PERFORMANCE EVALUATION OF OFF-STREET PARKING IN ADDIS ABABA CITY (A CASE STUDY IN SELECTED CENTRAL BUSINESS DISTRICTS)

MSc. THESIS

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HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA

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A THESIS SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING
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ADVISORS' APPROVAL SHEET

This is to certify that the thesis entitled **"Performance evaluation of off-street parking in Addis Ababa city (A case study in selected central business districts)"** submitted in partial fulfillment of the requirements for the degree of **Master's** with specialization in **Road and Transport Engineering,** the Graduate Program of the **Department of Civil Engineering,** and has been carried out by **Alemseged Eshete** (ID. No. **PGRO/03/10),** under our supervision. Therefore, we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

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We, the undersigned, members of the Board of Examiners of the final open defense by Alemseged Eshete have read and evaluated his thesis entitled "Performance evaluation of off-street parking in Addis Ababa city (A case study in selected central business districts)", and examined the candidate. This is therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree.

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DECLARATION

I hereby declare that this MSc thesis entitled **"Performance evaluation of off-street parking in Addis Ababa city (A case study in selected central business districts)"** is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

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LIST OF ABBREVIATIONS

CBD: Central Business District

CSA: central statistics Agency

ECA: United Nations Economic Commission for Africa

FDRE: Federal Democratic Republic of Ethiopia

FTA: Federal Transport Authority

GSF: Gross square footage

IRC: Indian Road Congress.

ITE: Institute of Transport Engineers.

LOS: Level of Service

OAU: Organization for African Union

TSM: Transport system Management

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ABSTRACT

Car-parking sector has always been of great importance in terms of urban mobility, since it is a fundamental element in achieving a high level of accessibility in the city centers. Central Business Districts (CBD) are areas of dense traffic which result in parking problems. Addis Ababa, the administrative and financial capital of Ethiopia, is experiencing continued growth and change. But due to the fact that more than 60% of the vehicles in the country are operated in this city, parking problem is crucial. Parking plays an important role in mobility, access and the economic development of Addis Ababa. The space that parking requires can be problematic in any city, but it poses particular problem in Central Business Districts (CBD). Due to the absence of clearly designated areas of parking in Ethiopia, shortage of parking facilities has been a long standing problem in the country. Especially cities with greater economic activities, greatly faced to traffic congestion and delay problems. The general objective of this research is to evaluate the efficiency of off-street car parking in the Central Business District area of Addis Ababa City. Depending upon their greater demand requirement for a parking facilities, three central business districts of the capital (i.e. 'Megenagna', 'Bole' and 'Merkato') were chosen for detailed analysis. From the stated locations; 11, 13 and 11 off-street parking sites were selected for further analysis respectively. For data collection in and out data collection technique were used. Data was collected from May to September 2019 during the interval of time 8 am-6 pm. From the accumulation graph, peak hour for the demand was selected. The performance analysis result shows that off-street parking's in the central business district of the city is over their capacity. Demand study was also made to 'Megenagna' site by using land use analysis method. From the demand analysis 2,454 additional parking spaces were required to afford the existing demand. In addition to this, structured interview was made to the users of the parking facilities to strengthen the analysis. The research conclude that the main problem of parking in the areas is lack of enough off-street parking space supplies, lack of parking policy and management system, absence of parking signs and marks which results in confusion for finding available parking spaces and lack of knowledge of users for parking usage and shared parking strategies.

Key Words: Central Business District, In and out method, off-street parking, accumulation curve

1. INTRODUCTION

1.1 Background of the study

The significant role of transport in the movement of people, good and services from origin to destination which thus improves the socio-economic status and the general development of the nation cannot be over-emphasized. Transport problems are very common in the CBD of Addis Ababa as a result of the growing concentration of population, rapid urbanization and economic activities. According to Ogundare and Ogunbodede (2014), the city is an engine of economic development and center of industry, commerce and administration, which functions only with an efficient system of transportation. A high urbanization rate in combination with the intense desire for car ownership in developing countries causes a rapid growth of motorization, On the other hand, a lack of infrastructure and weak maintenance exerts extra stress on these growing traffic flows with congestion, pollution and a low road safety level as a result. Parking, an integral component of the transport system, is a serious problem that confronts the urban planner and traffic engineer, as it plays a crucial role in the management of traffic and congestion mitigation. Any vehicles traveling on highways will at one time or another be parked at some point for either a relatively short time or a much longer time, depending on the reason for parking. The provision of parking facilities is therefore an essential element of the highway mode of transportation (Joseph, 2016).

Off street Parking is a Parking Area designed adjacent to the Road or in a place or building which is not the part of the road. In many urban centers, some areas are exclusively allotted for parking which will be at some distance away from the main stream of traffic. Such a parking is referred to as off-street parking. They may be operated by either public agencies or private firms (Edwards, 2012).

The growing use of the automobile as a personal feeder service to transit systems ("park-and-ride") has also increased the demand for parking spaces at transit stations. In areas of high density, where space is very expensive, the space provided for automobiles usually has to be divided between that allocated for their movement and that allocated for parking them. Providing adequate parking space to meet the demand for parking in the central business district (CBD) may necessitate the provision of parking bays along curbs which reduces the capacity of the streets and may affect the

level of service (LOS). Central business district of the city is 1,276 hectare which is 2.4% of the land use of the capital (Ayalneh, 2012).

Addis Ababa has a large concentration of motorized vehicles. Comparative to other cities in the nation, the greater numbers of motor vehicles are found in Addis Ababa with a total share of 63.19% percent of the total motor vehicles in the nation (FTA, 2016). One of the crucial issues of Addis Ababa traffic activity is the scarcity of car parking.

Car-parking sector has always been of great importance in terms of urban mobility, since it is a fundamental element in achieving a high level of accessibility in the city centers. In fact, many businesses and municipalities see an adequate supply of parking, especially for visitors, as crucial for their competitive growth. Yet, at the same time parking is, and will remain for most cities, the most powerful means of traffic restraint available. The enhancement of the urban environment is also partly dependent on adequately managing parking (Joseph, 2016).

1.2 Statement of the Problem

Addis Ababa is the administrative and financial capital of Ethiopia. However, the functions of Addis Ababa Metropolitan Area as a central business district (CBD) are undermined by the inefficient use of road space, such as illegal on-street parking, the lack of convenient public transport system and congestion problems due to on street parked vehicles. Parking has been a long standing problem in many urban centers in Ethiopia. This has been due to the absence of clearly designated areas of parking in many of urban centers/off-street parking. This has led to traffic congestion and delay problems.

Scarcity of Parking is a major challenge in the traffic activity of the city. Though on-street parking facilities are provided on many routes in Addis, but increased car ownership has rendered them grossly inadequate and also policy makers and advocates have argued that on-street parking narrows the road, causes unnecessary congestion and accidents. The parking problem is more acute on major arterials which provide access to centers of activities in the city.

According to Asfaw (2016), in 2016, number of vehicles registered for the year 2016 has reached 447,669 vehicles in the city, it has 71.63% growth when compared with 2011/12 data that was 260,837. It’s a major issue for proper parking facilities in order to maintain the traffic conditions

and adequate traffic flow. So, to overcome with the traffic and parking problems, we need to evaluate how the available parking facilities performs, after that the solution can be suggested. Despite the fact of the problems there is little studies done in this area therefore this research try to fill the gap by investigating how the existing off-street parking facilities are operating in order to open the road for future researches.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of this research is to evaluate the efficiency of off-street car parking in the Central Business District area of Addis Ababa City.

1.3.2 Specific Objectives

- To evaluate the performance of the off-street car parking facilities using accepted guidelines.
- To evaluate the importance and challenges of car parking, due to the rapid development of Addis Ababa.
- To investigate the operational condition of off-street car parking in the selected central business districts of Addis Ababa city.

1.4 Research Questions

This research answers the following questions:

1. What is the existing performance of these off street parking facilities?
2. What are the challenges and importance facing the city in terms of off-street parking?
3. What are the current operational conditions and demand to the facilities?

1.5 Significance of the study

This study attempts to assess the current parking situation and practice of Addis Ababa. It is, therefore, hoped and expected to provide insights on the future strategy on the master plan of Addis Ababa. Accordingly, this study will contribute significant information on the following issues.

- It would provide insights in an attempt to revise and establish car parking strategic directions on the master plan of Addis Ababa that will be up to date and efficient for the city under study.
- It will provide information about the improvement strategies for the existing off-street car parking facilities.
- It helps to stimulate further investigation in the area.

1.6 Scope of the study

In the city of Addis Ababa even if there are different parking facilities (i.e., on street parking) this study will only focuses on off-street parking facilities of the city which is located in the CBD (Central Business District) of Addis Ababa city. Even though, the scope of the research is limited to specific locations, it is expected to provide the general idea to have convenient public and/or private parking lots.

1.7 Limitations of the study

Even though the study concerns about off-street car parking in Addis Ababa city it only concentrated only on three selected locations based on pilot study made by the researcher. In addition demand study were also made only to 'Megenagna' site because the main intention of the research is to measure the performance of the selected sites and the purpose of the demand study is only to show the way for the upcoming researchers who are interested to work on this area of research.

- There is no available data of the parking sites in the concern authority.
- Lack of willingness of some drivers to response for the interview questionnaires was also other limitation of the study.

2. LITERATURE REVIEW

2.1 General overview

Transportation is a process that involves the movement of commuters, goods and services from a given point of origin to a specific destination. It is a means to access business activities, education, employment and recreational opportunities (World Bank, 2002). However, Urbanization is increasing at an alarming rate with 50% of the world population expected to be living in urban areas by 2025 and more transformation is expected in developing countries (World Bank Report, 2003). With rapid urbanization and economic growth, motorization has been accelerating in cities in developing countries. This rapid urbanization with its increase in both vehicular and human population is foreseen to affect sustainable development through its negative consequences such as traffic congestion, traffic accidents, global warming through air pollution and traffic noise pollution, among others.

Transport is described as the maker and breaker of the cities. Ogunsanya (2002) confirmed how transport has built cities over the year in some urban areas and how it has gradually destroyed them inadequate and poorly maintained infrastructure facilities, accidents, the relative immobility of the disadvantaged, waiting for a long period at the bus-stop, pollution from transportation, traffic congestion and parking problems are becoming acute in the cities.

Traffic congestion is therefore one of the most predominant problems encountered in such environment, and the case of Addis Ababa is no exemption. Traffic congestion and parking difficulties in the CBD of Addis Ababa is a major cause of traffic congestion that is why on street parking is one of the major causes of traffic congestion in the city due to unavailability or poor performance of off-street parking facilities. This ideal can be supported by the study done by Addis Ababa Transport Bureau in 2014 as shown on the table 2.1.

Table 2. 1: Number of Congested area in Addis Ababa city and causes of congestion

Sl. No	Sub city	Congested area and roundabout in numbers	Causes of Congestion
1	Akaki kality	3	Too narrow roads
2	Nifas silk lafto	7	Too narrow roads, road side parking
3	Yeka	3	Unavailability of alternative roads, road side parking
4	Kolefae keraneyo	3	Unavailability of alternative roads
5	Lideta	4	Road expansion and development work, unavailability of alternative road
6	Kirkos	8	Operators not using the available alternative roads
7	Gullele	12	Poor road condition, unavailability of traffic signs, increased number of bus stations, too narrow road, unavailability of sufficient pedestrian walkway
8	Addis Ketema	3	Too narrow road and roundabout, road side parking
9	Arada	8	Road side parking
10	Bole	4	Entering and exiting of heavy trucks in the area, too narrow road , tax terminals with too many vehicles at a time
Total Congested area		55	

Source: Addis Ababa Transport Bureau, 2014

On-street parking constitutes one major problem that makes the traffic situation chaotic in Addis Ababa. Because most of the roads in Addis Ababa are narrow and lack pedestrian lanes; parking along these narrow roads therefore causes traffic congestion. This is due to the unavailability of off-street parking facilities along the transportation routes coupled with inadequate traffic management. However, in western countries, standards for parking requirements have been reoriented towards limiting the use of private car in congested central areas but maintaining minimum levels to preserve city center activities (Olorunfemi, 2013). This is most feasible in CBDs, where activities are interrelated because of the mix of land uses and efficient public transportation system that would decrease reliance on private cars.

Cities are characterized by different various land uses activities, and patterns of circulation is partly a functions of the land use activities and their spatial distribution. The efficiency of this circulation depends upon existing transportation systems, of which parking facilities are major component. Situations of lack of provision and poor planning in respect to other urban land use activities, the economic activities of the city may be affected. Increase in numbers of vehicles without adequate infrastructure has accentuated the problems of traffic congestion, traffic delays, parking problems, accidents, and urban land use severance (Raji and Wasiri, 2008).

