	Mid-day	104.6	62
	Evening	242	66.5
Madina hospital	Morning	673.8	224.8
	Mid-day	401.8	100.5
	Evening	571.8	175.2
Seybiyano	Morning	308.7	69.9
	Mid-day	433.7	110.6
	Evening	288.2	66.4

Figure 8

Average Delay (sec) before and After the Optimization at Banadir Intersection

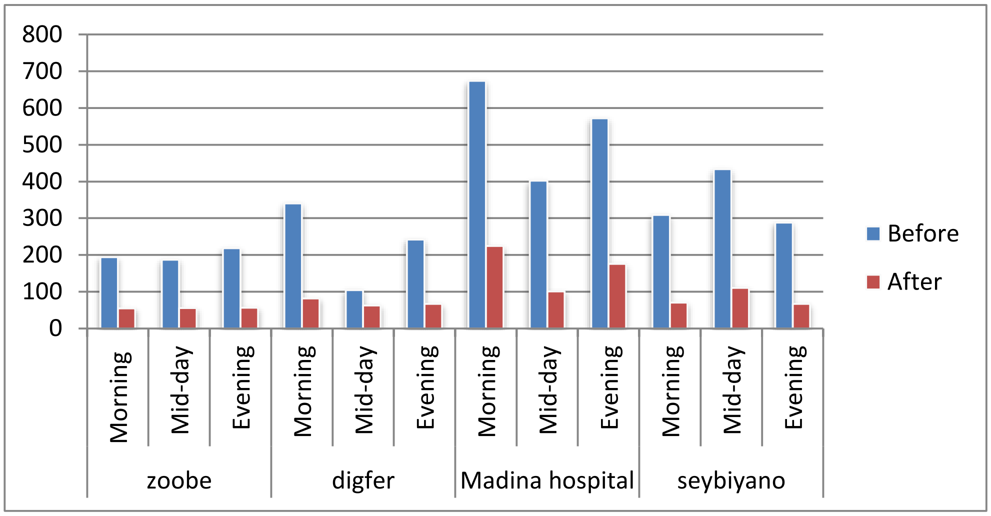


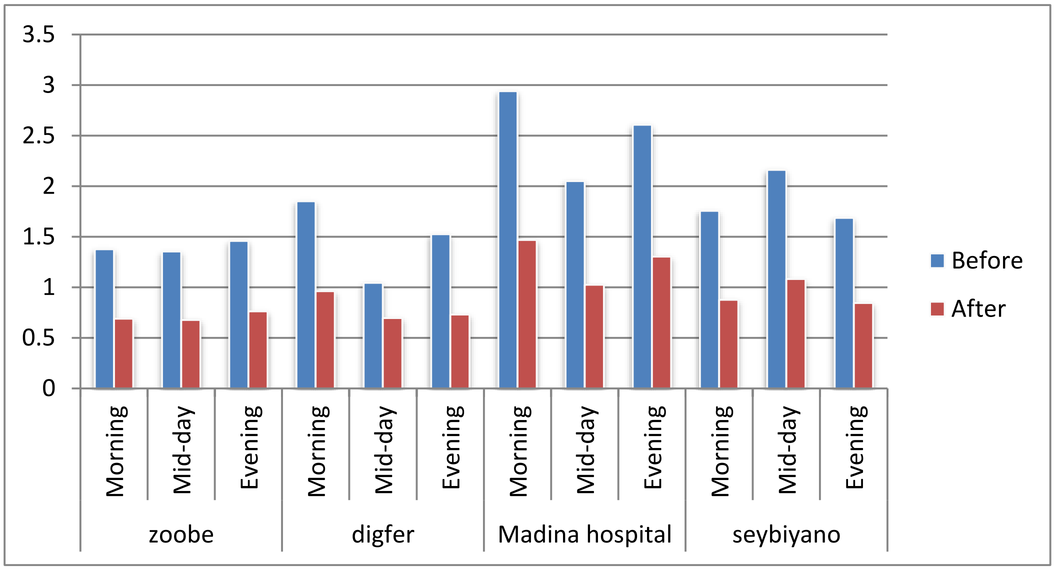
Table 10

Degree of Saturation (v/c) Analysis at Banadir Intersection

Degree of Saturation V/C			
Approach	Periods	Before	After
zoobe	Morning	1.378	0.689
	Mid-day	1.354	0.677
	Evening	1.459	0.763
digfer	Morning	1.853	0.963
	Mid-day	1.045	0.695
	Evening	1.526	0.73
Madina hospital	Morning	2.94	1.47
	Mid-day	2.052	1.026
	Evening	2.609	1.304
seybiyano	Morning	1.756	0.878
	Mid-day	2.161	1.081
	Evening	1.688	0.844

Figure 9

Degree of Saturation (v/c) before and After the Optimization at Banadir Intersection



The table below showed that the result LOS before and after the optimization with large different ranks or scales for all approaches, so this intersection must do more improvement by increasing the capacity of the road or by adding additional lines (slip) Rail Transient and also by reducing the number of vehicles specially the rickshaw because it causes the highest congestion for both intersections.

