ABDIRAHMAN ABDIRASHID QORANE

EVALUATION OF TRAFFIC FLOW AT TWO INTERSECTIONS: A CASE STUDY OF MOGADISHU CITY, SOMALIA

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M.Sc.THESIS

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Approval

We certify that we have read the thesis submitted by **Abdirahman Abdirashid QORANE** titled "**EVALUATION OF TRAFFIC FLOW AT TWO INTERSECTIONS: A CASE STUDY OF MOGADISHU CITY, SOMALIA**" 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 as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Abdirahman Abdirashid QORANE

20/07/22

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Abdirahman Abdirashid QORANE

Abstract

EVALUATION OF TRAFFIC FLOW AT TWO INTERSECTIONS: A CASE STUDY OF MOGADISHU CITY, SOMALIA

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An intersection's traffic flow can be used as a measure of a road network's efficiency, among other things. During rush hour, any given intersection would be congested, especially in the vicinity. In the Somali capital of Mogadishu, the study examined traffic congestion at four leg intersections. It was decided to conduct the study during three different peak times (morning: 9Am -10Am; noon or mid-day: 12Am - 13Pm, afternoon: 17Pm -18Pm). The SIDRA Intersection Software was used to analyze the data by starting the currently considering evaluation by the level of service and proposing before and after optimization in accordance with the parameters, total delay, degree of saturation, queue lengths, travel speed, CO_2 emission and the level of service, respectively. The result of the currently evaluation for both intersections showed that the level of service are failed with rank F. After the optimizations for both intersections by adding additional two lines showed that there is reduction in the amount of total delays, degree of saturation, queue lengths, CO_2 emissions respectively. While the travel speed increased for both intersections after the improvement. But the level of service for both intersections still is with rank F (highly congestion) after the enhancement.

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

Congestion on the roads is the result of numerous procedures and components working together at the same time. Growth of private transportation will rise, causing more traffic jams during rush hour (Yahia 2017). Delays and narrow spacing between vehicles are commonplace in the city's public transportation system in Mogadishu, Somalia. In many cities around the world, especially in developing countries, traffic congestion is a major problem, especially due to poor road network strategies that have resulted in massive delays, increased Average Delays AVD, Fuel Consumption FUC and Operating Cost OPC. During rush hour, Malaysian drivers have reported encountering gridlock and long lines at intersections. The demand for vehicles in Malaysia has increased significantly in recent years, coinciding with the country's rapid economic improvement (J. Kasipillai and P. Chan. 2008). Intersection software SIDRA 5 "micro-analytical traffic evaluation tool that employs lane-by-lane and vehicle drive cycle models," would be employed to conduct these analyses (Irtema et al. 2015). Different approaches to signalized and un-signalized roundabout intersections are compared, as are intersection networks that include both. It was found that average delays were cut in half, and travel speeds increased when SIDRA intersection 4 was used to measure flow of traffic in Malaysia. According to the findings of the study, traffic flow at intersections and roundabouts has also significantly improved (Albrka et al. 2014).

Statement of the Problem

Increased urbanization and industrialization in Mogadishu City have resulted in traffic congestion that impedes the movement of residents and goods that must be delivered on time. Because of this, Mogadishu City's traffic congestion causes issues such as long waits for public transportation, delays to workplaces and schools, longer transient times and increased energy consumption, air and noise pollution, and delays in the delivery of goods and services.

People's health and productivity are negatively impacted by these issues, as well as the loss of business, increased fuel use has led to longer delivery times and more traffic accidents. As a result, reducing traffic congestion has become a top priority for several countries.

The Aim and Objectives of the Study

Aim of the Study

The main aim of this study is to analyze the traffic congestion in the selected Area using SIDRA intersection software and also to suggest possible solutions to minimize the negative socio-economic-environmental impact of congestion.

Specific Objectives of the Study

- ✓ To analyze the traffic volume and the vehicle type that cause high congestion during the peak hour periods on selected intersections.
- ✓ To evaluate before and after optimization by considering the queue lengths, vehicular Delay, degree of saturation, CO_2 emission, travel speed, and level of service using SIDRA intersection software on selected intersections.
- ✓ To suggest general possible solutions to minimize traffic congestion in the study area.

Scope of the Study

Four leg intersections during (morning, midday, and evening peak hours) were evaluated for their optimization performance in this study in order to identify intersection performance parameters. A variety of metrics, including queue lengths, degree of saturation, travel speeds, level of service and CO_2 emission cost, will be examined using the SIDRA software program. SIDRA is a traffic management system.

CHAPTER II

Literature review

The demand for transportation has grown due to population growth and development. Thus, traffic volume increases, Therefore, both road users and non-road users will have to pay more money. Infrastructure and traffic control are necessary to alleviate road congestion. There are numerous transportation issues in various cities around the world. The Ministry of Transportation of Somalia (2018) cites the following challenges in urban transportation: Rising transportation costs, Poor traffic flow, and an increasing rate of traffic accidents.

Definition of Traffic Congestion

When it comes to traffic, there is no one-size-fits-all definition of congestion. Unanimity is challenging as the supply of road space approaches its maximum capacity, partly because traffic congestion is a real-world occurrence and a perception created by users of the road system's capabilities. When the number of vehicles on a roadway exceeds the capacity of the traffic network, the flow of traffic is slowed down to a level that is considered unacceptable. If this happens, it can have various adverse effects on the economy and people's quality of life and productivity, the environment, and the added costs and reduced service areas for workers, suppliers, or customers (NCHRP report 463, 2011). As stated by Wallis and Lupton in 2013, there are three ways to define congestion:

Congestion, according to economists, is the result of on-road interactions between vehicles. As a result, all major roads with heavy traffic volumes are congested. Congestion is perceived by road users when speeds drop below an acceptable level. The term "congested" refers to a situation where the number of vehicles on a roadway exceeds its capacity.

Causes of Traffic Congestion

A variety of factors cause traffic congestion. According to Schrank et al.(2013), three factors contribute to congestion: A large number of people and goods are moving simultaneously, the slow increase in supply, a large number of trips are delayed due to unpredictable events. However, a wide range of traffic congestion issues is brought on by various factors, including the occurrence of accidents, vehicle breakdowns, incorrectly timed traffic signals, and even inclement weather.

Following is a list from a different study conducted by Mekonnen (2015), which summarizes the significant factors contributing to traffic congestion: Damage to a vehicle and parking on the street. Mahmud1 et al. (2012) has summarized their findings on the primary causes of traffic congestion:

Narrow Roads

Due to unauthorized possession on the road, the streets are becoming more congested and causing traffic jams. As a result, expanding the road by their right-of-way is a viable option for easing traffic congestion. Furthermore, this will save money and time because no land acquisition will be necessary.

Illegal Parking

Every day, traffic has been snarled because of illegal parking. Parking cars in the road is a major cause of traffic jams along major highways and highway segments.

An increasing population

All urban areas see population growth, bad news for traffic management, which could be a significant contributor to traffic jams.

The higher purchasing power of the public

Private transportation is becoming more popular among city residents as their purchasing power rises, but highways cannot significantly accommodate the increased traffic. Vehicle congestion has skyrocketed as a result.

Improper planning of city development

The city's long-term development plan is contained in the Development Plan. That strategy, on the other hand, is flawed. There are many instances where illegally seized roadside land goes unnoticed due to the lack of a clear development plan.

Improper lane management

Managing traffic is a complex task, and lane management is critical. Some vehicles try to pass others even when there is only one undivided road in front of them. The lack of lane dividers on city streets is primarily due to this.

Measuring Traffic Congestion

Depending on the purpose of the study, congestion can be measured in a variety of ways. Some parameters indicate the degree of traffic congestion, which can be used to calculate congestion. Measuring traffic congestion can be broken down into four broad categories, according to Aftabuzzaman (2007): basic measures, proportional measures, service level measures, and indices. Delay estimation is one of the most basic measures. Traffic delays can be measured in how long it takes to get where you're going compared to how long it would typically take to get there. According to Lomax et al. (1997), the full roadway length (weighted by volume or by the number of people) and segment delays are congestion measures. Measures of travel time or uncertainty are frequently divided into ratios and then used to calculate traffic congestion levels. It was developed by Lomax et al (1997) that several ratio measures based on travel rates were developed. Traffic congestion can also be measured using the level of service (LOS). An operational range is defined by the 1985 Highway Capacity Manual's LOS concept. All of these factors play a role in determining the LOS of different types of facilities, including vehicle density, volume-to-capacity ratio, average speed, and intersection delay. LOS classifications range from A to F, with A representing the highest level of LOS quality. As the traffic stream is virtually unaffected by other traffic, individual users are free to choose their own speeds and maneuver within the stream. Forced or breakdown flow is represented by LOS F, which indicates the most congested and congested flow. Congestion indices, which include travel rate indexes and others, are the final parameters for measuring congestion.

NCHRP report 463 (2011) stated that congestion impacts could be divided into user and non-user impacts, which we can further categorize. There are several different ways to measure the impact of traffic congestion on users, including time-related metrics, volumetric indices, delay metrics, and LOS metrics. Travel speed, duration, and rate are all examples of time-related metrics. Vehicle miles traveled/lane miles, and traffic volume is examples of volumetric measurements. Congestion indices, such as the congestion index, the road congestion index, and the excess delay metric, must be measured correctly. Congestion levels, corner LOS, and lane miles at/during LOS vehicle hours are all part of LOS measurement, encompassing other variables. LOS It's not just the time it takes to get to your destination, but also the time it takes to get there. Transportation costs, logistics and JIT processing, market size accessibility, and business commuting are all non-user impacts of congestion. LOS analysis is shown in Table 1, as well as the volume to capacity ratio.