In Addis Ababa, like elsewhere, where cars are one of the dominant modes of transportation, urban circulation is one of the most obvious problems and parking seems to be an overlooked element in transportation development. However, for a city to function as a system, transportation must be efficient and reliable to facilitate, not only intercity movement of people and their activities, but encourage intra-city movements within the city. These movements are from point of origin to the point of destination. It is also recommended the use of benefit districts, where parking areas are shared within neighborhoods, not only for maximizing the use of parking, but also in improving the efficiency of land use.

2.2 Types of car parking facilities

There are four kinds of car parking facilities (Tom, 2017):

Private car park: A multi-story building and underground parking lot.

Public car park: Which is includes like gateway and railway station parking.

On-street parking: is the adequate space for vehicles at the side of the road. Bus-stop – is a parking space provided for motorists along the road way in the central business districts and also at designated place. Common types of on-street parking are as listed below. This classification is based on the angle in which the vehicles are parked with respect to the road alignment. As per IRC the standard dimensions of a car is taken as 5× 2.5 meters and that for a truck is 3.75× 7.5 meters.

Parallel parking: The vehicles are parked along the length of the road. Here there is no backward movement involved while parking or un-parking the vehicle. Hence, it is the safest parking from the accident perspective. However, it consumes the maximum curb length and therefore only a minimum number of vehicles can be parked for a given kerb length. This method of parking

produces least obstruction to the on-going traffic on the road since least road width is used. Parallel parking of cars is shown in figure 2.1. The length available to park N number of vehicles, L=N/5.9

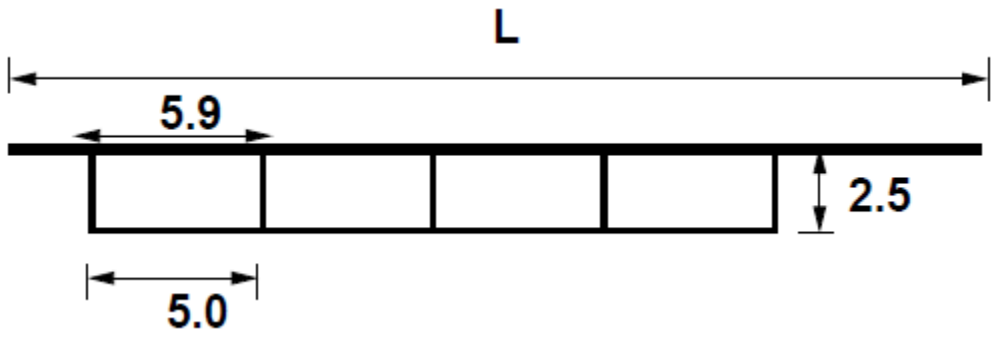

Figure 2. 1: Illustration of parallel parking (source: Tom, 2017)

- 30◦ parking: In thirty degree parking, the vehicles are parked at 30◦ with respect to the road alignment. In this case, more vehicles can be parked compared to parallel parking.

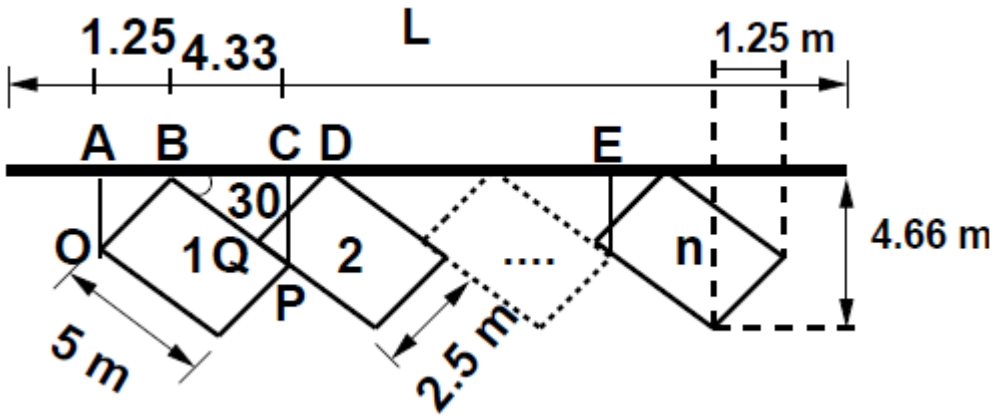

Figure 2. 2: Illustration of 30◦ parking (source: Tom, 2017)

- 45◦ parking: As the angle of parking increases, more number of vehicles can be parked. Hence compared to parallel parking and thirty degree parking, more number of vehicles can be accommodated in this type of parking. From figure 2.3, length of parking space available for parking N number of vehicles in a given kerb is L = 3.54 N+1.77

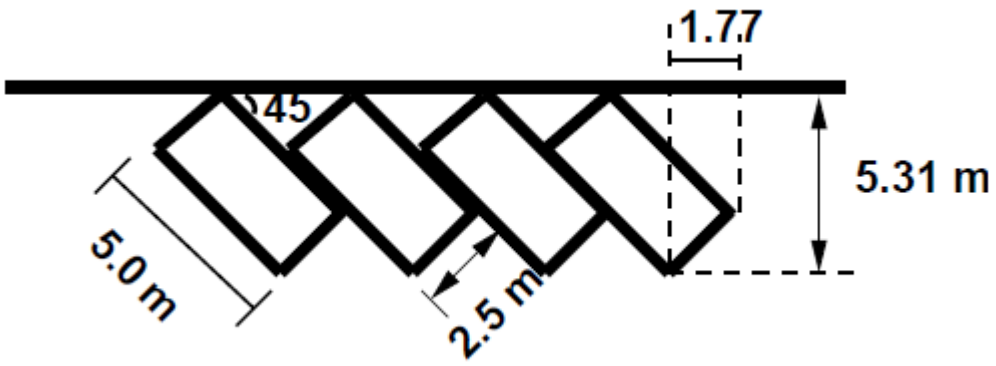

Figure 2. 3 : Illustration of 45◦ parking (source: Tom, 2017)

- 60◦ parking: The vehicles are parked at 60◦ to the direction of road. More number of vehicles can be accommodated in this parking type. From the figure 2.4, length available for parking N vehicles =2.89N+2.16.

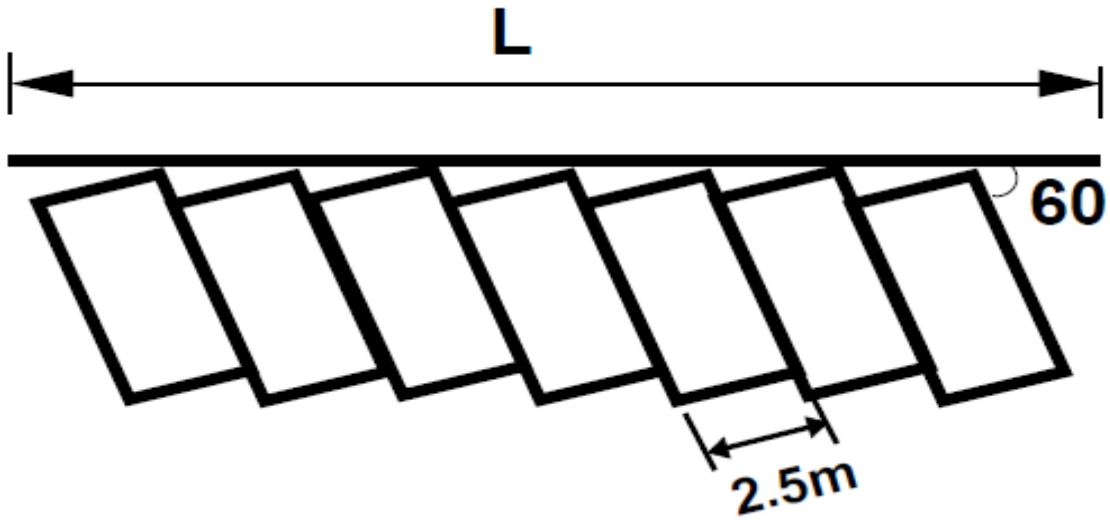

Figure 2. 4: Illustration of 60◦ parking (source: Tom, 2017)

- Right angle parking: In right angle parking or 90◦ parking, the vehicles are parked perpendicular to the direction of the road. Although it consumes maximum width kerb length required is very little. In this type of parking, the vehicles need complex maneuvering and this may cause severe accidents. This arrangement causes obstruction to the road traffic particularly if the road width is less. However, it can accommodate maximum number of vehicles for a given kerb length. An example is shown in figure 2.5. Length available for parking N number of vehicles is L = 2.5N.

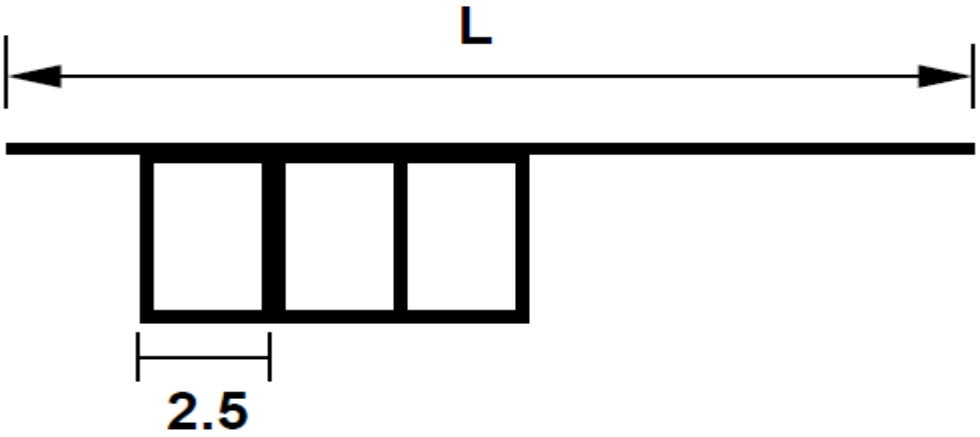

Figure 2. 5: Illustration of 90◦ parking (source: Tom, 2017)

The forth one is off-street parking: it is very near to their destination and close to the carriageway and it's a parking space whether at the earth or off-street in a lot, garage, shopping center or private driveway. Figure 2.6 illustrates a typical off-street parking (Tom, 2017).

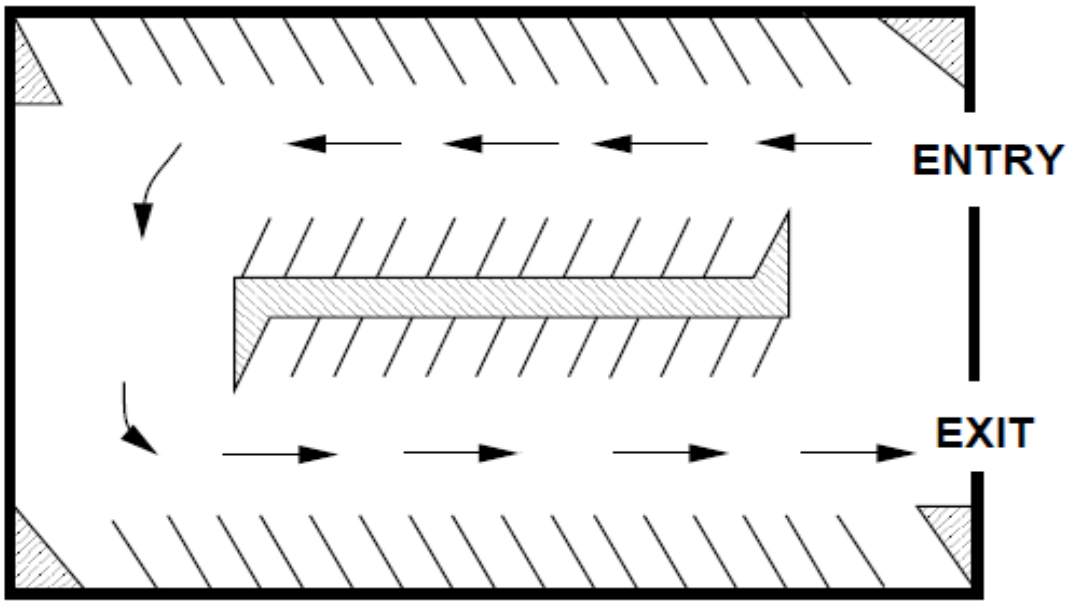

Figure 2. 6: Illustration of off-street parking (source: Tom, 2017)

2.3. Parking analysis theory

Parking is one of the major problems that are created by the increasing road traffic. It is an impact of transport development. The availability of less space in urban areas has increased the demand for parking space especially in areas like central business district. This affects the mode of transport

choice and has a great economic impact. Before taking any measures for the betterment of conditions, data regarding availability of parking space, extent of its usage and parking demand is essential. It is also required to estimate the parking charges also. Parking surveys are intended to provide all these information. Since the duration of parking varies with different vehicles, several statistics are used to access the parking need (Joseph, 2016).