Table 11

LOS Before and After the Optimization at Banadir Intersection

Banadir Intersection		Level of service					
		Before			After		
Approach	Periods	LT	TH	RT	LT	TH	RT
zoobe	Morning	F	F	F	E	D	E
	Mid-day	F	F	F	E	D	E
	Evening	F	F	F	E	D	E
digfer	Morning	F	F	F	F	E	E
	Mid-day	F	F	F	E	E	E
	Evening	F	F	F	E	E	E
Madina hospital	Morning	F	F	F	F	F	F
	Mid-day	F	F	F	F	F	F
	Evening	F	F	F	F	F	F
seybiyano	Morning	F	F	F	E	E	E
	Mid-day	F	F	F	F	F	F
	Evening	F	F	F	E	E	E

Zoobe Intersection Before and After the Optimization

In figures 10, 11 presents before and after optimization of the following parameters: average delay, degree of saturation respectively, and it’s clear that more amount of reduction are found after optimization or enhancement.

Table 12

Average Delay (sec) Analysis at Zoobe Intersection

Average delay(sec)			
Approach	Periods	Before	After
Banadir	Morning	63.4	39.5
	Mid-day	39.1	36.2
	Evening	99	39.4
Bulaxubey	Morning	537.5	177.3
	Mid-day	217.6	96.8
	Evening	535.2	183.5
KM4	Morning	260	111.7
	Mid-day	64.2	40.3
	Evening	381.7	201.4