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 low average speeds in unstable operations.	0.81-0.90
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

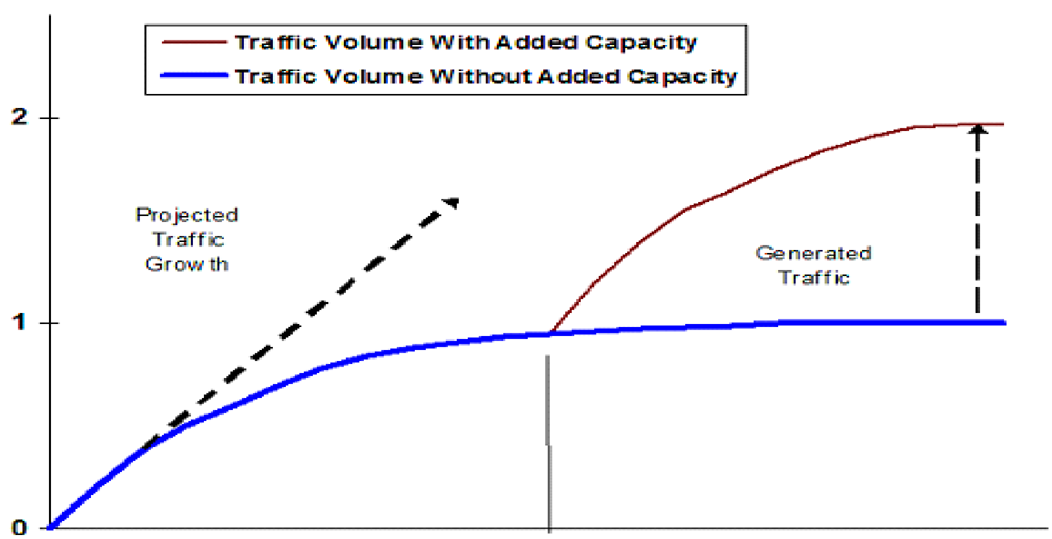
As a result of increased travel times, congestion costs the economy and has many adverse effects on urban areas and their residents. It is important to note that congestion has a wide range of indirect effects, including those on the environment, quality of life, Other road space users, like pedestrians and those who own properties near the road's edge, are also taken into account when determining design and safety. (Mahmud1 and coworkers, 2012). In terms of the economy, health, and the environment, there are three ways to look at traffic congestion. The following four ways in which society loses money due to traffic congestion have a significant economic impact (Mahmud1 et al, 2012): a reduction in person-hours, cost of additional transportation; fuel consumption is going up; operating costs of a vehicle; costs not explicitly related to the project. Congestion has a variety of social consequences. As well as its direct impact on the environment harmful effects that impact people's quality of life, stress, and security, and even non-vehicular road space users like walkers, bicyclists, and owners of property along with the road (European Conference of Ministers of Transport, 2007). As a result of increased travel times, congestion costs the economy and has many adverse effects on urban areas and their residents.

Measures to Reduce Traffic Congestion

As a result of the above reasons, traffic management strategies must be implemented to reduce traffic congestion. If implemented correctly, traffic management strategies could mitigate the aforementioned negative consequences. Managing traffic serves three distinct purposes, according to Joshua and Iyiola (2009): Increasing the carrying capacity of a vehicle, maximizing the capacity to carry people, the practice of reserving a portion of a roadway for pedestrian use in order to improve the quality of life and public safety. Increased road capacity may not alleviate traffic congestion because additional traffic is induced by adding other lanes or grade-separated intersections. When roads are not congested, traffic grows, but as congestion increases, growth slows to a halt, creating a self-limiting situation. The volume of traffic will continue to rise unless the balance of power shifts (Grant-Muller and Laird, 2007). A road's capacity is related to the amount of traffic it can handle, as shown in figure 1.

Figure 1

Traffic Volume and Roadway Capacity



Source: (Grant-Muller and Laird, 2007)

Haregewein (2007) conducted a study that summarizes the most effective ways to reduce traffic congestion as the following: Increasing the coverage of the road network, increasing the capacity of the roads, implementing a flexible work schedule, altering the beginning and ending times of the workday, ensuring effective parking management, providing ample parking spaces, introducing skilled traffic police. Modernizing and expanding the parking infrastructure.

Overview of Intersection

Intersections are areas of the road where multiple roads meet or cross over one another. Allowing motorists to alter their course is one of its primary goals. In order to keep traffic moving in the right direction and avoid collisions, numerous traffic signs, road markings and traffic lights were in use. (Wang, Wang, Song, & Raghavan, 2017). Many traffic movements occur at intersections and are influenced by signalization and visibility conditions, making intersections composite road units (Ferreira & Couto, 2013). Intersections play an essential role in city traffic. The capacity of the intersections determines the efficiency of the city's traffic system. "(Zhu et al., 2016; Gao and Wang et al., 2017). Various replication models can be used to study traffic flow at the intersection (Fan et al., 2014). A major problem for urban intersections has been oversaturation, particularly at choke points where traffic backs up, and the network becomes clogged (Sun et al., 2015). The efficiency and capability of city traffic are severely hampered when intersections fail to perform as expected. (Yao, Jia, Zhong, & Li, 2018). Control devices, such as traffic lights or stop signs, are installed at some intersections, while others don't.

Signalized intersection

Signalized intersections are intersections with traffic lights and signs that restrict the driver's freedom and reduce accidents. Non-signalized intersections, on the other hand, are very different from their signalized counterparts in this regard. Traffic flow at these intersections is mostly dictated by the drivers' associations (Yao et al., 2018).

Non-signalized intersection

Vehicles are free to ignore the posted movement instructions and proceed through non-signalized intersections without a signal device. A high number of traffic collisions and car accidents could result if these practices continue. (Fan et al., 2014).

Level of Service (LOS)

There are number of vehicles or road users that a specific facility or road system can accommodate in a given period under particular conditions at a specific level of service (facility capacity). As a synonym for capacity, "ability" is frequently used to describe a person's ability level. This is a measure of the quality of service (LOS) rather than the quantity of service (capacity). There may be a steady flow of traffic at a particular location. However, the actual traffic volume on any given day may vary depending on the time of day. Traffic flow rate is a key factor in determining a roadway's quality of service (LOS). Essentially, it's a phenomenon that selects a set of operating conditions for a specific facility form. In some cases, it could be used to refer to a particular type of service. Highway Capacity Manual provides some tools for determining the level of service that is available. From A to F, traffic flow quality can be rated, with A being the most accessible and comfortable for drivers to drive at or above the posted speed. At the same time, F is a poor quality of traffic flow that restricts the driver's freedom and comfort. Based on the MOE, the level of service is defined (a measure of effectiveness). In most cases, the MOE comprises three components: travel time, traffic density, and delay time. One of the essential quality indicators is the amount of time spent travelling. As a result, travel time and speed characterize a facility's level of service (LOS). Density refers to the number of cars sharing the road at any time. Consequently, drivers' ability to maneuver in the traffic stream is affected. Numerous delay measures clearly defined and used as MOEs are included in the HCM (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, occasionally wait 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 volume 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, costs of operation. (Marfani et al., 2018).

Overview of the SIDRA Software

Many traffic modelling tools and software's are currently available. Only one software collection focuses solely on traffic flow operations is the most popular Applications for traffic procedure software tools are numerous and varied. Highway capacity analysis methods are commonly used, but some the software provides an alternative. However, other sections use simulations to analyze the impact of controlling techniques for regulating the flow of traffic, as well as geometric patterns. Other apparatuses have built-in optimization features that allow for the development of better control devices. SIDRA, TRANSYT-7F, PASSER IV, HCS2000, and PASSER IV are just a few examples of the wide range of software available. SIDRA software is used to create intersections and networks of intersections, as well as to assess system capacity, timing, LOS, and execution. For intersections under signal control, including two-way stops, all-way stops, and roundabouts with up to eight legs, SIDRA is an essential analytical package. For example, SIDRA shows the sum of the lanes and the lanes for turning and networking, all while enhancing the phase separations and cycle lengths. All phases of a road intersection can be analyzed using SIDRA, the primary program for determining capacity-based MOEs. Based on the intersection database, SIDRA may be the best MOE available.

CHAPTER III

Study Area and Methodology

For the study, two major intersections in Mogadishu city were selected: Tarbuun (Figure 2) and Afarta Jardin (Figure 3) intersections. In Mogadishu city, these two intersections are among the most congested. The intersection was chosen based on a combination of aerial, geometric, and traffic information. Detailed procedures for selecting, collecting, and analyzing data were outlined in detail in this chapter.

Area of the Study

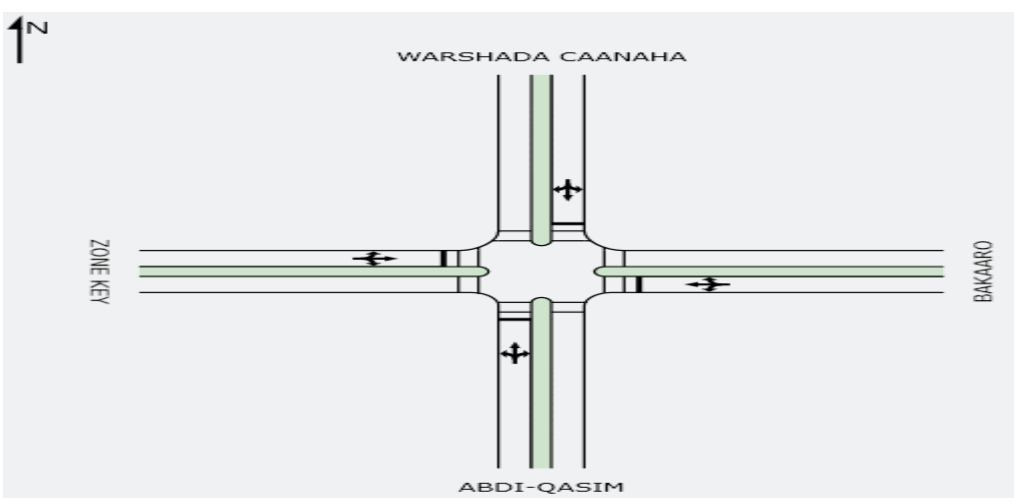
Somalia's capital city, Mogadishu, is located in the Horn of Africa and is just a few miles from the Red Sea. Islamic Sunni Muslimism is the dominant faith, and Somali is the official language. In 2022, Mogadishu's metro area population is 2,497,000, an increase of 4.56 percent from the year before. (Mogadishu Administration Integrated Land Information 2022). There are numerous intersections in the study area, but two of them are deteriorating rapidly due to traffic congestion.

Description of Tarbun Intersection

The first crowded region in the area is this intersection. It has four legs: The BAKAARO approach. The ZONE KEY approach, the ABDI-QASIM approach, the WARSHADA CAANAHA approach.