2.3.1. Parking statistics

The following are the parameters that used to evaluate the given parking facilities (Tom, 2017).

Parking accumulation: - It is defined as the number of vehicles parked at a given instant of time. Normally this is expressed by accumulation curve. Accumulation curve is the graph obtained by plotting the number of vehicles with respect to time.

Parking volume: - Parking volume is the total number of vehicles parked at a given duration of time. This does not account for repetition of vehicles. The actual volume of vehicles entered in the area is recorded.

Parking load: - It can be obtained by simply multiplying the number of vehicles occupying the parking area at each time interval with the time interval. It is expressed as vehicle hours.

Average parking duration: - It is the ratio of total vehicle hours to the number of vehicles parked.

Parking turnover: - It is the ratio of number of vehicles parked in duration to the number of parking bays available. This can be expressed as number of vehicles per bay per time duration.

Parking index: - Parking index is also called occupancy or efficiency. It is defined as the ratio of number of bays occupied in time duration to the total space available. It gives an aggregate measure of how effectively the parking space is utilized.

2.3.2 Parking surveys

Parking surveys are conducted to collect the above said parking statistics. The most common types of parking surveys conducted are in-out survey, fixed period sampling and license plate method of survey.

2.3.2.1 In-out survey

In this survey, the occupancy count in the selected parking lot is taken at the beginning. Then the number of vehicles that enter the parking lot for a particular time interval is counted. The number

of vehicles that leave the parking lot is also taken. The final occupancy in the parking lot is also taken. Here the labor required is very less. Only one person may be enough. But not possible to any data regarding the time duration for which a particular vehicle used that parking lot. Parking duration and turnover is not obtained in this method. Hence one cannot estimate the parking fare from this survey. For quick survey purposes, a fixed period sampling can also be done. This is almost similar to in-out survey. All vehicles are counted at the beginning of the survey. Then after a fixed time interval that may vary between 15 minutes to 1 hour, the count is again repeated. Here there are chances of missing the number of vehicles that were parked for a short duration (Tom, 2017).

2.3.2.2 License plate method of survey

This results in the most accurate and realistic data, in this survey, every parking stalls monitored at a continuous interval of 15 minutes or so and the license plate number of vehicles are noted down. This will give the data regarding the duration for which a particular vehicle was using the parking bay. This will help in calculating the parking fare because parking fare is estimated based on the duration for which the vehicle was parked. If the time interval is shorter, then there are less chances of missing short-term parkers. But this method is labor intensive (Tom, 2017).

2.4 Challenges of car parking in Addis Ababa

Addis Ababa city located at the center and is among the most important commercial city with a highly concentrated population in Ethiopia. Recent, study shows that the morphology (form) of the city has changed very rapidly beyond the ability of municipalities to recover its original status. For example, the construction of different activities attracts more people with a private vehicle who often visit the areas for leisure, employment and other services. On the contrary, parking space is not enough to accommodate the number of clients visiting the areas. Parking challenges occurring in the capital city will continue to be the major problem due poor parking policies, poor planning of the city, population growth, increase of car to mention in a few (Bundara, 2010).

- Rapid Urbanization: - The population in Addis Ababa has been changing very rapidly in a rate of 2.1% per year (Central Statistical Agency, 2010). For example, according to Addis Ababa transport branch office 2003 – 2007 strategic plan shows that, human settlement and population in Addis Ababa estimated to be 4.5 million people in 2020. This increase does not correspond to the capacity of the municipalities for providing reliable service such

as parking facilities which has a tendency to reduce the traffic congestion and smoothen the travel time in the city. The increase of the population will also continue to exert pressure on parking spaces and other social and economic services unless deliberate efforts are made to address the problems particularly in the poor parking facilities, management and policy development.

- Increased number of cars: - According to Ministry of Transport (2011), out of the total number of vehicles in the country about 75% is estimated to be concentrated in Addis Ababa and different vehicle types are showing different growth: private cars are increasing at a rate of 5.02% and commercial vehicles are increasing at a rate of 5.74 % respectively
  The annual motorization rate of the city vehicle had been 5.8 percent on an average (Federal Transport Authority (FTA) computer database for the year 2016/2017). This rate will be added for the current situation of Addis Ababa city. The data obtained show that, total number of vehicles are 447,669 for the year 2016/17.
  And thus, the transport sector has adverse impact on the rate and growth process of the city that may have an effect on the change and direction of the country. Physical size of the city is increasing to accommodate the population and their activities. Due to this, the travel demand and the number of vehicles on roads are also increasing.
- Inadequacy of parking spaces: - Roadside and illegal parking are common phenomenon in Addis Ababa especially in the central business district, this is due to the limited spaces for parking. The on-street parking narrows the road, cause unnecessary congestion and accidents in the city. Shoup (2005) conducted a study in 11 international cities. The study found that on averages 30% of traffic is cruising looking for parking spaces with the average search time being 8.1 minutes. Recent research organized by the Ministry of Transport (2011) found that 48% of respondents acknowledged that have parked illegally. Parking policy should not be developed in isolated but as part of local and region spatial and transportation planning processes.
- Demand for right of way: - Streets in Addis Ababa are used in different ways but mostly for movements/mobility (cars, passenger vehicles, pedestrians and motorcyclists), exchange (social interaction and street vending) and storage (parking). Many streets in the CBD (central business district) area, does not freely allow right of way to accommodate all

the functions. It is clear that spaces dedicated to parking are unavailable to get service from different shops and offices.

- Pedestrian safety and comfort: - On some streets illegal parking in the CBD hinders the movements of vehicles and walkway which is important for pedestrian comfort and safety. Poor parking on the walkway on pedestrian crossings forces pedestrians into the roadway and affects visibility. This does not attract people to use non-motorized facilities to travel in the city of Addis Ababa.
- Traffic Congestion: - Addis Ababa street network has a finite capacity, poor parking planning and inadequacy of the policy developed to coordinate the decision on roadway capacity. If no new roadway capacity is planned to the CBD, as seem likely and therefore, it is ultimately futile to the construction of more parking for all day commuter use in the CBD. This parking would only add to the existing congestion and undermine the ridership.

2.5 Pattern of traffic growth in the city

The annual motorization rate of the city vehicle had been 5.8 percent on the average according to the Federal Transport Authority (FTA) computer database for the year 2010/2011. The data obtained show that, total number of vehicles are 260,837 for the year 2010/2011 out of these 95,131 are private and 114,190 are business vehicles which is 36.47% and 43.78% of the total vehicles, respectively. In the fiscal year 2013/14 the registered were 340,880 vehicles and the number of vehicles registered for the year 2016 has reached 447,669 vehicles in the city. From the total 708,416 vehicles in Ethiopia, more than 63.19% are found in Addis Ababa as can be seen in the following table 2.2. From this it is understood that the number of vehicles is growing at a rapid rate with the development of the socio-economic activity of the city.

Table 2. 2: Number of vehicles operating in Addis Ababa city

Description	Number
Ambulance	15,229
Automobile	122,637
Bajaj	98
Bus(>12 seats)	20,847
Bus(>11 seats)	12,636
Combiner	16
Dozer	14
Dry cargo (<=10 Quintals)	25,898
Dry cargo(>10 quintals)	81,641
Dual purpose vehicle	36,084
Field vehicle	41,684
Grader	4
Forklift	16
Gotach	665
Liquid cargo	4,745
Liquid trailer	559
Motor bicycle	16,353
Other	12,117
Three wheel public load	13
Tractor	715
Trailer	17,133
Vehicle with machinery	149
Not specified	38,416
Total	447,669

Source: (FTA, 2016)

2.6 Impact of parking on congestion

Parking and traffic congestion are inter-related in the sense that the absence of parking will augment traffic congestion situations. When there is more parking supply than there is roadway capacity to serve that supply, congestion will result. Also, too much parking in the wrong location, that is, where parking supply is concentrated so that large flows of cars exceed the capacity of local streets, localized congestion will result. Poor management of parking which include on-street, parking lots, parking garages, public and private, if not properly managed to ensure few spaces are almost always available in all locations, motorists will drive in circles trying to find available

parking spaces. This situation may result in severe and entirely unnecessary traffic congestion. All parking should be managed to achieve a 15% availability target at all times of the day. Typically, the best way to meet the available target is to change the lowest hourly price that meets the target. Again, if parking is underpriced so that driving is cheaper than taking a bus, it encourages excessive speed driving habits. Most especially in situations were on-street parking is cheaper than off-street parking drivers will always cruise around looking for empty spaces to park, thereby causing traffic.

For CBD areas, the challenge of the patronage has been to accommodate the automobile, enough to maintain their vitality, but not so much that they became paralyzed by congestion. Parking lots are considered unattractive and hostile; they can increase congestion and lower land values. Also, the problems of intra-urban traffic in Lagos Nigeria have been studied by Bashiru and Waziri (2008). The study found that 57% of commuters and motorists spend between 30 to 60 minutes on the road due to traffic congestion. They also found that the worst traffic congestion occurred on Mondays. This agrees with similar findings by Marsden and May (2006), listed the causes of traffic congestion in Lagos to include the following: Presence of pot holes/bad road, trading activities, on-street parking, loading and discharging of passengers, illegal bus stops, flooding/poor drainage, vehicle breakdown, narrow road sections, religious activities, high volume of traffic, lack of parking space and lack of traffic light at some road intersections. Roadside and on roads parking, roadside trading and total disregard of traffic regulation by road uses are significant human contribution to the traffic problems.

According to Eunice et al (2016) Traffic congestions cannot be looked at without giving due consideration to solving parking problems in a city's CBD. Therefore, to solve traffic congestions, parking shortfalls must be tackled first. Therefore, managing congestion in a city can include the elimination of minimum parking requirements, establishment of maximum parking allowances which is tied to available roadway capacity, pricing public parking to achieve 15% available parking target, working with private owners of parking to manage parking to achieve the availability target and investing in walking, cycling and transit to make sure that they serve as more efficient modes and more attractive than driving for more trips.

Naturally, every town center, Addis Ababa central business area included, would like to prosper. Thus, Addis Ababa central business area would want to encourage visitors and shoppers that bring trade and consequent prospering of the area. The natural desire to have Addis Ababa central business area prospering raises the need to seek ways of easing the area's traffic congestion.

Anything that can be done to reduce congestion, and allow people to travel to the town center in a shorter time, will make the central area more accessible- and thus will help people to decide to shop there as against in the suburbs or out of town Eunice et al (2016) stales that there are basically two alternative solutions to controlling traffic congestion. The solution is either a change in demand to meet system capacity or a change in system capacity to meet demand.

Measures that change system capacity to meet demand normally include provision of more infrastructure and are generally capital intensive. Moreover, a traffic congestion problem is not solved simply by providing more infrastructure (even if that were feasible in the centers of large cities) because of the way in which users pay for their space. Congestion has to be tackled through means which tailor demand to fit existing road network (Bundara, 2010).

Unlike provision of new infrastructure that generally increases system capacity, traffic management methods (normally referred to as TSM) are best seen as actions or groups of actions that usually produce shifts in supply-demand equilibriums of existing transportation systems (Paquette et al, 1982).

Parking facilities form part of transportation facilities. The imposition of rules governing use of parking facilities, otherwise referred to as parking controls, is one TSM measure that has already been recommended as a solution to Addis Ababa central area's traffic congestion problem. Therefore in central business district areas of the city we can reduce illegal on street parking that contributes to traffic congestion by providing adequate off-street parking facilities.

2.7 Parking policy in the city

According to Marsden and May (2006), parking policy should not be developed in isolation but as part of the local and regional, spatial as well as the transport planning processes. This is so because parking policy plays the role of an interconnector between the implementation of land-use and

transport policies. Planning for parking plays a vital role in shaping our physical environment and landscape as well as determining the outcome of how workable the built environment can become. According to Rui Wang et al (2013), an available data reflects that the gap between parking supply and parking demand has enlarged tremendously. The inadequacy of parking facilities in cities often result in difficulty in finding a parking space and causing a lot of illegal parking of vehicles on already crowded streets causing huge traffic at certain times gridlock and also posing traffic safety hazard.