Figure 10

Average Delay (sec) before and After the Optimization at Zoobe Intersection

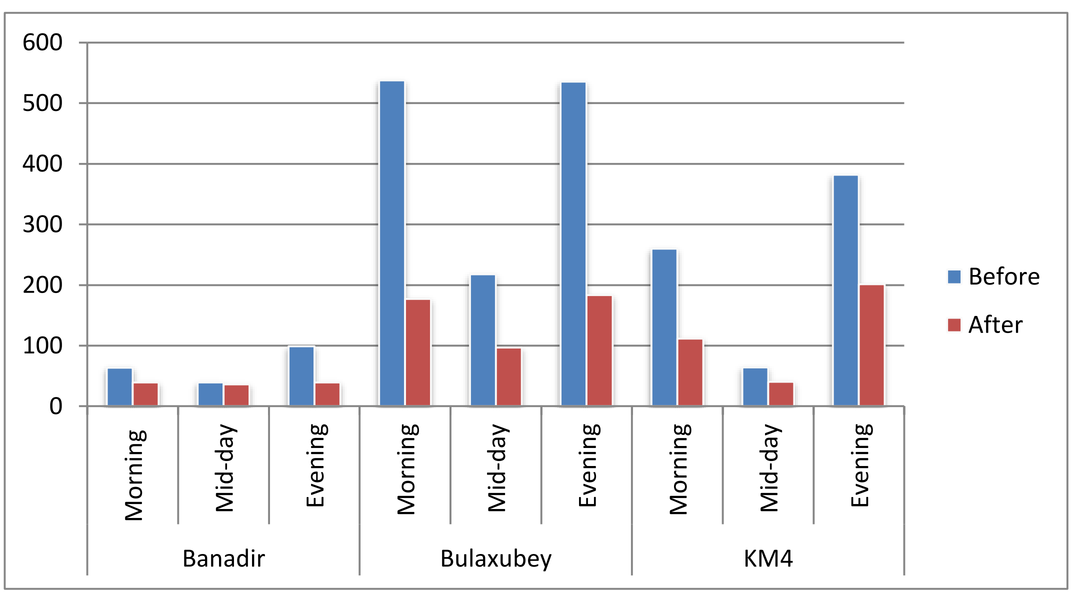


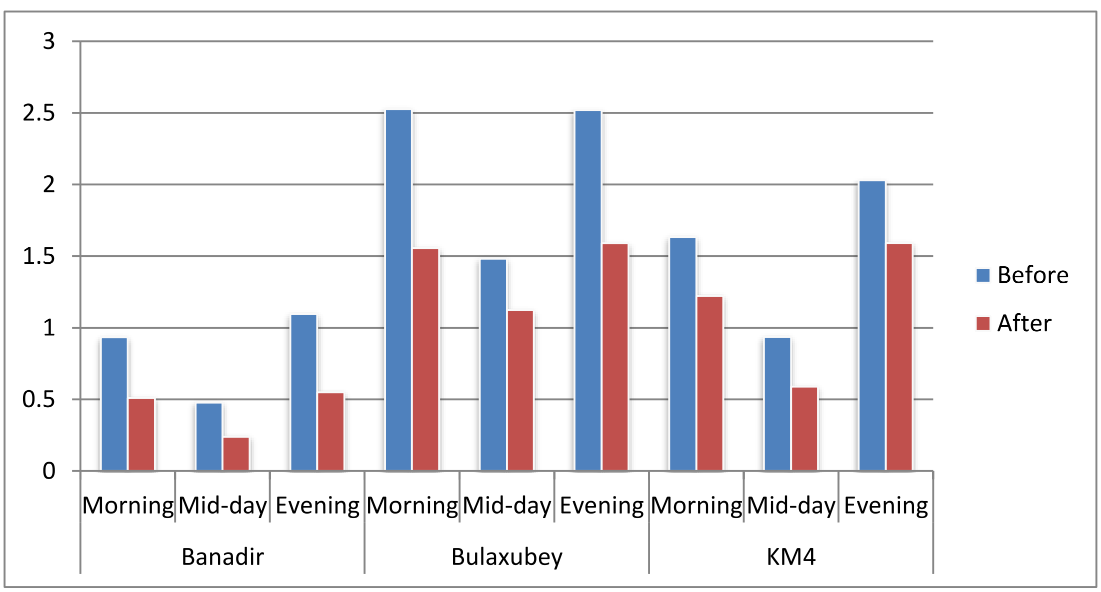
Table 13

Degree of Saturation (v/c) Analysis at Zoobe Intersection

Degree of Saturation V/C			
Approach	Periods	Before	After
Banadir	Morning	0.934	0.51
	Mid-day	0.477	0.238
	Evening	1.096	0.548
Bulaxubey	Morning	2.527	1.555
	Mid-day	1.481	1.123
	Evening	2.52	1.589
KM4	Morning	1.633	1.223
	Mid-day	0.935	0.589
	Evening	2.029	1.592

Figure 11

Degree of Saturation (v/c) before and After the Optimization at Zoobe Intersection



The table below showed that the result LOS before and after the optimization had large different ranks or scales for all approaches, so this intersection must do more improvement by increasing the capacity of the road or by adding additional lines (slip) Rail Transient and also by reducing the number of vehicles, especially the rickshaw, because it causes the highest congestion for both intersections.

Table 14

LOS Before and After the Optimization at Zoobe Intersection

Zoobe Intersection		Level of service					
		Before			After		
Approach	Periods	LT	TH	RT	LT	TH	RT
Banadir	Morning	No	E	E	No	C	D
	Mid-day	No	D	D	No	C	D
	Evening	No	F	F	No	D	D
Bulaxubey	Morning	F	No	F	E	No	F
	Mid-day	F	No	F	D	No	F
	Evening	F	No	F	E	No	F
KM4	Morning	F	F	No	F	C	No
	Mid-day	E	E	No	D	C	No
	Evening	F	F	No	F	C	No

CHAPTER V

Conclusion and Recommendations

Conclusion

Based on the findings of the analysis in this study, the following points are concluded:

- ✓ This study evaluated traffic flow at two intersections in Mogadishu city. A site survey and current traffic data were used to select these two intersections.
- ✓ Banadir and Zoobe Intersections were the two intersections chosen. In order to select the most congested intersections in the city, all four-legged and three-legged vehicles as both intersections were chosen for consideration.
- ✓ During the peak periods of morning, noon, and afternoon, traffic volumes were measured. The number of working days and the volume of traffic for various vehicle types were taken into account in order to obtain accurate information.
- ✓ Firstly, this study intends to evaluate the current analysis for both intersections. Analyses were all used in the analysis of the collected data by Sidra Intersection. The target level of service (LOS) rank D and the saturation degree (below 1.0) were used as performance criteria for optimal intersection design.

- ✓ Secondly, this study intended to add two additional lines for both intersections to evaluate after and before optimization or improvement by using SIDRA intersection software, and the results for both intersections showed that the amount of average delay and degree of saturation were decreased after the enhancement, which means also the LOS were decreased.