Figure 2

Direction Vehicle Flow in Tarbuun

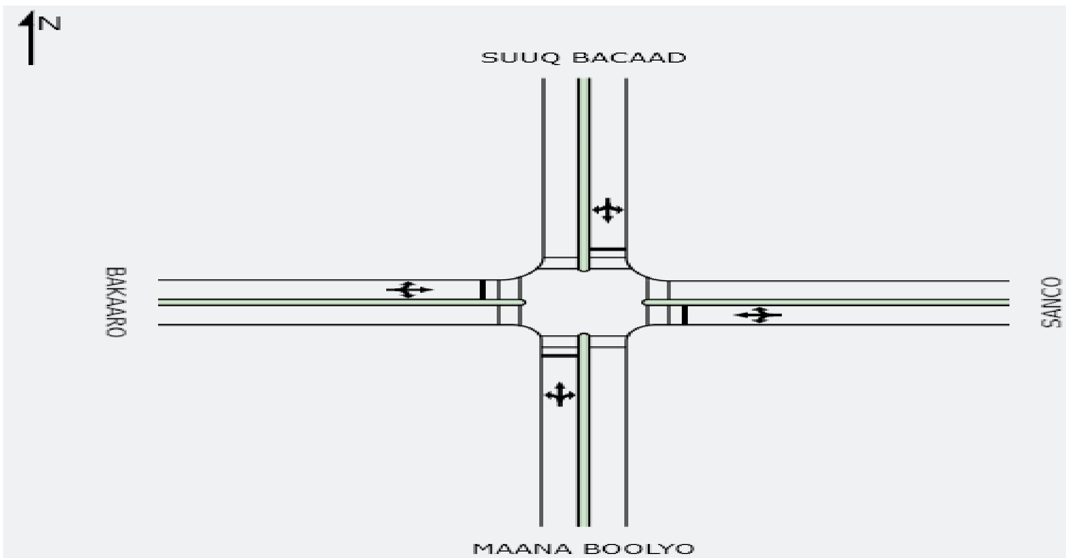


Description of Afarta Jardin Intersection

The second crowded region in the area is this intersection. It has four legs: SUUQ BACAAD approach, the MAANABOLYO approach, the BAKAARO approach, the SANCO approach.

Figure 3

Direction Vehicle Flow in Afarta Jardin

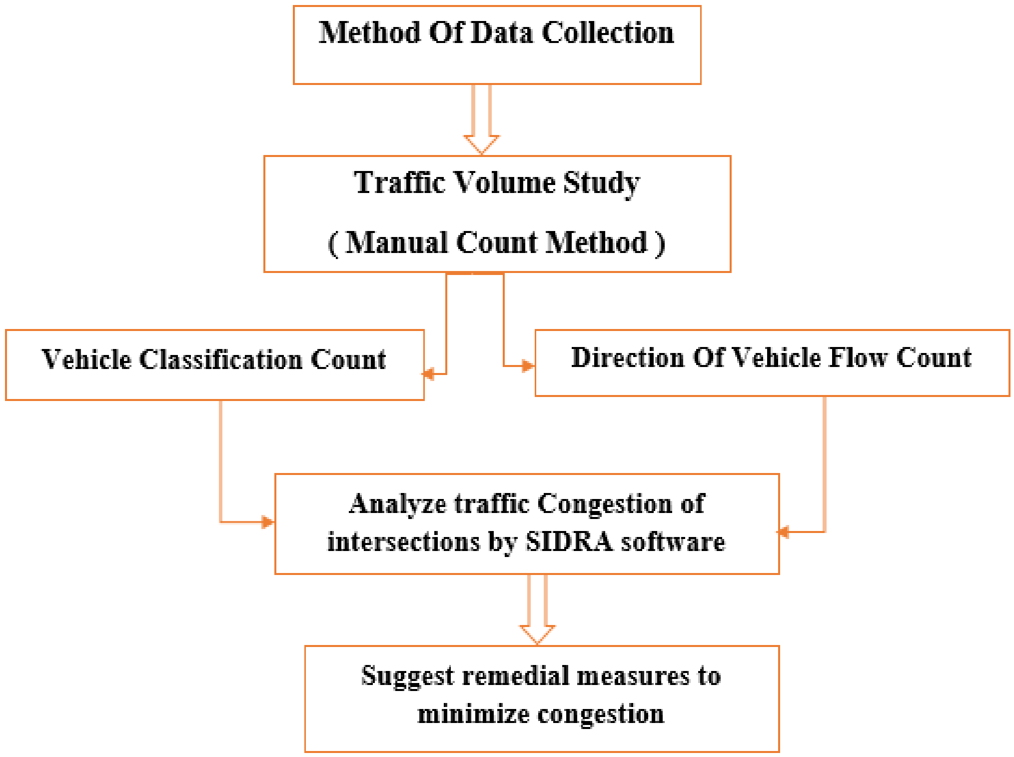


Data Collection Methodology

The data was gathered during the busiest times of the day: beginnings, noon, and late evening. As a result of the wide variety of recorded unit sizes, this is thought to be an appropriate choice. Information was not gathered in the midst of inclement weather or unusual movement patterns, such as those associated with a car accident. The selected methodology for evaluating traffic congestion is depicted in figure 4 below in order to meet the above-mentioned goals.

Figure 4

Outline of the Study



Traffic Volume Studies

It is necessary to undertake traffic volume studies to understand vehicles' types, quantities, and movements on the road in a specific area. Oversized vehicles and pedestrians can significantly impact vehicular traffic flow, and these data can be used to identify peak hours of high traffic volume. The sampling period's length is determined by the type of count and the planned use of the recorded information. During peak flow, for example, an intersection count may be undertaken. A manual count of traffic volume at 10-minute intervals could be employed if this is the case.

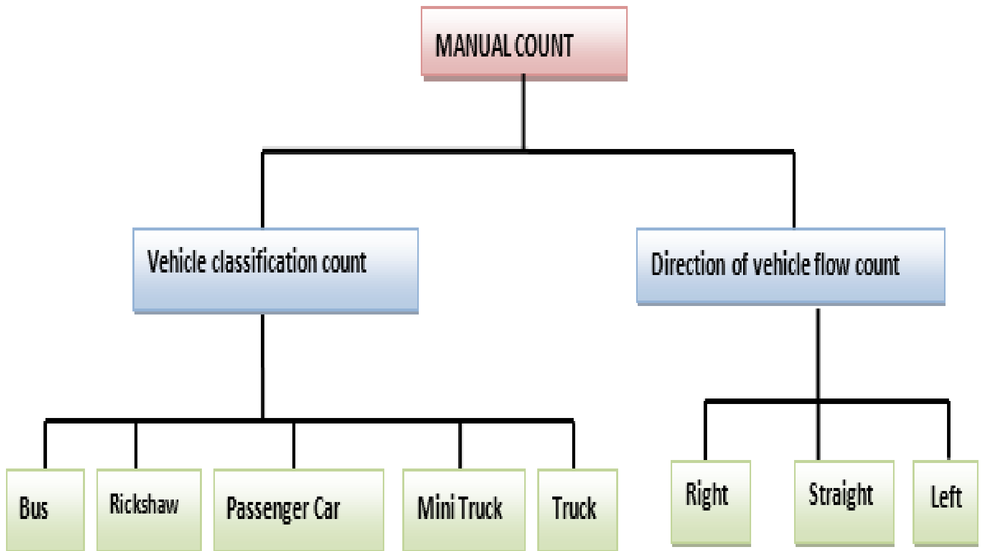
Manual Count Method

Data collection in the form of manually assigning a person to record traffic is the most typical way. In terms of labor, this type of data collection can be too expensive. Counting vehicles by hand necessitates the use of a counter by one or more people.

Vehicle kinds and turning movements at intersections can both be tracked with this counter.

Figure 5

Manual Count Method



For less than a day intervals, manual counting is the most common method. For a manual count, the typical time intervals are 5, 10, or 15. Tally sheets, mechanical counting boards, and electronic counting boards are all options for recording manual counts. Without a mechanical or electronic counting board, the city chose to undertake a manual traffic census using the tally sheet method.

Vehicle Classification Counts

Traffic counting relies heavily on vehicle categorization counts. To better understand how vehicles travel, how they impact traffic, and what design standards should be used, it helps to know the number of vehicles and the type of vehicles present on a given roadway, however; there are other methods for gathering vehicle data, each with varying degrees of precision based on the situation. Structure and geometry can be established using vehicle classification counts and predicted highway user income and computing capability. If a high percentage of heavy trucks are present or if the vehicle mix at the incident site is suspected of leading to the accident problem, then classification counts must be undertaken.

Figure 6

Vehicle Classification

CLASSIFICATION NAME	CLASSIFICATION TYPE
PASSENGER CARS	 
RICKSHAW	 
MINI TRUCK	 
BUS	 
TRUCKS	 

The Direction of Vehicle Flow Count

Turning Movement Count, also known as Intersection count, counts people, bikes, and vehicles moving toward an intersection. The primary goal is to collect vehicle data to determine the traffic flow in the area. The left turn, tight turn, and straight turn of moving vehicles are all determined using the Turning Movement Count. The estimation of error Because of variations in roadway geometry, traffic flow, signal timing, and vehicle classification, the number of turning movements changes. Traffic congestion at intersections and road junctions can be easily managed with the help of Turning Movement Count Services. Turn count data is essential for transportation planning based on footage analytics and traffic data count services that are ready to interpret. Data on traffic volume and composition was the primary goal of the Manual Traffic Counts.

Time Period for Data Recording

The following are the three primary categories of time that can be classified as peak periods and volumes were counted up in 10-minute intervals: The 8:00-09:00 A.M. morning peak period is included, 12:00 a.m. to 13:00 p.m. is the noon peak period, Evening Peak Period: includes from 17:00 PM-18:00 PM.

Field Measurement

The selected intersections' geometric features were measured in the field. Legs, crosswalks, sidewalks, and the number of lanes are the primary components of intersection layout. Turning movements are channeled and treated differently depending on the layout. People, vehicles, freight, and public transportation must be considered when designing an intersection. Along with intersection layout, the practitioner must collaborate with a multidisciplinary team to address issues such as accessibility, traffic control, and equipment placement, traffic operations, lighting (both pedestrian- and safety-scaled), and urban design. On each approach to the selected intersection, measurements were taken of leg alignment, lane width, crosswalks, the number of lanes, the median, and the treatment and channelization method for turning movements.