The Federal Democratic Republic of Ethiopia Ministry of Transport (August, 2011) has prepared transport policy for Addis Ababa city. In order to be a competent city on the regional, continental and international levels, the FDRE outlined eleven key policy issues and implementation strategies. Under these policies, expansion of transport infrastructure is included and it further elaborate that : “car parking facilities shall be built by private, government and public private partnership in the city center and in areas with high traffic volume and land supply shall be given special attention by the city administration”.

GTIDR, (2014) reviewed the transport policy of Addis Ababa and Parking is identified as one of the key "infrastructural" challenges in Addis Ababa under the 2011 Transport Policy of Addis Ababa. However, the nature of the problem as identified in that document is essentially that there is not enough off-street parking, and too much on-street parking. For example, under section 1.3 "Critical issues in the Transport Sector" of the aforementioned Transport Policy, "lack of off-street parking facilities and over utilization of road space by parked vehicles" is high on the list of infrastructure issues. The issue of parking especially the overutilization of road space by parked vehicles, lack of off-street parking facilities, and the need to create and incentivize the use of park-and-ride facilities related to mass transit services is indeed an important area of concern for sustainable transport policy. However, this phenomenon is better understood as a market failure, rather than as a problem of infrastructure. While there are instances when developers flout the law and do not provide the necessary off-street parking or illegally convert parking to other uses, the main issue is that parking in general is not appropriately recognized as a commodity and regulated as such. In reorienting parking policy along these lines, parking can be a useful tool to help shape streets as the building blocks of neighborhoods.

2.8 Parking demand and supply

The determination of the demand and supply levels, although a market system approach, is seen by others to offers the foundation for an efficient and equitable decision-making from both the production and consumption viewpoints. Price determination from the classical economic view point is therefore seen to be equitable when demand and supply intersects, also known as the equilibrium point. The irony here is well alluded to by Shoup (2008) in his paper on "the politics and economics of parking on CBD", when he describes CBD parking decision-making process and it resultant policies as that which makes little or not room for an emotion and politics free discussions, which campuses were expected to hold as the custodians of intellectual and transparent decision-making arm of society.

The demand and supply for parking of an area are informed by the vehicle ownership, trip rates, mode split, duration (how long motorists park), geographic location, the quality of travel alternatives, type of trip, and factors such as fuel and road pricing (MRSC, 2012 and Litman, 2012a). As to whether demand influences supply or vice versa in parking planning, are issues of conceptual debates closely related to "demand-induced-supply" versus "supply-induced-demand" in parking planning. In the midst of these debates, which forms the basis for campus and other city parking policies is the one fact that, issues of demand and supply are closely tied to cost and benefits.

Let's consider it this way, should you decide to supply parking spaces in anticipation of future demand, those who could have thought of transit and among other economically and environmentally efficient alternative means of transport to their destinations will now have the incentive to drive their own vehicles since there are parking spaces available. Similarly, when the approach is such that, parking spaces are supplied as and when there is a demand (mostly determined through spill-over parking or long search duration for parking spaces by users), the same scenario as in the case of the former will emerge. Therefore, irrespective of the approach adopted, the determination here should be on the costs and benefits that should be anticipated in supplying the parking spaces demanded.

In his discussion of the "paradigm shift" in parking planning (as summarized in Table 2.3), Litman (2012b) brings to the fore that the new order of things relates to the how problems are perceived

and solutions evaluated. Thus, while the old paradigm focuses on maximizing supply and minimizing price, the new paradigm considers too much supply as harmful as too little, and prices that too low as harmful as those that are too high. This way, the new paradigm in parking planning, tries to maintain the balance between demand and supply as well as cost and benefits, to both users and suppliers.

Table 2. 3: Comparison of Old and New Parking Paradigms

Old Parking Paradigm	**New Parking Paradigm**
"Parking problem" means inadequate parking supply.	There can be many types of parking problems, including inadequate or excessive supply, too low or high prices, inadequate user information, and inefficient management.
Abundant parking supply is always desirable.	Too much supply is as harmful as too little.
Parking should generally be provided free, funded indirectly, through rents and taxes.	As much as possible, users should pay directly for parking facilities.
Parking should be available on a first come basis.	Parking should be regulated to favor higher priority uses and encourage efficiency.
Parking requirements should be applied rigidly, without exception or variation.	Parking requirements should reflect each particular situation, and should be applied flexibly.
Innovation faces a high burden of proof and should only be applied if proven and widely accepted.	Innovations should be encouraged, since even Unsuccessful experiments often provide useful information.
Parking management is a last resort, to be applied only if increasing supply is infeasible.	Parking management programs should be widely applied to prevent parking problems.
"Transportation" means driving. Land use dispersion (sprawl) is acceptable or even desirable.	Driving is just one type of transport. Dispersed, automobile dependent land use patterns can be undesirable.

Source: Litman, 2012b

2.8.1 Determination of parking demand and supply

The number of parking spaces demanded is mostly defined by the parking requirements stipulated in the zoning code. It is therefore expressed as a unit space per square unit of an area. Litman (2012b) suggests this method of providing indexes or ratios for parking gives unconstrained and

unadjusted values. Hence, such indexes or ratios only reflect the maximum supply that could be needed and often adjusted significantly downward (Topp, 2009).

Consequently, parking demand according to Litman (2012b) has therefore been determined through parking surveys at 85th percentile demand curves (implying that facility is full if 85% of spaces are occupied at the peak period), and at 10th design hour (implying parking hours are full only 10 hours per day).

The 85th percentile as an industry standard in itself may vary based on the land location and its uses, parking pricing options, and the alternative transportation options available to the people. Again, what is the parking situation like, beyond 10 hours or any stipulated hours in which parking occupancy is determined. The errors inherent in such standards therefore are seen by Litman (2012b) to point towards the oversupply of parking spaces in many ways. As already posited, the issue then becomes the costs and benefits associated with such oversupply oriented policies. The argument here is not to put forward the idea that there is a perfect system of determining parking demand and supply. Instead, it only seeks to clarify the position that, existing parking models mostly lean towards an over estimation of what needs to supplied. Without considering the location, land uses, alternative transportation options, and most importantly the parking prices, parking policies might overestimate the demand and hence the supply. And when this occurs the costs and benefits results is quite obvious, especially when indirect costs like storm water management and other environmental consequences are factored into the equation.

2.9 Nature of parking in commercial district

According to Marsden (2006), parking is one of the comprehensive components in land use appearing in residential shopping and industrial areas and is related to all kinds of trips occurring in commuting, shopping and leisure trips. Parking plays an important role in mobility access and the economic development of cities, at the same time it is profitable business for both the private and public sectors. Motorists are increasingly being called upon to pay directly for use of parking facilities. Parking supply management and pricing may be used as a strategy to reduce vehicle traffic and parking problems in a particular location. In additions, parking prices may be set to recover parking facility costs or to generate revenue for other purposes. Parking supply

management, particularly pricing could help shift auto dependence to more sustainable alternative modes and reduce congestion (Shoup, 2005).

Parking is seen as an infrastructure but it can only be a structure if it is paid for by those who use the infrastructure and left in the hand of the experts to manage the parking area is a major terminal facility and if not provided vehicles may be parked on the carriage way and this could reduce the road capacity and cause delay and accident as motorists obstruct traffic by involving in road side parking.

Kelly (2006), states that ‘’Parking facilities are constructed in combination with some buildings to facilitate the coming and going of the buildings users. Although a car is parked in a variety of places for a large part of its life, little or no debate has focused on parking areas and in fact seen as transport hubs where the variety of transit means take place (e.g. car/bus, car/walking, car/cycling etc.). It can be argued that much has not been done for parking despite the vital role that it plays”.

Hibbs (2000), states that the purpose for parking is to provide a safe and convenient place for a vehicle to park. Traffic moves towards a destination but at a point it must be parked while some business, whether private or public, recreation or servicing are transacted. Failure to supply suitable terminal facilities “results in jams, frustration and confusion.” This eventually leads to the decline in importance and value of those areas which are at present considered most desirable for the day to day business of a city or town. Various land uses generate and attract traffic of varying proportions hence parking demand is generated according to distribution and type of land used in an area together with the level of accessibility provided by competing modes of transport. Commercial vehicle drivers like taxi and minibuses want easy delivery and its parking space are not immediately available. The tendency is that they will double park. However, the balance between the space for flow of traffic and that for parking has to be carefully decided as the amount of space required for parking and the flow of traffic will not be conflicting.

Research has improved the understanding of factors that affect accessibility. For example, Edwards (2012), found that urban density has about ten times as much influence on the number of destinations motorists can access in a given time period as a proportional increase in traffic speeds. Bates and Bradley (2010), found that a 10% increase in roadway connectivity reduces average travel distances by 1.2%. These studies indicate that cities can provide high levels of accessibility, despite lower average traffic speed. However, increased density can also increase potential

conflicts, also called external costs, such as traffic and parking congestion, of transport is instantaneous movement from one place to another, at no cost' accident risk, and pollution emissions. Of all common activities people engage in, motor vehicle travel tends to impose the greatest external costs.

A large percentage of congestion in urban areas (8 to 74%) is caused by automobiles in search for a parking place. On street parking could be cheap, off street parking could be expensive, fuel could be cheap, the car user wants to park for a long time or the car user is alone and saving time is not important. Shoup (2006) also states that the search for an on street parking place generally takes between 3.5 and 14 minutes. According to parking estimates done during this classified survey by Step and Mint, most cities in Africa could lack up to one million parking spots by 2020.

2.10 Individual (Trip and Personal) characteristics

2.10.1 Trip purpose

Different trip purposes (for instance, work, personal business, shopping and social) are an influencing factor on parking choice and likelihood of parking search, as time constraints may be more significant for certain trip purposes than for others, meaning less willingness on the part of individuals' to spend time searching for a parking space. Miresa (2017) noted that parking search is almost always undertaken under a fixed time horizon arising from time constraints due to driver engagements or appointments; however, the level of flexibility in time constraints and hence in time allocated to parking search varies according to the trip purpose.

2.10.2 Parking duration

Parking duration is concerned with the length of time for which individuals intend to park on any one specific trip and is an influencing factor of parking choice, parking search, and, indeed, travel decisions, as shown by Shang et al., (2007) who found higher parking charges arising from longer duration parking prompted individuals to transfer from car use to alternative transport modes. This increased the availability of previously occupied parking places, resulting in reduced search times for short and medium-duration parking. It was found that optimal utilization of parking facilities would be achieved by assigning longer-duration parkers to private (employer-provided) parking facilities and 'park houses' (multi-story car parks), while short- and medium-duration users would be assigned to on-street spaces and public surface car parks. Preference for on- or off-street parking was investigated by Hensher and King (2001) who examined parking duration, parking charges,

search and egress time, and found an increased preference for off-street car parking as parking duration lengthened; a finding explained by more favorable off-street parking charges and heightened security measures, which were thought to be of less priority for short-duration parkers.

2.10.3 Previously visited car parks and travel time to parking alternatives

Two potential, but under-researched, parking choice and parking search influencing factors are the number of previously visited car parks per trip occurrence, and the perceived travel time to alternative parking facilities. Van der Waerden et al. (2014) investigated the influence of these variables on waiting and search time and found individuals showed decreasing likelihood of waiting and searching with an increasing number of previously visited car parks. By contrast, travel time to parking alternatives had less significance on waiting time, search time, and parking choice (van der Waerden et al., 2014).

2.10.4 Trip and parking frequency

The number of occasions an individual may be required to travel to and park within a particular locality may influence initial and subsequent parking choice and search. This may be a result of increasing familiarity with an area and perceived parking availability or due to rising accumulative parking costs over repeat visits. Research conducted on trip and parking frequency found frequent car use increased familiarity with free-of-charge car parks (Hunt and Teply, 1993).

2.10.5 Perception of vehicle security and personal safety within parking places

Individual perception of personal safety and vehicle security as a parking choice and parking search influencing factor has been investigated. Shoup, (2008) found 60% of respondents (79% of female respondents) considered safety and security when deciding on which level to park within a multi-storey facility. Meanwhile, Hensher and King (2001) found differences in the importance of security stated by users of on-street or off-street/multi-storey car parks, with off-street parking facility users highlighting security as the most important factor.

2.11 Summary of Literature Review

Many literatures reviewed to support the intention of the research, here is the summary of what has been reviewed.