Recommendation

The following recommendation is forwarded for possible use by pertinent policymakers:

- ✓ There is evidence that intersections are being over utilized, according to the study's results. Consequently, the city government should take this into account and devise strategies for increasing capacity. As a result, traffic congestion will be reduced by removing or shifting rickshaws to other intersections.
- ✓ According to the study, traffic congestion is high at both intersections. We therefore recommend that policymakers pay close attention to vehicle types and fuel efficiency in order to reduce traffic congestion costs.
- ✓ To make sure traffic flows safely, quickly, and easily in Mogadishu, the whole city needs to work to ease traffic congestion. Furthermore, a better understanding of how the light rail transit system can be used to alleviate traffic congestion by incorporating vehicles of all ages and grades and at grade intersections is needed, as is a better understanding of how the environmental costs of traffic congestion and its mitigation Methods can be reduced, and the improvement of public transportation in Mogadishu can reduce traffic congestion.

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APPENDICES

Appendix A

Input Data to SIDARA Software for Both Intersections

A. Input Data to SIDARA Software at Banadir Intersection

Banadir Intersection Before the Optimization					Total Traffic Volume(veh)			Peak Hour Factor (%)		
Approach	No of lanes	Lane width(m)	Median width(m)	Periods	TH	RT	LT	TH	RT	LT
Zoobe	1	5	1	Morning	141	172	176	90	84	70
				Noon	115	191	198	91	80	84
				evening	117	192	182	80	70	80
digfer	1	7.5	0	Morning	75	82	145	50	60	48
				Noon	46	79	119	83	72	72
				evening	44	144	148	63	78	65
Madina hospital	1	3.5	1	Morning	164	181	344	72	82	82
				Noon	120	133	243	84	77	84
				evening	201	149	299	86	86	82
seybiyano	1	5	1	Morning	189	137	201	79	78	78
				Noon	167	264	212	81	78	76
				evening	188	129	212	83	87	78

Banadir Intersection After the Optimization					Total Traffic Volume(veh)			Peak Hour Factor (%)		
Approach	No of lanes	Lane width(m)	Median width(m)	Periods	TH	RT	LT	TH	RT	LT
Zoobe	2	5	1	Morning	141	172	176	90	84	70
				Noon	115	191	198	91	80	84
				evening	117	192	182	80	70	80
digfer	2	7.5	0	Morning	75	82	145	50	60	48
				Noon	46	79	119	83	72	72
				evening	44	144	148	63	78	65
Madina hospital	2	3.5	1	Morning	164	181	344	72	82	82
				Noon	120	133	243	84	77	84
				evening	201	149	299	86	86	82
seybiyano	2	5	1	Morning	189	137	201	79	78	78
				Noon	167	264	212	81	78	76
				evening	188	129	212	83	87	78

B. Input Data to SIDARA Software at Zoobe Intersection

Zoobe Intersection Before the Optimization					Total Traffic Volume(veh)			Peak Hour Factor (%)		
Approach	No of lanes	Lane width(m)	Median width(m)	Periods	TH	RT	LT	TH	RT	LT
Km4	1	5	1	Morning	211	No	523	95	No	83
				Noon	163	No	270	87	No	89
				evening	175	No	640	74	No	78
Banadir	1	5	0	Morning	202	184	No	88	70	No
				Noon	106	98	No	82	80	No
				evening	311	184	No	90	78	No
Bulaxubey	1	5	1	Morning	No	584	335	No	85	78
				Noon	No	372	95	N0	75	60
				evening	No	639	337	No	91	82

Zoobe Intersection After the Optimization					Total Traffic Volume(veh)			Peak Hour Factor (%)		
Approach	No of lanes	Lane width(m)	Median width(m)	Periods	TH	RT	LT	TH	RT	LT
Km4	2	5	1	Morning	211	No	523	95	No	83
				Noon	163	No	270	87	No	89
				evening	175	No	640	74	No	78
Banadir	2	5	0	Morning	202	184	No	88	70	No
				Noon	106	98	No	82	80	No
				evening	311	184	No	90	78	No
Bulaxubey	2	5	1	Morning	No	584	335	No	85	78
				Noon	No	372	95	N0	75	60
				evening	No	639	337	No	91	82

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REF: 1/2023

ETHICS LETTER

TO GRADUATE SCHOOL OF APPLIED SCIENCES

***REFERENCE: ILHAM YAHYA AMIR (*20225999)**

I would like to inform you that the above candidate is one of our postgraduate students in the Civil Engineering department she is taking a thesis under my supervision and the thesis entailed: **VALUATION OF TRAFFIC CONGESTION AT INTERSECTIONS IN MOGADISHU CITY A CASE STUDY OF MAKA –AL MUKARAMA ROAD**. The data used in his study was our data collected from the filed by the student.

Please do not hesitate to contact me if you have any further queries or questions.

Thank you very much indeed.

Best Regards,

Assoc. Prof. Dr. Shaban Ismael Albrka Ali

Student's Supervisor & Head of Transportation Unit
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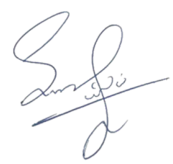

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