Table 4

Field data for intersections

Tarbuun Intersection				
Approach	No of lane	Lane width(m)	Median width(m)	Lane Type
Sanco	1	3.5	1	Normal
Bakaaro	1	3.5	1	Normal
Maana Bolyo	1	3.5	1	Normal
Suuq Bacaad	1	3.5	1	Normal

Afarta Jardiin Intersection

Afarta Jardiin Intersection				
Approach	No of lane	Lane width(m)	Median width(m)	Lane Type
Sanco	1	3.5	1	Normal
Bakaaro	1	3.5	1	Normal
Maana Bolyo	1	3.5	1	Normal
Suuq Bacaad	1	3.5	1	Normal

Vehicle Classification Count at Two Intersections

Table 5

Vehicle Classification in Tarbuun Intersection

Interval Volume	Bus	Rickshaw	Passenger	Mini truck	Truck
8:00-8:10	75	335	48	11	2
8:00-8:20	78	441	80	9	4
8:00-8:30	63	456	60	14	4
8:00-8:40	87	518	110	25	2
8:00-8:50	106	475	96	32	2
8:00-9:00	80	366	80	13	1
TOTAL	489	2591	474	104	15
12:00-12:10	70	377	31	17	2
12:00-12:20	50	328	27	10	2
12:00-12:30	70	325	25	10	2
12:00-12:40	101	421	46	33	1
12:00-12:50	90	353	40	19	1
12:00-13:00	88	272	30	13	0
TOTAL	469	2076	199	102	8
17:00-17:10	64	302	56	23	4

Table 5 (Continued)

17:00-17:20	93	367	84	15	2
17:00-17:30	59	431	58	19	3
17:00-17:40	95	481	97	25	3
17:00-17:50	81	478	94	31	4
17:00-18:00	82	436	88	25	5
TOTAL	474	2495	477	138	21

Table 6

Vehicle classification in Afarta Jardiin intersection

Interval Volume	Bus	Rickshaw	Passenger	Mini truck	Truck
8:00-8:10	59	238	13	13	2
8:00-8:20	71	239	20	9	4
8:00-8:30	65	299	25	6	2
8:00-8:40	71	269	22	8	3
8:00-8:50	54	197	22	6	4
8:00-9:00	44	161	13	1	2
TOTAL	364	1403	115	43	17
12:00-12:10	59	238	8	9	4
12:00-12:20	65	253	15	12	2
12:00-12:30	82	256	24	14	3
12:00-12:40	84	230	25	8	4
12:00-12:50	87	196	15	5	3
12:00-13:00	68	170	10	4	2
TOTAL	445	1343	97	52	18

Table 6 (Continued)

17:00 17:10	70	195	14	1	3
17:00- 17:20	88	213	15	3	4
17:00- 17:30	78	239	27	1	1
17:00- 17:40	88	264	24	3	5
17:00- 17:50	110	291	21	5	4
17:00- 18:00	*99*	*312*	*22*	*8*	*6*
TOTAL	533	1514	123	21	23

Peak Hour Factor and Design Hourly Volume

It is commonly known in your area that the heaviest traffic flow rates occur (7:30 A.M to 8:30 A.M), (11:00 AM to 1:00 PM) and (5:00 P.M to 6:00 P.M). An assignment for the day is to find the peak hour volume, peak hour factor (PHF), and the actual or design flow rate. To do this, you obtain a click-counter and position yourself at the intersection. For each 5, 10, 15 minute interval, you record the numbers of right-turns, left-turns and straight.

Table 7

Sample of Calculation Peak Hour Factor and *Design Hourly Volume*

TIME	Volume (PCU)
8:00 - 8:10 AM	471
8:10 - 8:20 AM	612
8:20 – 8: 30 AM	597
8:30 - 8:40 AM	742
8:40 - 8:50 AM	711
8:50 – 9:00 AM	540

Total volume during peak hours = (471+612+597+742+711+540) = 3673

Volume during peak 10 min = 742

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

$$\text{PHF} = \frac{3673}{6*742} = 0.825$$

Obtaining design hourly volume

$$\text{DHV} = \frac{Peak\ hour\ volume}{PHF}$$

$$\text{DHV} = \frac{3673}{0.825} = 1648$$

Optimum Cycle Time

Over the past few decades, researchers have asked many questions about how long a traffic signal cycle should be. You can find the answer by entering the values into the equation. The cycle length represents the duration between successive instances of a given movement being given priority. The TRRL model has been widely utilized. Assuming that the effective green times of the phases were within the range of their respective flow ratio values, the TRRL formula for the optimal minimum delay cycle length was developed. (Webster and colleagues, 1966).

$$C_0 = \frac{1.5L + 5}{1 - Y}$$

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

Table 8

Sample of Calculation Phasing and *Timing*

Phasing Time Sec	**Directions**	**Saturated flow**	**Actual flow**	**Y=a/v**
		pcu/h	Am	
Phase A	L	1200	218/0.95= 229.5	0.191
	TH	1200	214/0.95= 225.3	0.178
	R	1200	196/0.95=206.3	0.163

In table 9, bellow presents the phasing and timing for all phases by following the equation 1 above

Table 9

Phasing and *Timing Data at Tarbuun Intersection*

Phase Number	Route	PCU Volume	Phase Green Time
Φ1	Left	646	40
	Through	476	
	Right	951	
Φ2	Left	344	35
	Through	600	
	Right	143	
Φ3	Left	250	50
	Through	2444	
	Right	1405	
Φ4	Left	864	42
	Through	1596	
	Right	413	

Table 9 (Continued)

Afarta Jardiin Intersection

Phase Number	Route	PCU Volume	Phase Green Time
Φ1	Left	198	30
	Through	291	
	Right	169	
Φ2	Left	332	30
	Through	475	
	Right	428	
Φ3	Left	893	40
	Through	944	
	Right	512	
Φ4	Left	390	35
	Through	888	
	Right	602	

SIDRA Intersection Input Data

It is possible to model traffic intersections with light, medium and heavy vehicles, as well as pedestrian traffic in the SIDRA Intersection technical software. The software's primary function is to simulate various scenarios for current and future intersections in order to regulate their performance in a wide range of situations.. There are a number of variables that need to be entered into the software for each intersection because of changing weather and traffic conditions.

In order to make a more accurate prediction and analysis, the following input data were assumed: Only standard movement classes were assumed in the SIDRA intersection movement class entry, SIDRA Standard capacity model was chosen for Intersection analysis as the Intersection capacity model, this method was chosen for intersection level of service analysis based on SIDRA Intersection LOS, environmental Factor - 1.0 was chosen as the environmental factor, size Factors: All movement classes were evaluated using a peak flow factor of different percent. All movement classes were set to grow at a 2% annual growth rate, data on gap acceptance – A minimum gap acceptance rate of 2.6 vehicles per minute was used, for all movement classes, the cruise speed was set at 40 kilometers per hour for the approach and exit phases, using the target level of service for the worst lane over a 10-year design life, an analysis was carried out, LOS D was chosen as the target level of service for the peak hour demand at the site, pump fuel price = 29Sh/L, Fuel Resource cost factor = 0.5, and the ratio of running cost to fuel price is 0.30, vehicle operating cost, time Value Factor 0.6, average income of 17 Sh per hour for vehicle time.

CHAPTER IV

Results and Discussion

In Mogadishu City large metropolitan areas, urban traffic congestion has become a serious problem, affecting the economy, travel habits, and land use, as well as causing significant discomfort for hundreds of drivers. The traditional approach of widening roads to increase vehicle capacity is often seen as impossibility and an undesirable solution in and of itself. There was a decrease in total delays, degree of saturation, queue lengths, and CO_2 emission, while an increase in travel speed after the application of SIDRA 5.0 was found to have reduced the percentage (percent) of results before and after enhancement. First we will start by presenting the currently evaluation for both intersections.

Traffic Volume Analysis

It is only during the busiest times of the day that traffic volume data is collected for directional analysis. To better understand traffic flow in both directions, the following two intersections were looked at: Tarbuun Intersection and Afarta Jardin Intersection.

Volume of Traffic Analysis for Tarbuun Intersection

This intersection is located near the largest hospital in the city known as Digfeer it has four entry legs on both approaches and It has high traffic volume towards the morning peak period, noon and afternoon peak periods. In the following graphic, Figure 7, we can see the traffic volume at the BAKAARO approach has the highest traffic volume of all approaches inTarbuun Intersection.

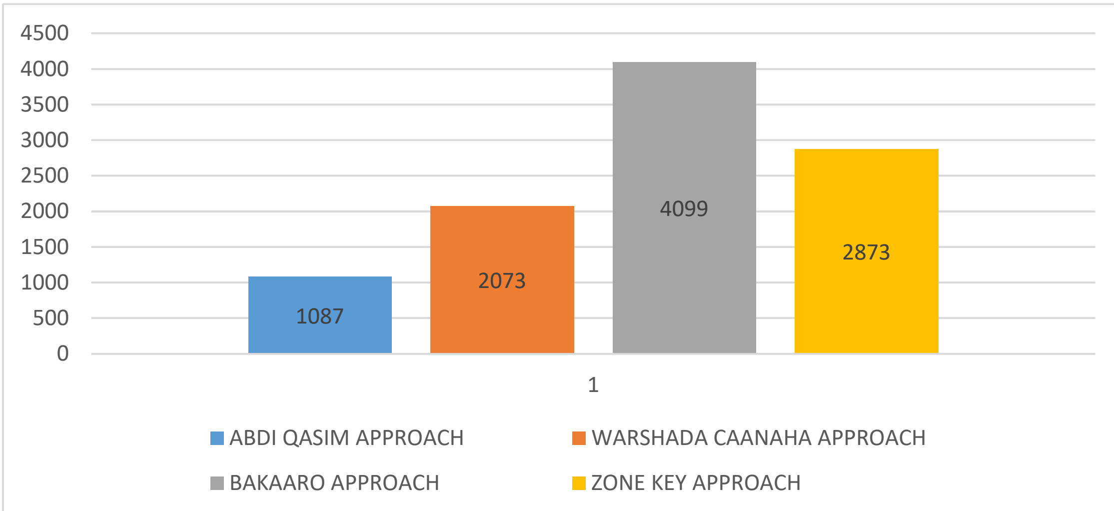
Table 10

Different Approaches of Traffic Volume at Tarbuun Intersection

Vehicles Approaches at Tarbuun Intersection	Number of Vehicles
Abdi Qasim Approach	1087
Warshada Caanaha Approach	2073
Bakaaro Approach	4099
Zone Key Approach	2873

Figure 7

Tarbuun intersection Traffic Volume



Analysis of Congestion with in Peak Hour Periods

Figure 8, 9 and 10 shows different types of congestions during the peak hour periods and also the type of the vehicle that causes the highest traffic congestion at the different peak hours.