Transportation is a process that involves the movement of commuters, goods and services from a given point of origin to a specific destination. Addis Ababa city located at the center and is among

the most important commercial city with a highly concentrated population in Ethiopia. Challenges of car parking in Addis Ababa includes rapid urbanization, increased number of cars, inadequacy of parking spaces, demand for right of way, pedestrian safety and comfort and traffic congestion. Traffic congestion is therefore one of the most predominant problems encountered in such environment, and the case of Addis Ababa is no exemption. Traffic congestion and parking difficulties in the CBD of Addis Ababa is a major cause of traffic congestion that is why on street parking is one of the major causes of traffic congestion in the city due to unavailability or poor performance of off-street parking facilities. Traffic congestions cannot be looked at without giving due consideration to solving parking problems in a city's CBD. Therefore, to solve traffic congestions, parking shortfalls must be tackled first. With rapid urbanization and economic growth, motorization has been accelerating in cities in developing countries, the data obtained show that, total number of vehicles are 260,837 for the year 2010/2011 out of these 95,131 are private and 114,190 are business vehicles which is 36.47% and 43.78% of the total vehicles, respectively. In the fiscal year 2013/14 the registered were 340,880 vehicles and the number of vehicles registered for the year 2016 has reached 447,669 vehicles in the city. An individual (trip and personal) characteristics have an impact on the performance of the given parking facility which includes, trip purpose, parking duration, previously visited car parks and travel time to parking alternatives, trip and parking frequency, perception of vehicle security and personal safety within parking places.

The review also includes about different types of car parking facilities (i.e., on-street, off-street etc.) it also includes about the parking statistics, how accumulation, parking volume, occupation etc. can be calculated and how they can be used to measure the performance of the given car parking facilities. In-and out and license plate method of car parking surveys used to collect parking data.

Parking policy should not be developed in isolation but as part of the local and regional, spatial as well as the transport planning processes. GTIDR, (2014) reviewed the transport policy of Addis Ababa and Parking is identified as one of the key "infrastructural" challenges in Addis Ababa under the 2011 Transport Policy of Addis Ababa. However, the nature of the problem as identified in that document is essentially that there is not enough off-street parking, and too much on-street parking.

3. MATERIALS AND METHODS

3.1 Description of the study area

Addis Ababa is located in latitude $9^0$1'48"N and longitude $38^0$44'24"E, it is the capital city of Ethiopia, was founded in 1886/1887 by Menelik II. Addis Ababa is located almost in the center of Ethiopia and it is at an altitude of about 2,400 meters above sea level. Addis Ababa has the state of both a city and a state. It is where the African Union and its predecessor the OAU were based. It also hosts the headquarters of the United Nations Economic Commission for Africa (ECA) and numerous other continental and international organizations. It has a built up area of 540 square km with 10 sub-cities, 116 weredas for administration purpose as shown in figure 3.1. The city expanded rapidly and now Addis Ababa is among the ten largest cities in Sub Saharan Africa. According to the CSA July 2015 estimate, Ethiopia's total population is about 90 million people. Of the total population 19.5% (17.5 million people) live in urban areas. This number is rising fast due to an annual urban population growth of 4.89%. Ethiopia's urban population is expected to triple by 2037 (World Bank, 2015). Addis Ababa hosts an estimated 3.238 million people, which is a 17% share of Ethiopia's total urban population. Currently, Addis Ababa is experiencing an annual growth rate of 3.8% and is estimated to reach 4.7 million inhabitants by 2030.It is located in the plateau of mountain ranges at height of 2,000 to 5,000 m above sea level. Its geography ranges from rolling to hilly area with relatively steep gradient and numerous rivers and valleys.

The number of paid parking places on Addis Ababa streets increased from 19 in 2010/11 to 72 in 2015/16. Management of parking spaces are left to registered parking operators' associations. Parking related jobs increased from 207 in 2010/11 to 1,244 in 2015/16. In addition to this, the yearly revenue generated from the service increased from Birr 2.1 million to Birr 8.3 million during that period. (Tefera, 2017)

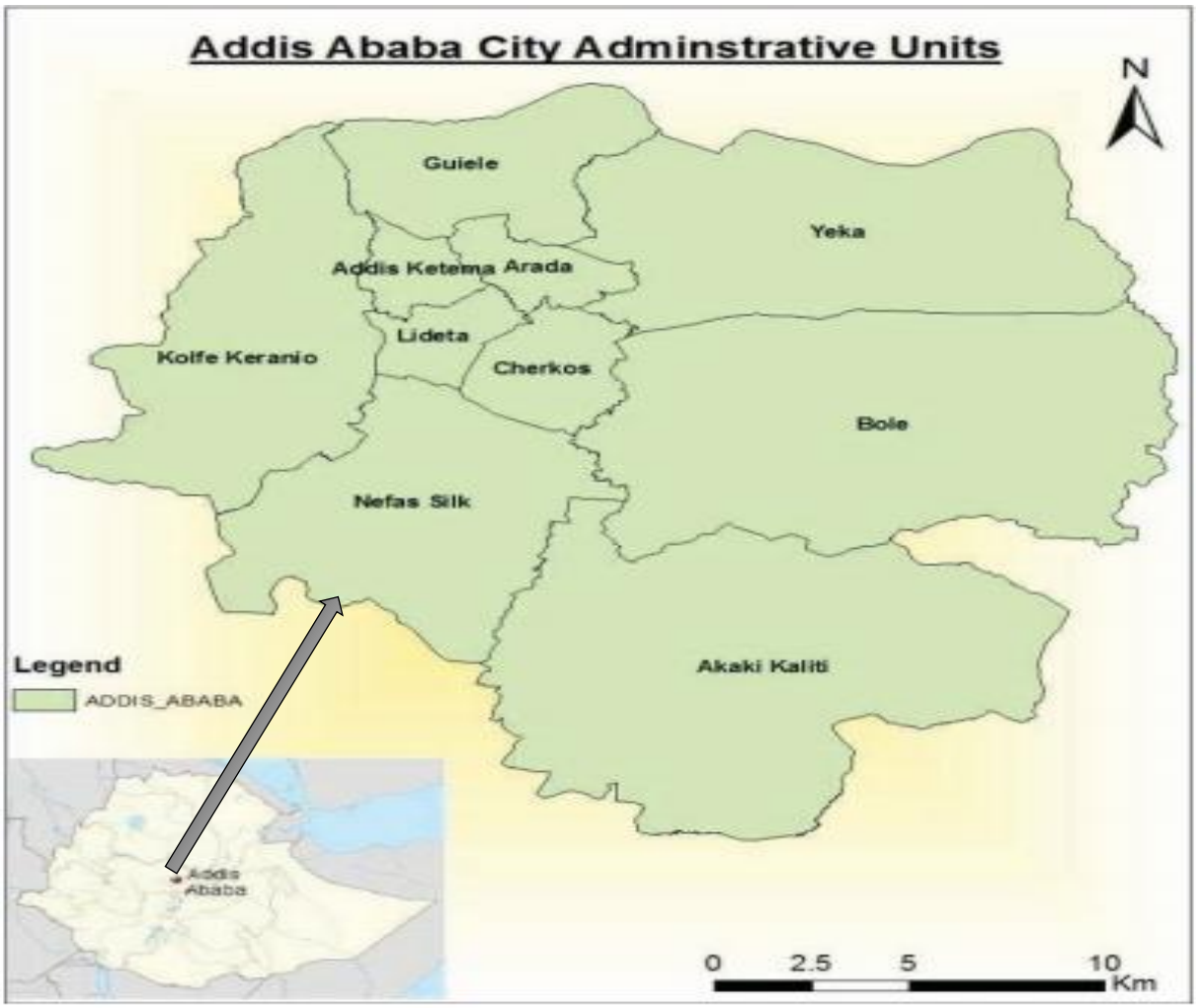

Figure 3. 1**:** Administrative map of Addis Ababa City (source: Addis Ababa city municipality, 2017))

3.2 Study Subject

Even though there are many business districts in Addis Ababa city such as Merkato, Hayahulet, Pizza, Bole, Megnagna etc, depending upon their greater demand requirements for a parking facilities, 3 central business districts of the capital (i.e. Megenagna, Bole and Merkato) were chosen for detail analysis. From the stated locations; 11, 13 and 11 off-street parking sites were selected for further analysis respectively using purposive sampling technique. The details about name of the selected parking location in each zone, capacity etc. are provided in tables 3.1, 3.2 and 3.3.

Table 3. 1**:** Parking inventory data at Bole

Sl. No.	Name of the parking location	Capacity/number of cars	Type of parking	Illegal on-street parking
B-1	Mafi Mall	36	Parallel parking	No
B-2	New bright Tower	16	Parallel parking	No
B-3	Hibret Bank Building	15	Angular parking	No
B-4	Oasis Building	16	Parallel parking	No
B-5	Edna mall	52	Parallel parking	No
B-6	Morning star mall	30	Parallel parking	Yes
B-7	Golden parking	100	Parallel parking	No
B-8	Parking at the back of mamas kitchen	90	Parallel parking	No
B-9	Ephrem,Dagmawi and their friends parking	50	Parallel parking	Yes
B-10	Sheger house Building	20	Angular parking	Yes
B-11	Medhanialem Mall	120	Parallel parking	Yes
B-12	Berehane Adere Mall	35	Parallel parking	No
B-13	Awelo Business Center	40	Angular parking	No

Table 3. 2: Parking inventory at Merkato

Sl. No.	Name of the parking location	Capacity/number of cars	Type of parking	Illegal on-street parking
MR-1	Building in front of CBE building	15	Parallel parking	Yes
MR-2	CBE building	40	Parallel parking	Yes
MR-3	Mares commercial center	32	Parallel parking	Yes
MR-4	Building right next to Addis Ababa shopping center	40	Parallel parking	No
MR-5	Addis Ababa shopping center	60	Parallel parking	Yes
MR-6	Amanual Parking at dubai tera	120	Parallel parking	No
MR-7	Building right next to Yedeget mesealal commercial center	50	Parallel parking	No
MR-8	Yedeget meselal Commercial center	45	Parallel parking	Yes
MR-9	Jakal parking service at antebaraki kokeb commercial center	35	Parallel parking	Yes
MR-10	Edget be andent commercial center	35	Parallel parking	Yes
MR-11	Teret commercial center	50	Parallel parking	No

Table 3. 3: Parking inventory at Megenagna

Sl. No.	Name of the parking location	Capacity/number of cars	Type of parking	Illegal on-street parking
M-1	Timugas Buld'g	22	Parallel parking	Yes
M-2	Mehal Hotel	5	Parallel parking	No
M-3	Sileshi sihen Business center	20	Parallel parking	Yes
M-4	Derartu tulu Building	60	Parallel parking	Yes
M-5	Mulugeta Zeleke Building	70	Parallel parking	Yes
M-6	Maraton motor	65	Parallel parking	No
M-7	Zefmesh buliding	150	Parallel parking	No
M-8	Metebaber Building	85	Parallel parking	No
M-9	Renaissance Building	55	Parallel parking	No
M-10	Genet Commercial center	25	Parallel parking	Yes
M-11	Smart Parking	120	Parallel parking	Yes

3.3 Sample size

To support the analysis it is better to get data from the users of the parking facilities but there is no evidence about the number of users of parking sites and population standard deviation (δ) is unknown. The minimum sample size needed for interval estimate of a population proportion is calculated as (Bluman, 2009).

$$n = p\hat{}q\hat{}\left(\frac{z\alpha/_2}{E}\right)^2 \quad \text{..... (3.1)}$$

Where n= Sample size, $p^{\wedge}$ = estimated proportion of an attribute that is present in a population, $q^{\wedge} = 1 - p$, $z\alpha_{/2}$ = z value, α = significance level, E = margin of error or maximum error of the estimate.

Take 99.9 % confidence interval

CI = 99.9 %, E = 10%, pˆ = 50%,

α = 1 - CI = 1 - 99.9 % = 1-0.999 = 0.001 and

$z\alpha_{/2} = z_{0.001/2} = z_{0.0005} = 3.291$ from table 3.4 below

Table 3. 4: Value of $z\alpha_{/2}$ to different confidence

Confidence	$z\alpha_{/2}$
90%	1.645
95%	1.960
99%	2.576
99.9%	3.291

qˆ=1- pˆ= 1-0.5= 0.5

qˆ= 50%

$n = 0.5 \times 0.5\left(\frac{3.291}{0.1}\right)^2 = 270.77$ This is the minimum sample size but to get better results 300 sample were taken, 100 samples were taken from each site randomly for interview which is an average 10 person from each facility.

3.4 Data type and source

The off-street parking around Merkato, Bole, and Megenagna, were considered for this study. For this study the types of off-street parking that is considered are smart parking, parking under building basements/cellar, public and private off-street parking facilities.

Before data collection begins appropriate sample were taken using equation 3.1. The primary data were obtained from in and out survey and personal interviews. In and out survey is used because it needs less manpower and most of the parking's are building cellar parking's which didn't allow data collectors to stay there for a longer period of time The in and out survey was made between

May to September 2019. Data collections were made on, Wednesday and Thursday to represent typical weekdays during the time from 8 am – 6 pm. Totally 6 data collectors were particpted for the collection of the data the surveyors/data collectors were positioned at/near the entrance(s) and exit(s) to record the number of vehicles that enter and exit from the facilities in 5 minutes interval using the form in appendix C. In this survey, the occupancy count in the selected parking lot is taken at the beginning then the number of vehicles that enter the parking lot for a particular time interval is counted. The number of vehicles that leave the parking lot is also taken. The final occupancy in the parking lot is also taken. Both close-ended and open-ended questions were also administered to users of the facilities, questionnaires are attached in appendix D. Data for demand estimation at 'Megenaga' site were taken from google using recent aerial photography.

3.5 Study design

3.5.1 Study variables

The variables that are needed for the analysis of the data in this study are:

- Variable related to the parking facility
  - ✓ Size
  - ✓ Capacity
  - ✓ Demand for the facilities
  - ✓ Accumulation
  - ✓ Parking volume
  - ✓ Occupancy
- The land uses that were identified actually are listed as shown below for demand study
  - ✓ Government office
  - ✓ General office
  - ✓ Bank
  - ✓ Restaurant/clubs
  - ✓ Residential units
  - ✓ Hotel units
  - ✓ Commercial centers
  - ✓ Miscellaneous land use including library, convention center, youth hostel, theatre

- ❖ variables related to the users of the facilities
    - ✓ Reason for selection of the parking location
    - ✓ Average parking time
    - ✓ Parking user's age, occupation and trip purpose
    - ✓ Types of users (i.e. commuter, business etc)
    - ✓ Frequency of use of the facilities

Step by step procedures regarding how the data are collected to meet the above mentioned variables are shown as under.

The first step is to select the sites to be studied. After appropriate sample of the sites being selected the next step is the collection of the relevant data from the selected sites (i.e., Merkato. Bole and Megenagna). The details of data's collected and methods that were used to collect the data are discussed below.

- ❖ Inventory of existing parking facilities

The relevant characteristics include:

- ➢ Type and number of parking spaces at each parking facility
- ➢ Times of operation and limit on duration of parking, if any
- ➢ Type of ownership (private or public)
- ➢ Restrictions on use (open or closed to the public)
- ➢ Probable degree of permanency (can the facility be regarded as permanent or is it just a temporary facility?)

- ❖ Collection of parking data

Accumulation: - Accumulation data were obtained by checking the amount of parking during regular intervals on different days of the week. The frequency checking was carried out on an hourly basis between 8 a.m. to 6 p.m. The information obtained was used to determine hourly variations of parking and peak periods of parking demand.

Additionally structured interviews were administered to the users of the facility in order to examine their perspective regarding the performance of the facilities. The summary of the study procedure is shown in Figure 3.2.

Secondary data such as the numbers, capacities and locations of off-street parking facilities were obtained from the owners of the facilities of each building administrative offices and traffic management office of the city for smart parking.

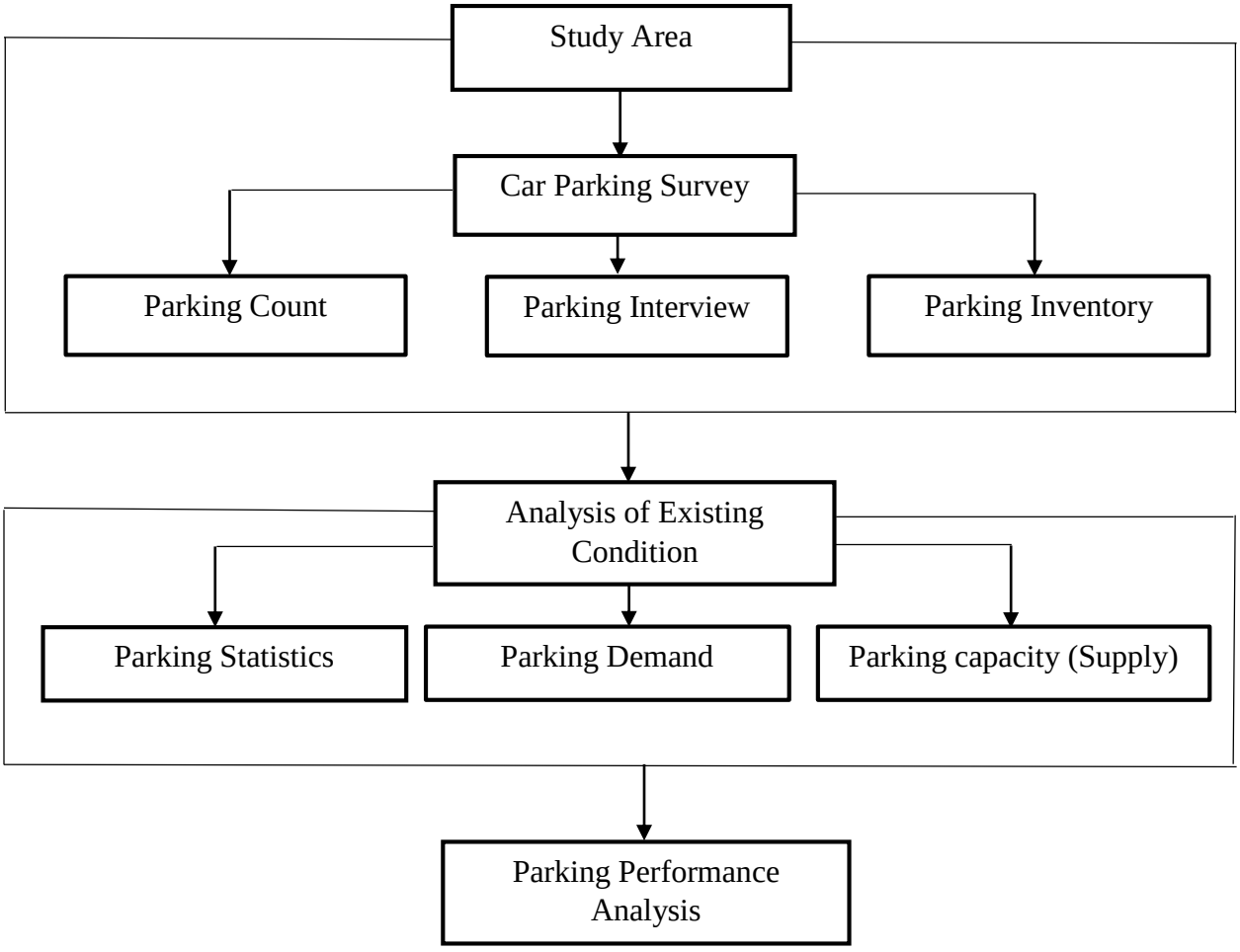

Figure 3. 2 : Schematic diagram of the research

3.6 Data management and analysis

The collected data were analyzed using Ms-excel 2013 quantitatively.

The procedure for estimating parking demand is complex. It involves many factors, including project size, type of zoning, type and number of persons expected to visit the site, availability of alternative transportation modes, and the time frame of the analysis.

Basically two methods of parking demand estimations are mostly used:

1. Based on specific land uses/regression model.

2. Analytical approach.

Because of the land use analysis takes the parking utilization data one step further by relating it to surrounding land uses and national standards to determine the demand and supply analysis, it is more accurate and easy. Therefore on this thesis the first method were applied.

Land use totals by sub-area for each category are then provided in table in appendix B.

For each land use a peak rate were identified. The rates for each land uses were derived from the actual data collected during site investigation and parking survey counts. And the derived peak demand rates were compared with the available national transportation parking industry standards. The most widely used standards in the industry is from the institute of transportation engineers (ITE).

And then parking demand was calculated based on the land use analysis for both cases as follow:

$$\text{Parking demands of each land use} = \text{peak rates} * \text{land use}$$

Inventory of existing parking facilities**: -** data regarding the number, location, size, capacity of the off-street parking facilities were obtained.

Parking volume **=** the total number of vehicles parked at a given duration of time.

Average duration: - is the average time for which the parking lot was used by the vehicles.it can be calculated as sum of the accumulation for each time interval × time interval divided by the parking volume.

Parking capacity = number of bays × number of hours.

Parking load = total number of vehicles accumulated at the end of each time interval*time

Occupancy: - for that time interval is accumulation in that particular interval divided by total number of bays. Average occupancy is found out as the average of total number of vehicles occupying the bay for each time interval it is expressed in percentage.

Accumulation**: -** the number of vehicles parked in the given interval of time in that specific bay it shows the maximum demand is on the time interval of time.

From the result average parking duration it is possible to know about the length of time the vehicles are parked.

From occupancy it is also possible to know about the efficiency of the facilities.

4. RESULTS AND DISCUSSIONS

4.1 Existing parking facilities inventories

Depending upon their greater demand requirement for a parking facilities, 3 central business districts of the capital (i.e. Megenagna, Bole and Merkato) were chosen for detail analysis. From the stated locations; 11, 13 and 11 off-street parking sites are selected for further analysis respectively. In and out survey was conducted from 8 am-6 pm.

4.1.1 Parking data analysis at Bole

At bole site, 13 off-street parking sites are selected based on their demand requirements and nearness to the main road. At this site, in and out survey was undertaken form May 8 to June 19, 2019 during the time interval between 8am-6pm.

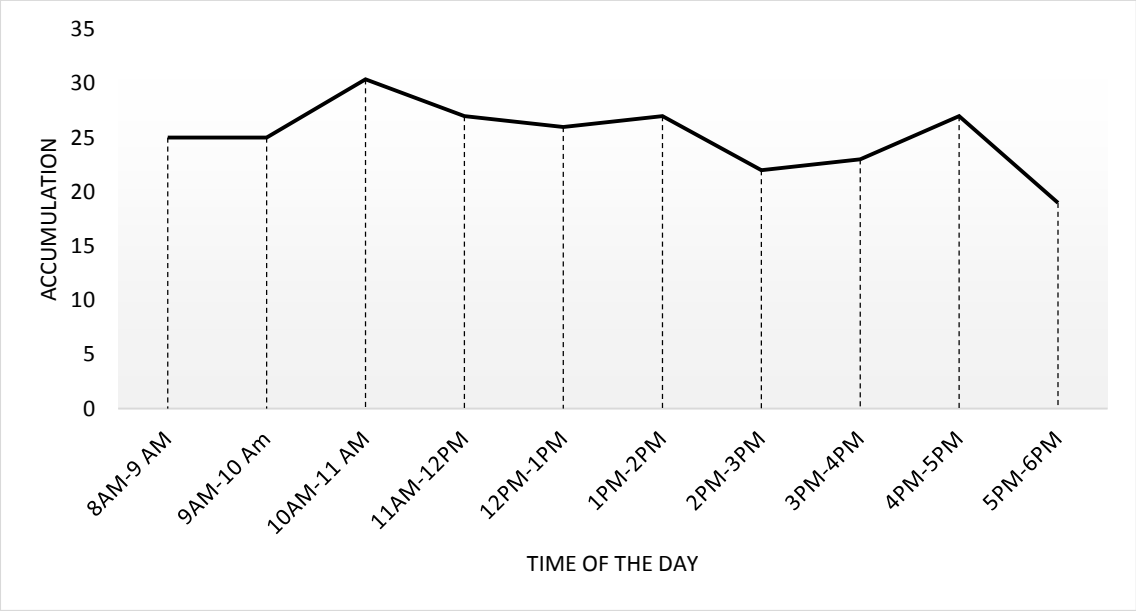

Figure 4. 1**:** Accumulation curve, Mafi mall, May 8, 2019

Figure 4.1 shows the maximum demand is during the time interval between 10:00 am to 11:00 am. This is due coffee break time; most customers park their vehicles within this time interval to get access for café, internet services and shops.

The high vehicle accumulation on the parking lot is identified from 10:00 am to 11:00 am, which is more than the allowable space capacity of the parking lot the 85 percentile which is greater than 85% of the capacity of the given parking stated in table 3.1. The in and out survey detail and

statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 4.1.