Figure 8

Morning shift in Tarbuun intersection

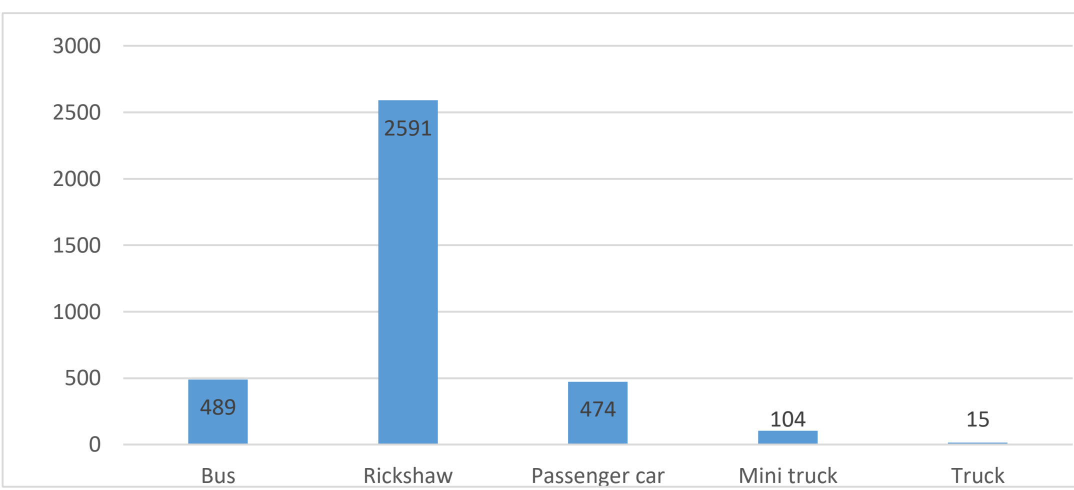


Figure 9

Mid-day (Noon) shift in Tarbuun intersection

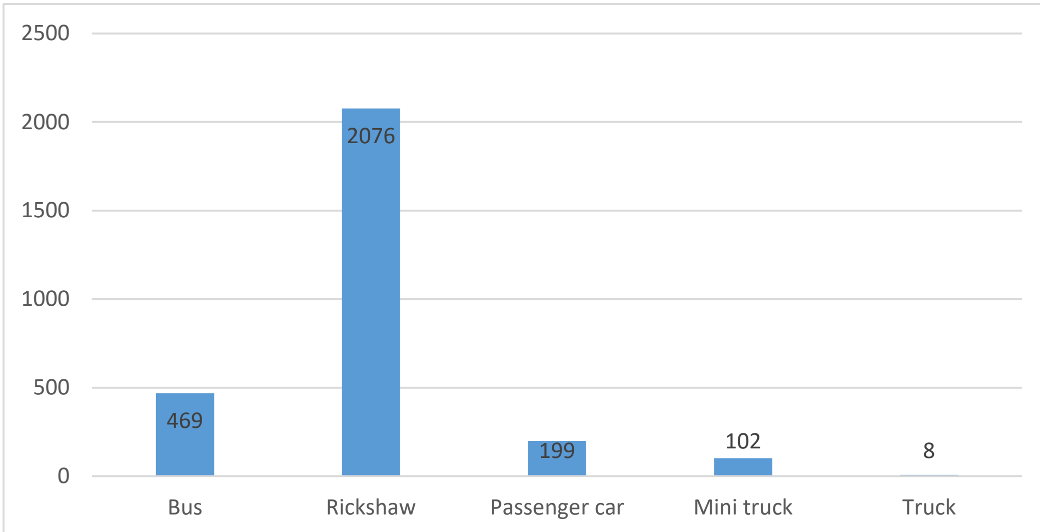
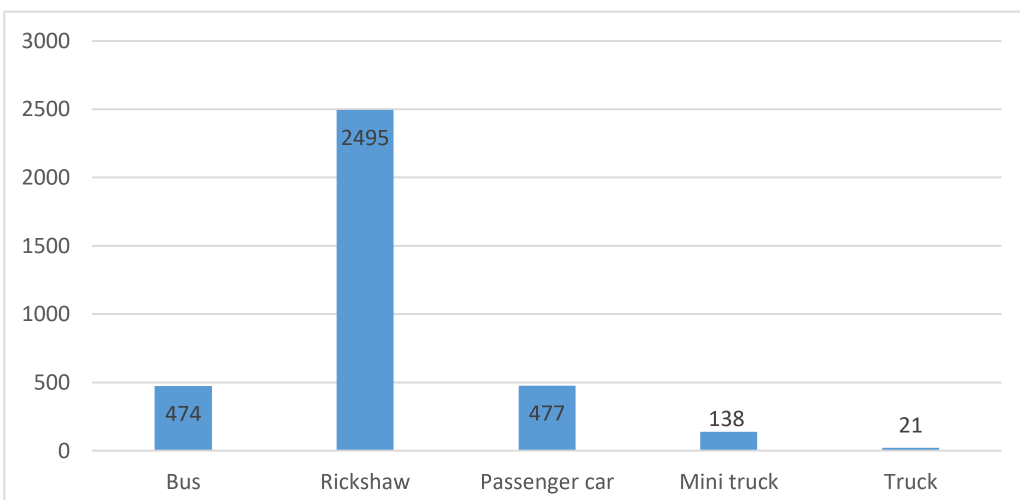


Figure 10

Tarbuun Intersection in the Afternoon Shift



Traffic Volume Analysis for Afarta Jardiin Intersection

This intersection also has four entry legs on both approaches and It has high traffic volume towards the morning peak period, noon and afternoon peak periods.

Figure 11 below shows that the traffic volume at the SANCO approach has the highest traffic volume of all approaches inTarbuun Intersection.

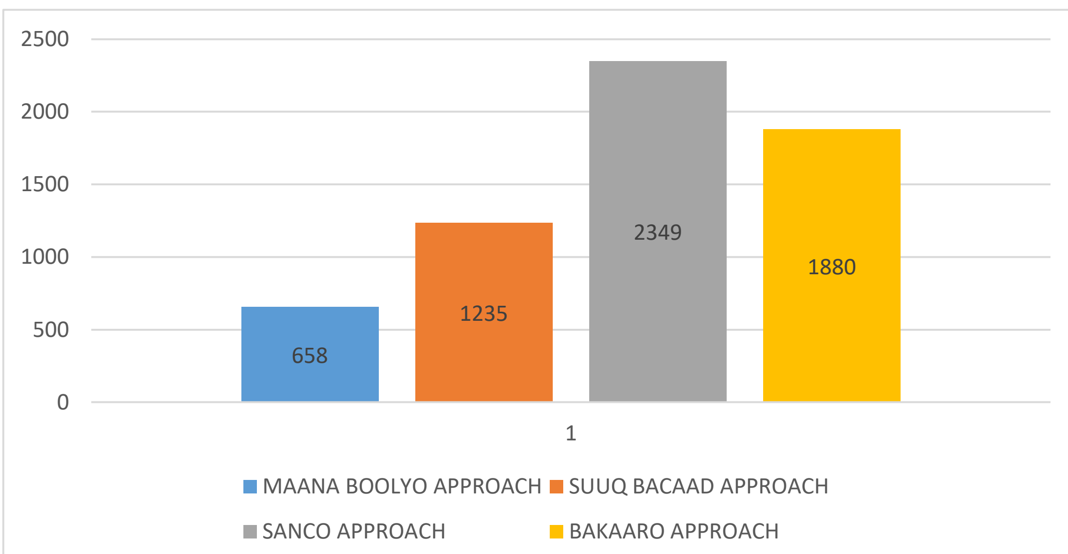
Table 11

Different Approaches of Traffic Volume at Afarta Jardiin Intersection

Vehicles Approaches at Tarbuun Intersection	Number of Vehicles
MAANA BOOLYO APPROACH	658
SUUQ BACAAD APPROACH	1235
SANCO APPROACH	2349
BAKAARO APPROACH	1880

Figure 11

Afarta Jardiin intersection Traffic Volume



Analysis of Congestion with in Peak Hour Periods

Figure 12, 13 and 14 shows different types of congestions during the peak hour periods and also the type of the vehicle that causes the highest traffic congestion at the different peak hours.