Table 4. 1 **:** In and out survey data result, Mafi mall on Wednesday May 8, 2019 from 10:00 am to 11:00 am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	6	7	24	66.67	120
10	4	2	26	72.22	130
15	6	3	29	80.56	145
20	5	7	27	75.00	135
25	10	5	32	88.89	160
30	3	5	30	83.33	150
35	6	4	32	88.89	160
40	11	7	36	100.00	180
45	9	10	35	97.22	175
50	7	8	34	94.44	170
55	9	11	32	88.89	160
60	4	8	28	77.78	140
Total					1825

- Accumulation can be found out as initial count plus number of vehicles that entered the parking lot till that time minus the number of vehicles that just exited for that particular time interval. For the first time interval of 5 minutes, accumulation can be found out as 25+6-7 = 24. It is being tabulated in column 4 of table 4.1.
- Occupancy or parking index is given by equation for the first time interval of five minutes, parking index $= \frac{24}{36} \times 100 = 66.67\%$ .The occupancy for the remaining time slot is similarly calculated and is tabulated in column 5 of table 4.1. Average occupancy is the average of the occupancy values for each time interval. Thus, it is the average of all values given in column 5 and the value is 85%.
- Parking load is tabulated in column 6 table 4.1. It is obtained by multiplying accumulation with the time interval. For the first time interval, parking load = 24 × 5 = 120 vehicle minutes.

- Total parking load is the summation of all the values in column 6 which is equal to 1825 vehicle minutes or 30.41 vehicle hours.

For the remaining sites the details of in and out survey results of the peak hour is attached in appendix A.

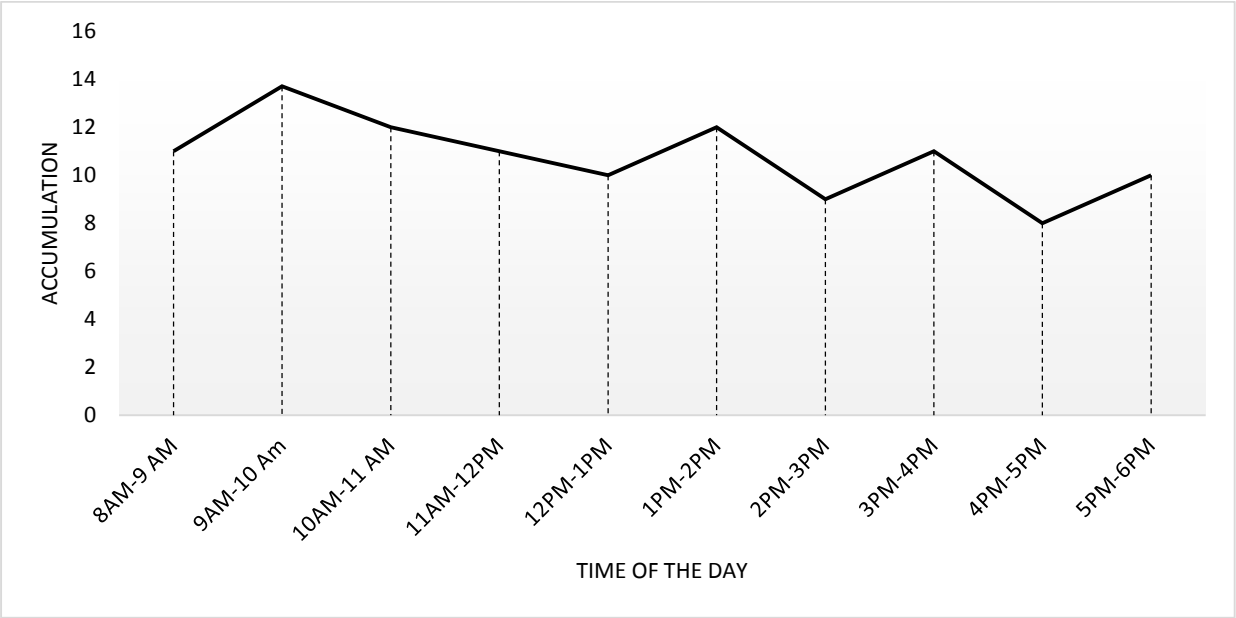

Figure 4. 2 **:** Accumulation curve, New Bright tower, May 9, 2019

Figure 4.2 shows the maximum demand is on the time interval between 9:00 am to 10:00 am. This is due to smaller capacity of the building and most of the shop owners will take up all the spaces available which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 1 of appendix A.

- Form table 1 average occupancy is 85.42% and the total parking load is the summation of all the values in column 6 which is equal to 820 vehicle minutes or 13.7 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

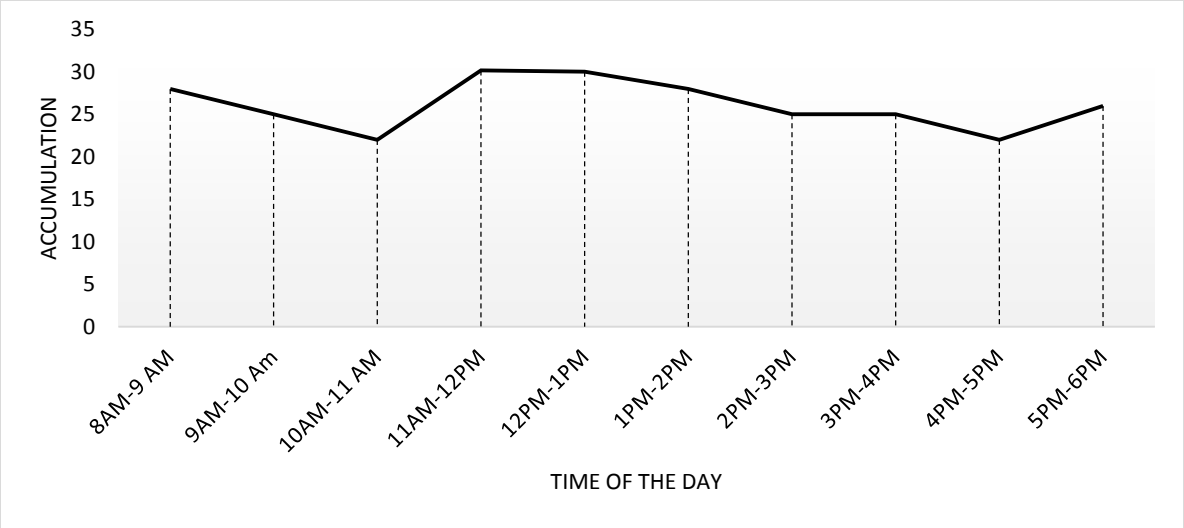

Figure 4. 3 **:** Accumulation curve, Awelo business center, May 15, 2019

Figure 4.3 shows the maximum demand is during the time interval between 11:00 am to 12:00 pm. This is due to there are popular restaurant and café, television station office and other shops though most of the customers will occupy the available space which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 2 of appendix A.

- Form table 2 average occupancy is 86.19% and the total parking load is the summation of all the values in column 6 which is equal to 1810 vehicle minutes or 30.17 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

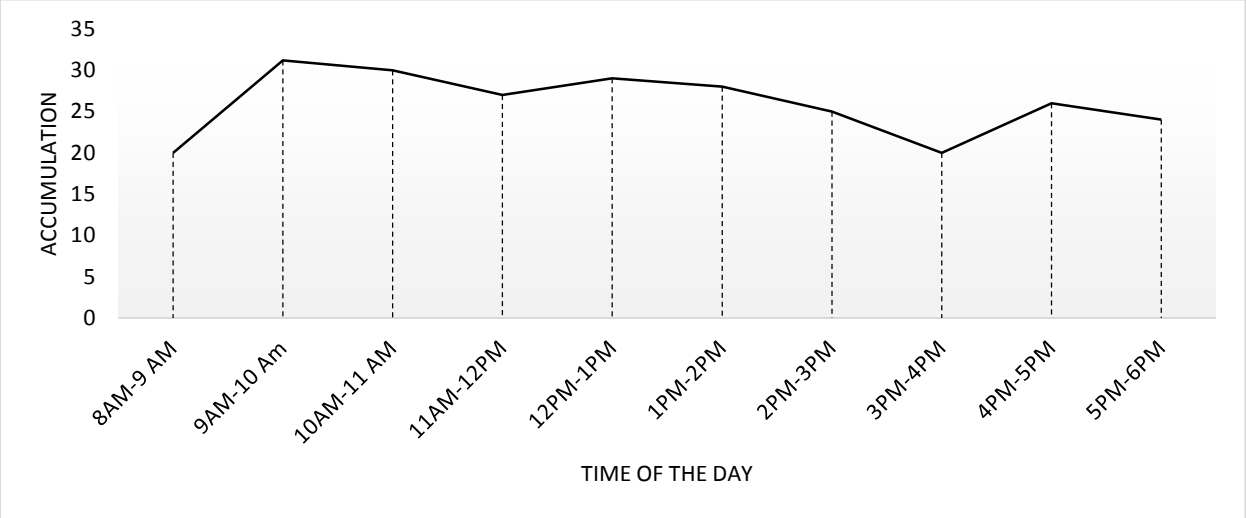

Figure 4. 4**:** Accumulation curve, Brehane Adere mall, May 16, 2019

Figure 4.4 shows the maximum demand is during the time interval between 9:00 am-10:00 am this is because even if there is large parking facility at the back of the mall most of the car owners prefer to park their vehicles in front of the mall and also the mall has less parking capacity because it has no cellar car parking facility. The detail of the parking survey and statistical outputs are presented in table 3 of appendix A.

- Form table 3 average occupancy is 86.57% and the total parking load is the summation of all the values in column 6 which is equal to 1870 vehicle minutes or 31.2 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

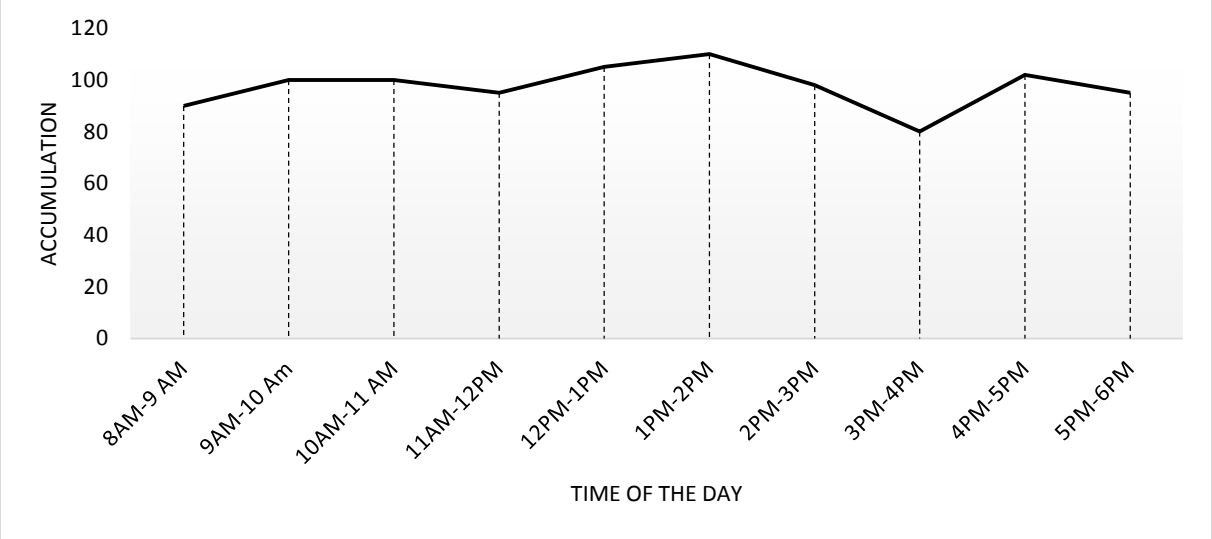

Figure 4. 5 **:** Accumulation curve, Medehanialem mall, May 22, 2019

Figure 4.5 shows the maximum demand during the time interval between 1:00 pm to 2:00 pm. This is due to lunch time and also there are different shops, recreation (i.e., 7D etc.) and popular cafes inside the mall and most of the customers will occupy the available space which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 4 of appendix A.