Figure 12

Morning shift in Afarta Jardiin Intersection

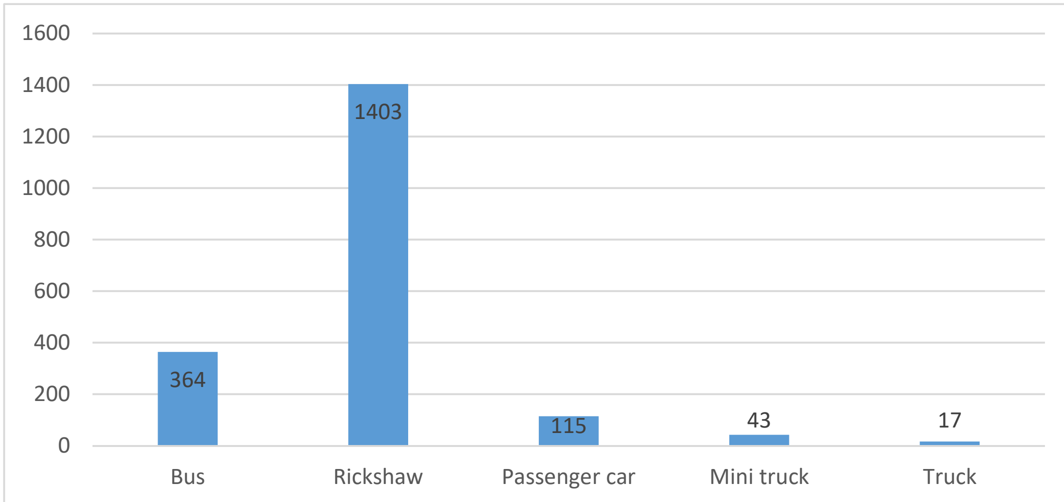


Figure 13

Mid-day (Noon) shift at Afarta Jardiin Intersection

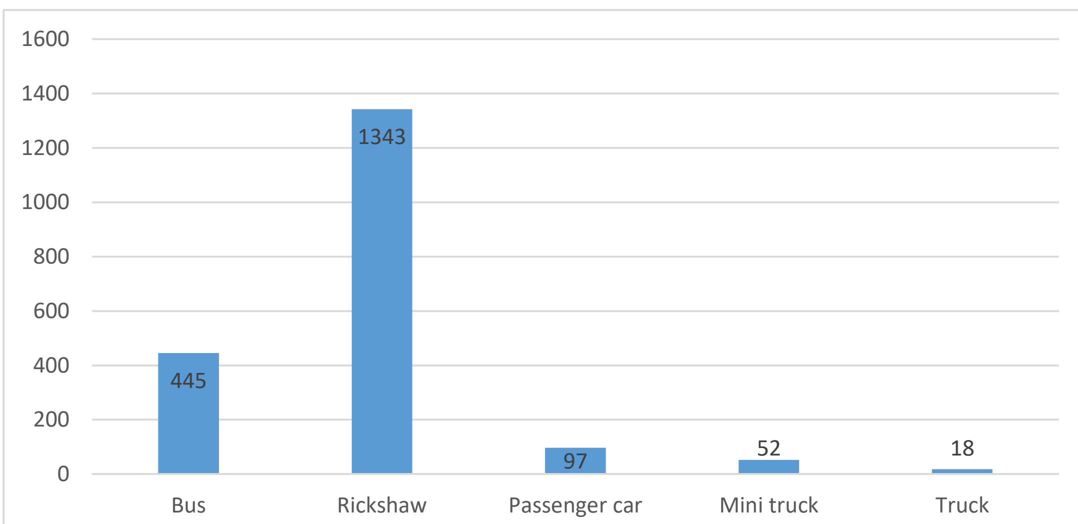
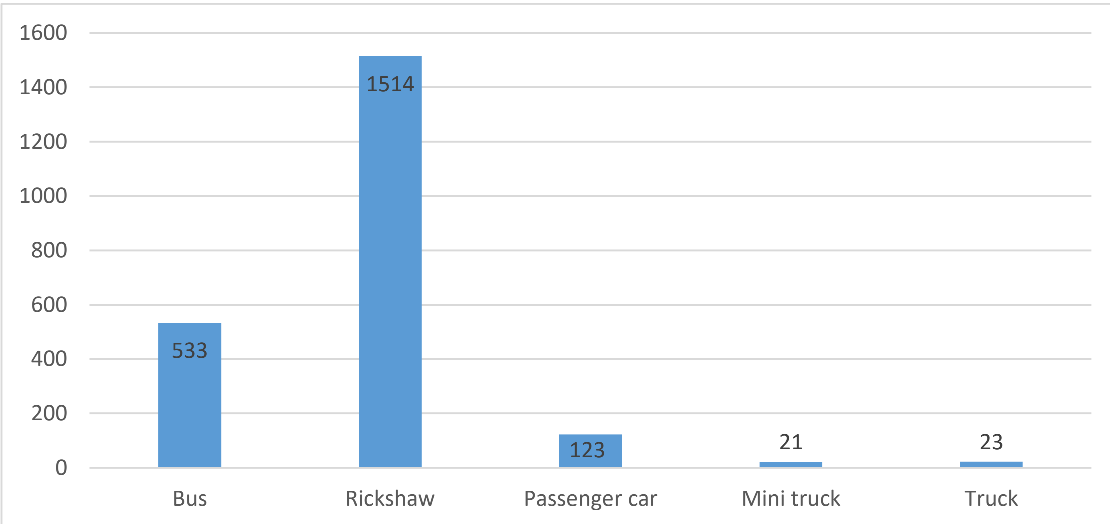


Figure 14

Afternoon shift in Afarta Jardiin 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: Pedestrian density, roadway geometry, and traffic volume. Since ideal road and traffic conditions do not exist, the basic saturated flow has been reduced from 1900 tcu/hour to 1200 tcu/hour.

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. Data from SIDRA software is presented in Table 12 below.

Table 12

Input Data to SIDRA Software for Both Intersections

Tarbuun Intersection					Total Traffic Volume(veh)			Peak Hour Factor (%)		
Approach	No of lanes	Lane width(m)	Median width(m)	Lane Type	TH	RT	LT	TH	RT	LT
Bakaaro	1	3.5	1	Normal	2444	1405	250	100	100	84
Zone Key	1	3.5	1	Normal	1596	413	864	100	89	97.4
Abdi Qasim	1	3.5	1	Normal	600	143	344	95	75	88
Warshada Caanaha	1	3.5	1	Normal	476	951	646	92	98.7	95.4

Afarta Jardiin Intersection					Total Traffic Volume(veh)			Peak Hour Factor (%)		
Approach	No of lanes	Lane width(m)	Median width(m)	Lane Type	TH	RT	LT	TH	RT	LT
Maana Boolyo	1	3.5	1	Normal	291	169	198	87.4	72.6	75
Suuq Bacaad	1	3.5	1	Normal	475	428	332	92.3	90.8	73.7
Bakaaro	1	3.5	1	Normal	888	602	390	98	94.4	90
Sanco	1	3.5	1	Normal	944	512	893	99.3	93.7	98.5

Table 13

Output of SIDRA Software Analysis for Both Intersections

Intersection	Approach legs	Delay(sec)			LOS		
		LT	TH	RT	LT	TH	RT
Tarbuun	ABDI QASIM Approach	2263.1	2254.8	2263.0	F	F	F
	BAKAARO Approach	1090.4	1082.0	1090.2	F	F	F
	ZONE KEY Approach	4537.3	4529.0	4537.1	F	F	F
Afarta Jardiin	MAANA BOOLYO Approach	1036.0	1027.8	1036.2	F	F	F
	SANCO Approach	2543.1	2534.9	2543.3	F	F	F
	SUUQ BACAAD Approach	2721.8	2713.6	2722.0	F	F	F
	BAKAARO Approach	3054.0	3045.9	3054.2	F	F	F

Note: LT stands for left turn, TH for through, and RT for right turn, respectively.

Suggestions for Optimization

Congestion and roadblocks at intersections can be avoided by prioritizing intersection widening and capacity-building projects that focus on the intersections. These intersections, in fact, have plans in place to improve the quality of service. New movement of phases may be added to the intersection proposals. As a result of the increased volume of traffic, additional lanes were added to the road and a special left-turning lane was added. In this study we are adding additional two lines for both intersections to evaluate before and after optimization.

Tarbuun Intersection Before* and *After the Optimization

In figures 15, 16, 17, 18, 19 presents before and after optimization of the following parameters: total delay, degree of saturation, queue lengths, travel speed and CO_2 emission respectively, and It's clear that more amount of reduction are found after optimization, While the travel speed increased after the enhancement.

Figure 15

Total Delay In Seconds Before and After The Optimization Tarbuun Intersection

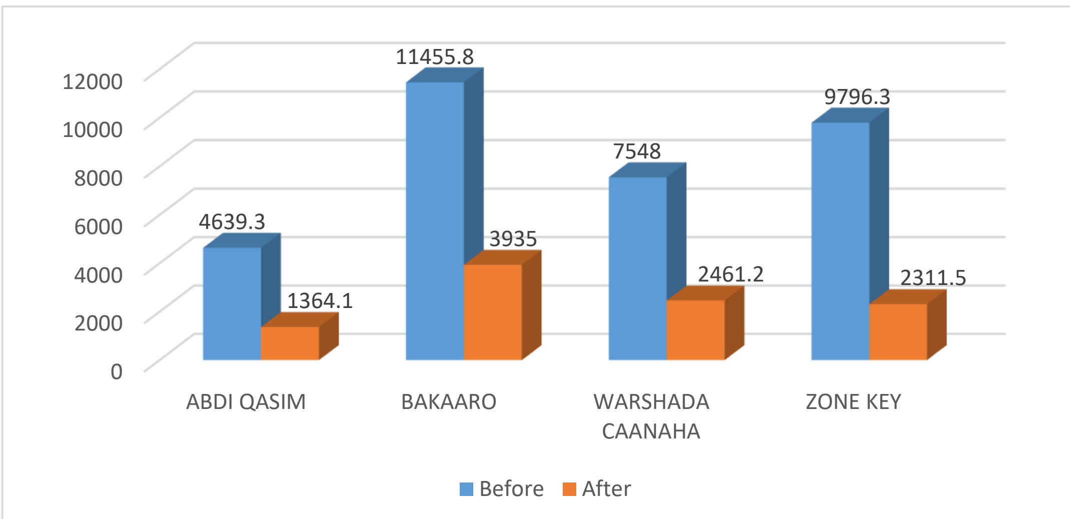


Figure 16

Degree of Saturation Before and After the Optimization at Tarbuun Intersection

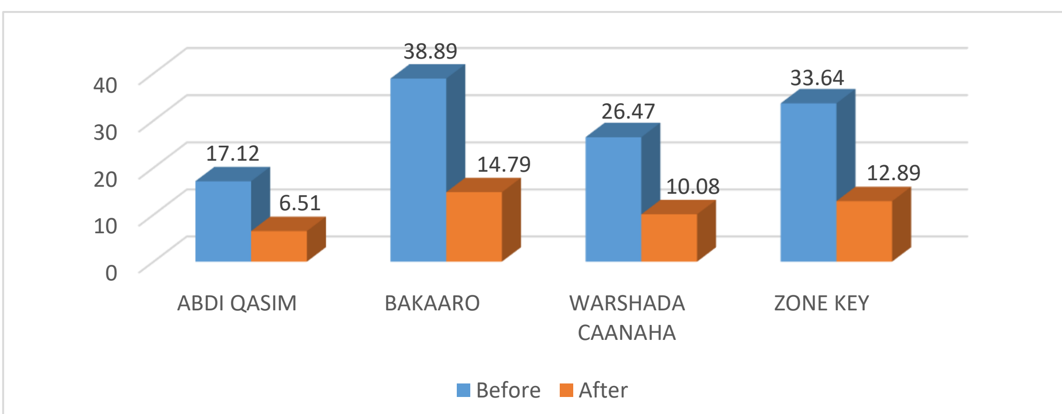


Figure 17

Queue Lengths Before and After the Optimization at Tarbuun Intersection

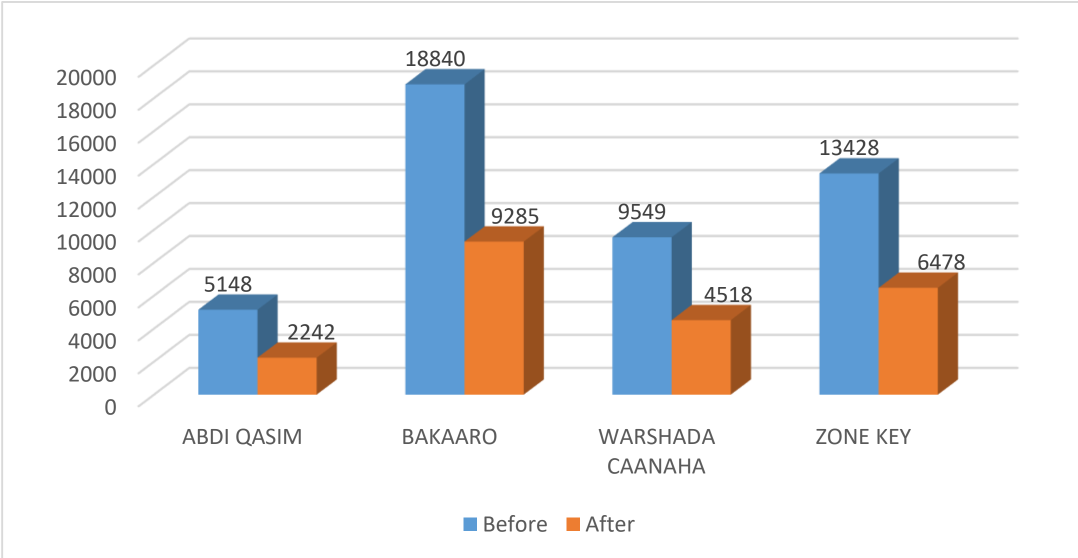


Figure 18

Travel Speed Before and After the Optimization at Tarbuun Intersection

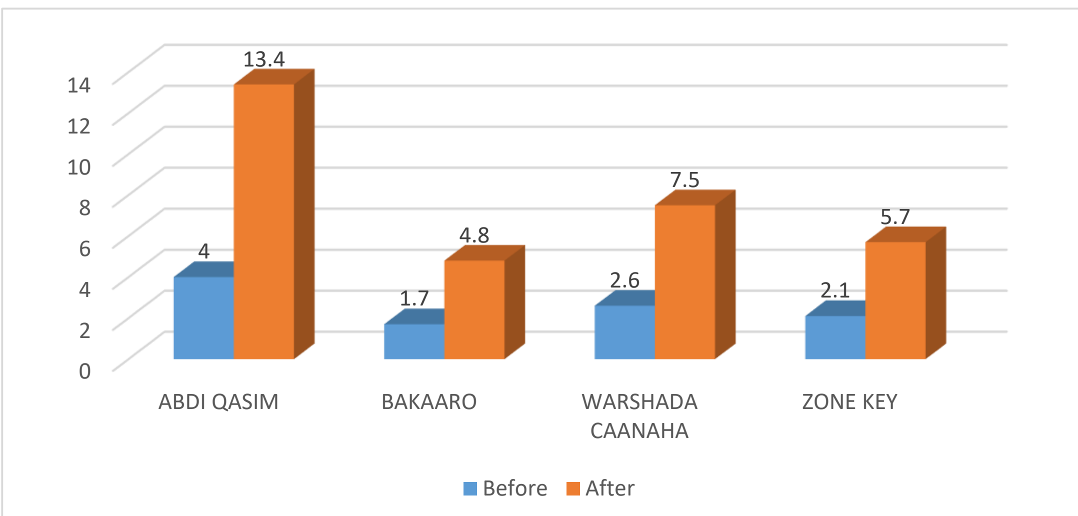


Figure 19

CO_2 Emission Before and After the Optimization at Tarbuun Intersection

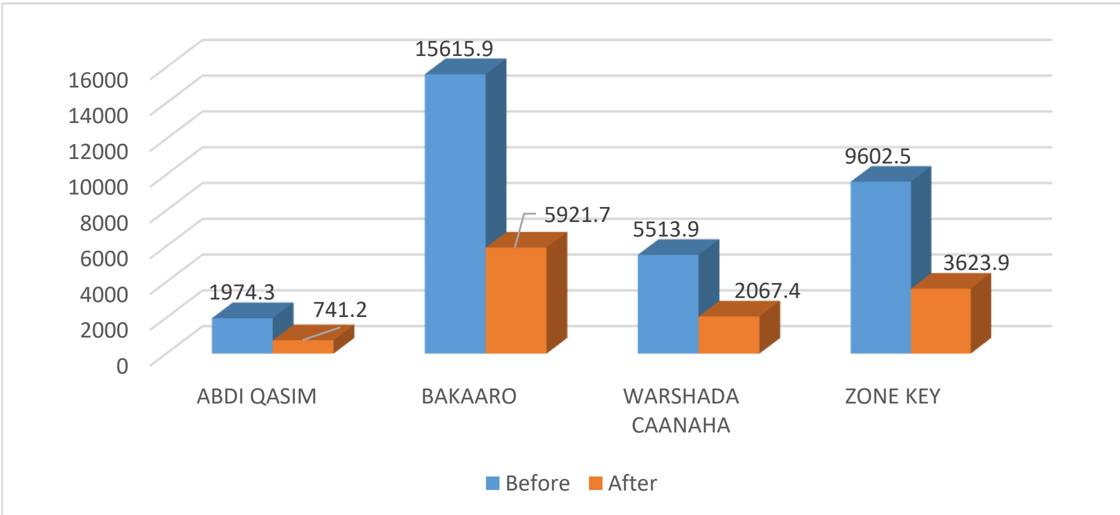


Table 14

LOS Before and *After the Optimization at Tarbuun Intersection*

Delay In Seconds				
Approaches	Before	After	LOS Before	Los After
Abdi Qasim	4639.3	1364.1	F	F
Bakaaro	11455.8	3935	F	F
Warshada Caanaha	7548	2461.2	F	F
Zone Key	9796.3	2311.5	F	F

This table showed that the result LOS before and after the optimization with rank F for all approaches, so this intersection must do more improvement by converting a roundabout or by adding additional lines (slip) Rail Transient.

Afarta Jardiin Intersection Before* and *After the Optimization

In figures 20, 21, 22, 23, 24 presents before and after optimization of the following parameters: total delay, degree of saturation, queue lengths, travel speed and CO_2 emission respectively, and It's clear that more amount of reduction are found after the optimization, While the travel speed increased after the enhancement.

Figure 20

Total Delay Before and After the Optimization at Afarta Jardiin Intersection

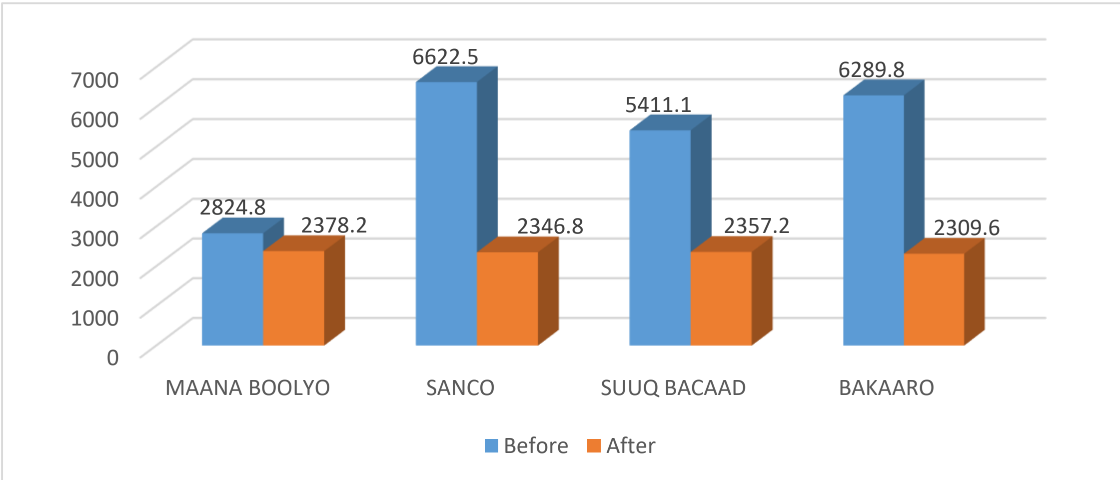


Figure 21

Degree of saturation before and after the optimization at afarta jardiin intersection

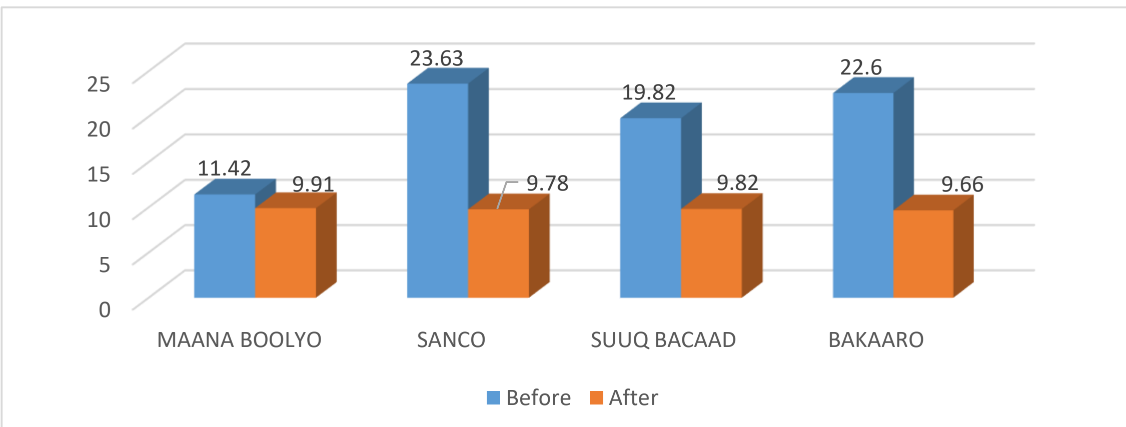


Figure 22

Queue Distance Before and After the Optimization at Afarta Jardiin Intersection

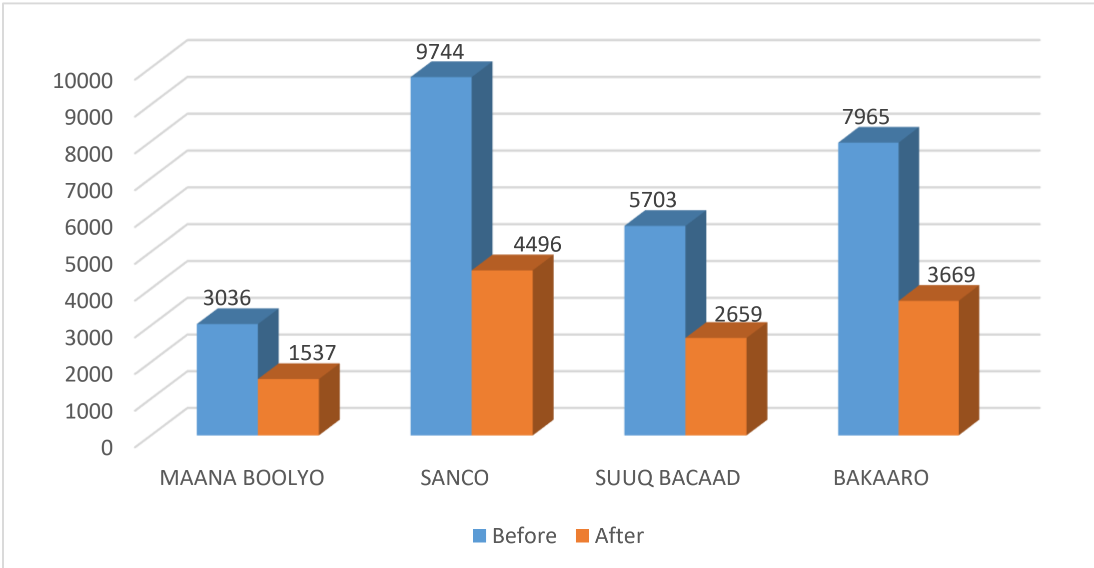


Figure 22

Travel Speed Before and After the Optimization at Afarta Jardiin Intersection

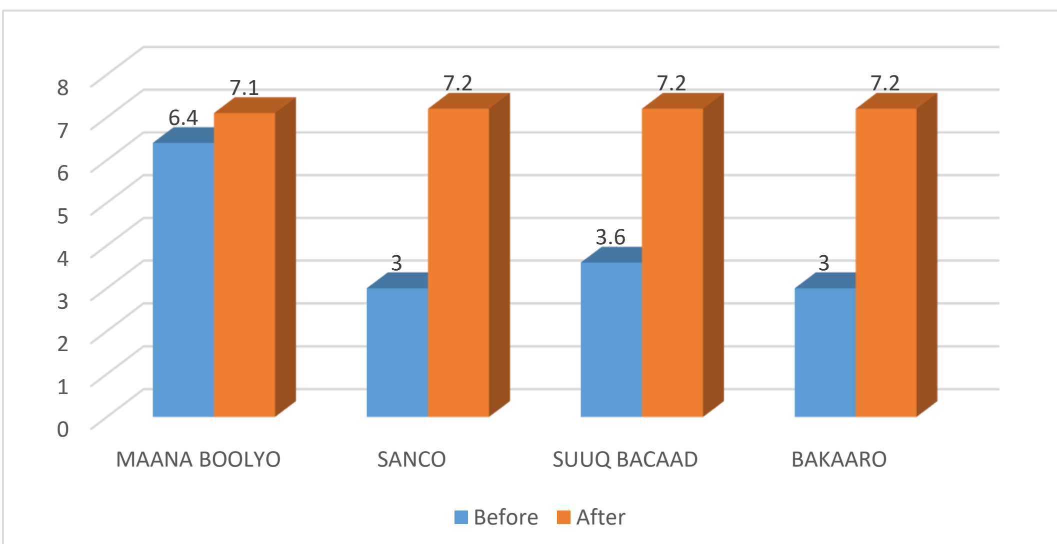


Figure 23

CO_2 Emissions Before and After the Optimization at Afarta Jardiin Intersection

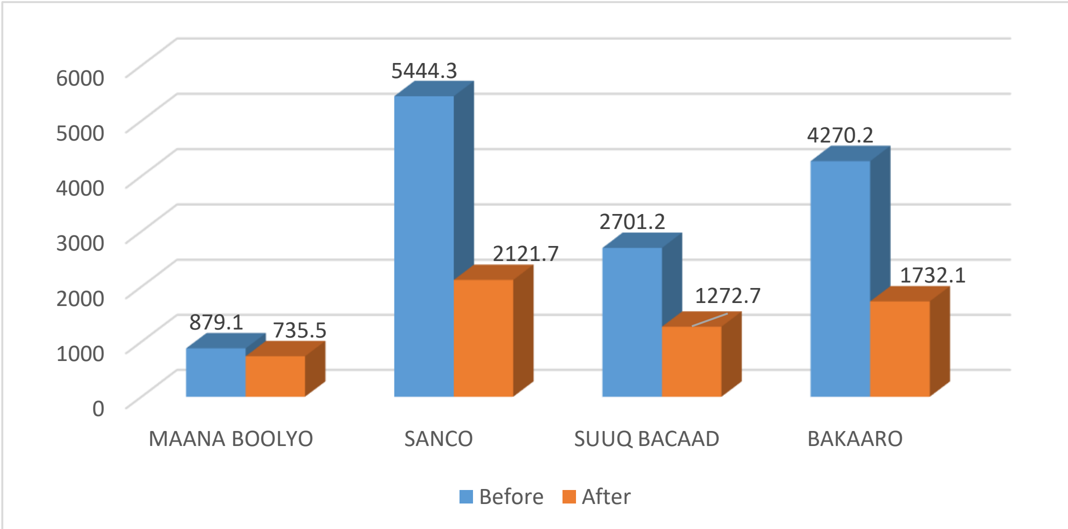


Table 15

LOS Before and *After the Optimization at Afarta Jardiin Intersection*

	Delay in Seconds			
APPROACHES	Before	After	LOS Before	LOS After
MAANA BOOLYO	2824.8	2378.2	F	F
SANCO	6622.5	2346.8	F	F
SUUQ BACAAD	5411.1	2357.2	F	F
BAKAARO	6289.8	2309.6	F	F

This table showed that the result LOS before and after the optimization with rank F for all approaches, so this intersection must do more improvement by converting a roundabout or by adding additional lines (slip) or Rail Transient.

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.
- ✓ Tarbuun and Afarta Jardiin Intersection were the two intersections chosen. In order to select the most congested intersections in the city, all four-legged 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 intended to evaluate the currently analysis for both intersection. 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 additional two 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 total delay, degree of saturation, queue lengths and the CO_2 emissions are decreased after the enhancement while the Travel speed for both intersections are increased because of the improvement.
- ✓ Finally, After the analysis with LOS rank F, the worst possible, all of the existing conditions for the two intersections that were chosen based on the criteria outlined above failed. It's therefore expected that all lanes

passing through the intersection must be at least Class D, which means that the intersection must be reduced in level of service by adding additional lines if these conditions are not met.

Recommendation

The following recommendation forwarded for possible use by pertinent policy makers:

- ✓ There is evidence that intersections are being over utilized, according to the results of the study. 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 in other directions.
- ✓ According to the study, the CO_2 emission costs associated with traffic congestion are 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.
- ✓ Efforts to reduce traffic congestion in Mogadishu need to be made across the entire city to ensure safe, efficient, and convenient traffic flow. Furthermore, a better understanding of how the Light Rail Transient can be used to alleviate traffic congestion by incorporating vehicles of all ages, grades, and at grade intersections is needed, as well as how the environmental costs of traffic congestion and its mitigation methods can be reduced and the improvement of public transportation in Mogadishu to 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 Tarbuun Intersection

Tarbuun Intersection					Total Traffic Volume(veh)			Peak Hour Factor (%)		
Approach	No of lanes	Lane width(m)	Median width(m)	Lane Type	TH	RT	LT	TH	RT	LT
Bakaaro	1	3.5	1	Normal	2444	1405	250	100	100	84
Zone Key	1	3.5	1	Normal	1596	413	864	100	89	97.4
Abdi Qasim	1	3.5	1	Normal	600	143	344	95	75	88
Warshada Caanaha	1	3.5	1	Normal	476	951	646	92	98.7	95.4

B. Input Data to SIDARA Software at Afarta Jardiin Intersection

Afarta Jardiin Intersection					Total Traffic Volume(veh)			Peak Hour Factor (%)		
Approach	No of lanes	Lane width(m)	Median width(m)	Lane Type	TH	RT	LT	TH	RT	LT
Maana Boolyo	1	3.5	1	Normal	291	169	198	87.4	72.6	75
Suuq Bacaad	1	3.5	1	Normal	475	428	332	92.3	90.8	73.7
Bakaaro	1	3.5	1	Normal	888	602	390	98	94.4	90
Sanco	1	3.5	1	Normal	944	512	893	99.3	93.7	98.5

Appendix B

NEAR EAST UNIVERSITY YAKIN DOĞU ÜNİVERSİTESİ

ETHICS LETTER

TO GRADUATE SCHOOL OF APPLIED SCIENCES

REFERENCE: **ABDIRAHMAN ABDIRASHID QORANE *(20206830)***

I would like to inform you that the above candidate is one of our postgraduate students in the Civil Engineering department he is taking a thesis under my supervision and the thesis entailed: **EVALUATION OF TRAFFIC FLOW AT TWO INTERSECTIONS: A CASE STUDY OF MOGADISHU CITY, SOMALIA**. The data used in his study was our data collcted from the filed in Mogadishu City.

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

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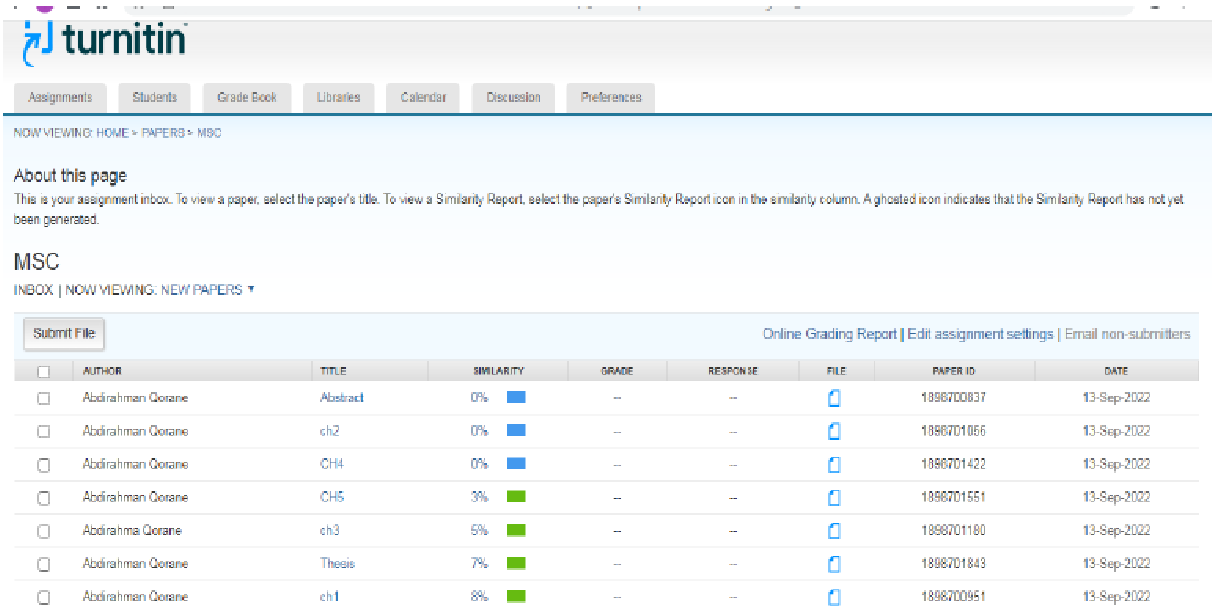
Appendix C

Turnitin Similarity Report



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