- Form table 4 average occupancy is 91.6% and the total parking load is the summation of all the values in column 6 which is equal to 6595 vehicle minutes or 109.92 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

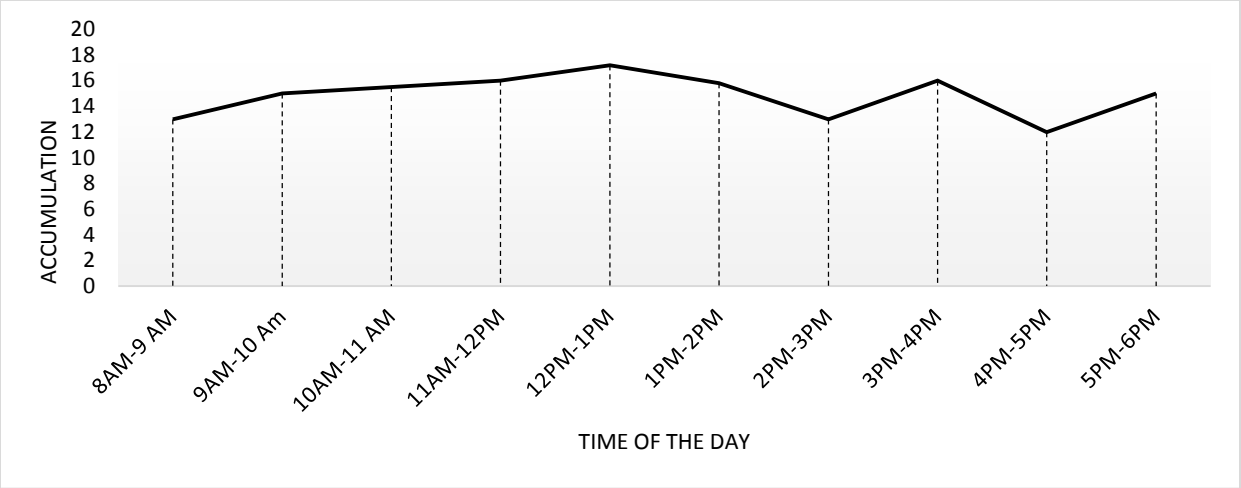

Figure 4. 6**:** Accumulation curve, Sheger House building, May 23, 2019

Figure 4.6 shows the maximum demand is during the time interval between 12:00 pm to 1:00 pm. This is due to most of the users of the parking are shop owners and they park their vehicles for a longer time which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 5 of appendix A.

- Form table 5 average occupancy is 87.08% and the Total parking load is the summation of all the values in column 6 which is equal to 1045 vehicle minutes or 17.42 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

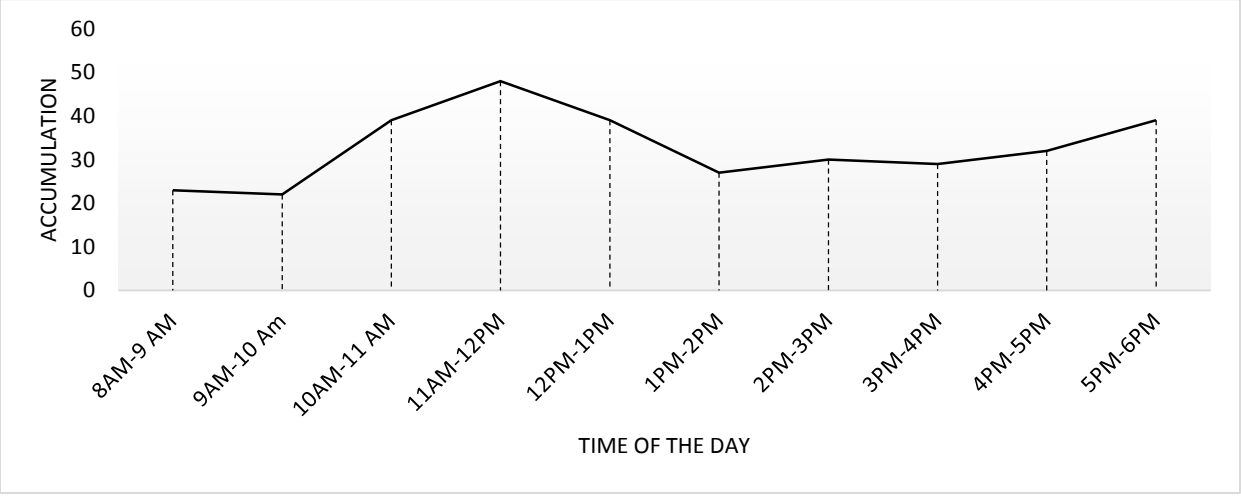

Figure 4. 7**:** Accumulation curve, Golden parking, May 29, 2019

Figure 4.7 shows the maximum demand during the time interval between 11:00 am to 12:00 pm. this is due to this time is lunch time though most of the customers will occupy the available space

which is much less than the allowable space capacity of the parking lot or the 85 percentile it is because of this parking facility is temporarily given to the youths by the city administration there is lack of awareness of the location, safety etc. of the facility by car owners. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 6 of appendix A.

- Form table 6 average occupancy is 48.08% and the total parking load is the summation of all the values in column 6 which is equal to 2885 vehicle minutes or 48.08 vehicle hours which shows the parking space coverage of the area is considered to be ideal, since the parking space is used effectively.

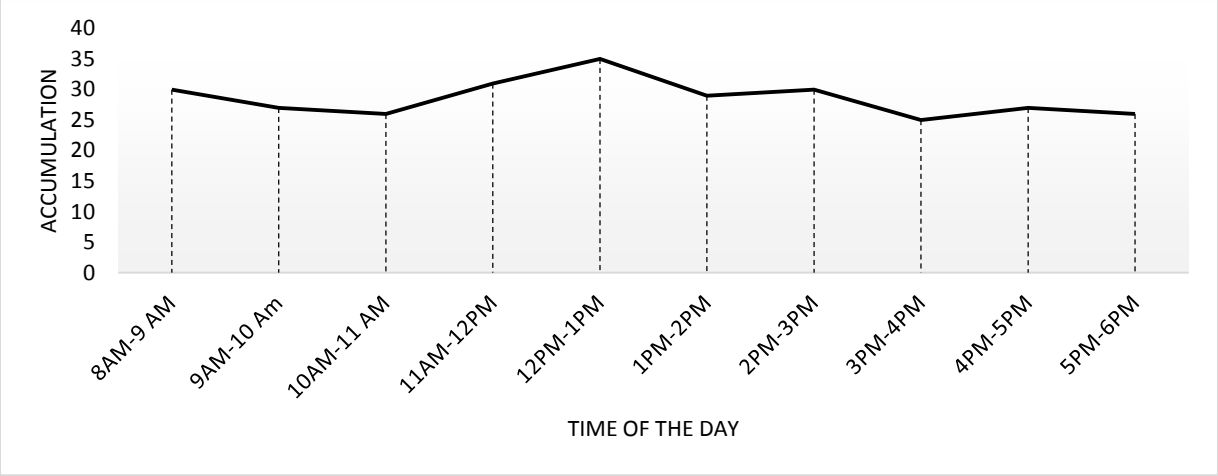

Figure 4. 8**:** Accumulation curve, Ephrem, Dagmawi and his friends parking, May 30, 2019

Figure 4.8 shows the maximum demand is during the time interval between 12:00 pm to 1:00 pm. this is due to lunch time though most of the customers will occupy the available space which is less than the allowable space capacity of the parking lot or the 85 percentile it's because of the facility is temporarily given for the youths by the city administration and also because of the lack of awareness of the car owners about safety, location and farness of the facility to the destination of the users. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 7 of appendix A.

- Form table 7 average occupancy is 64.17% and the total parking load is the summation of all the values in column 6 which is equal to 1925 vehicle minutes or 32.08 vehicle hours which shows the parking space coverage of the area is considered to be ideal.

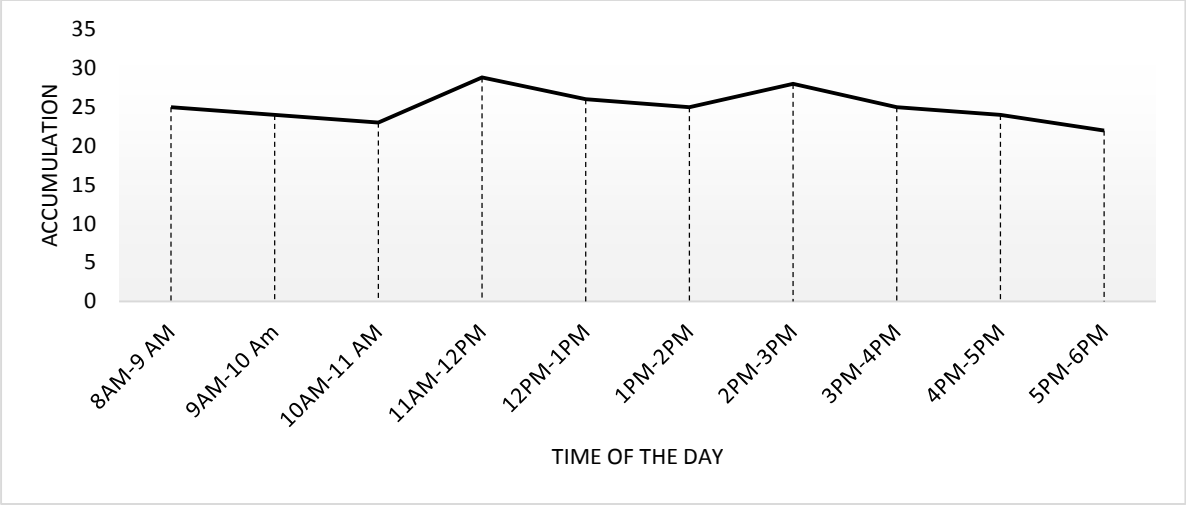

Figure 4. 9**:** Accumulation curve, Morning Star mall, June 5, 2019

Figure 4.9 shows the maximum demand is during the time interval between 11:00 am to 12:00 pm. This is due to a lot of hotels are available nearby though most of the customers will occupy the available space which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 8 of appendix A.

- Form table 8 average occupancy is 96.11% and the total parking load is the summation of all the values in column 6 which is equal to 1730 vehicle minutes or 28.83 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

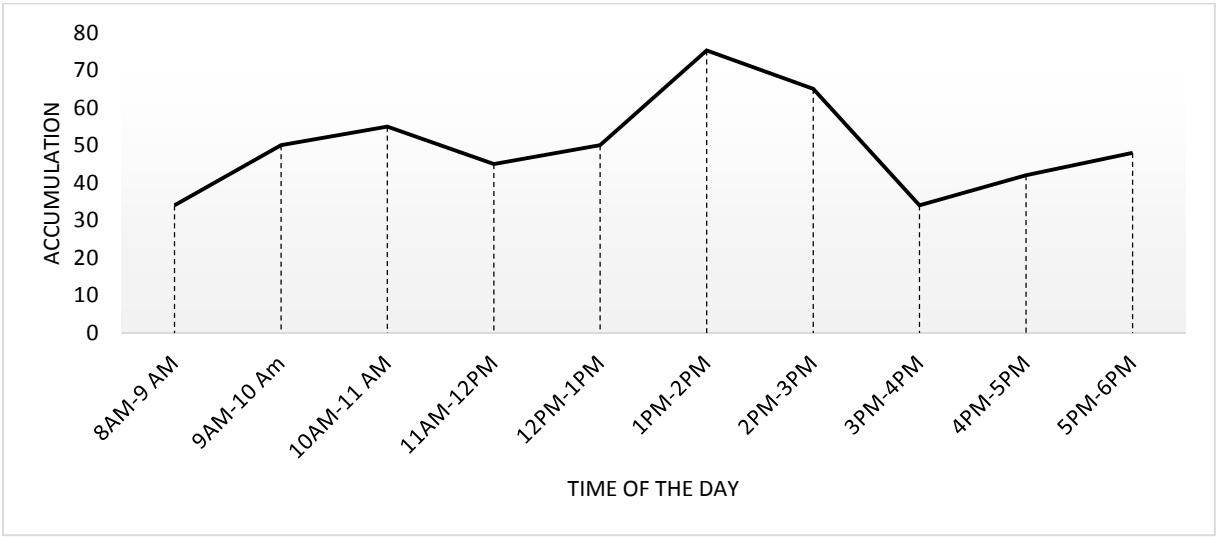

Figure 4. 10**:** Accumulation curve, parking at the back of Mamas kitchen, June 6, 2019

Figure 4.10 shows the maximum demand is during the time interval between 1:00 pm to 2:00 pm. This is due to there are a lot of shops, malls, restaurants, hotels and multi-purpose buildings in the nearby areas which is less than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented table 9 of appendix A.

- Form table 9 average occupancy is 83.61% and the total parking load is the summation of all the values in column 6 which is equal to 4515 vehicle minutes or 75.25 vehicle hours which shows the parking space coverage of the area is considered to be ideal, since the parking space is used effectively.

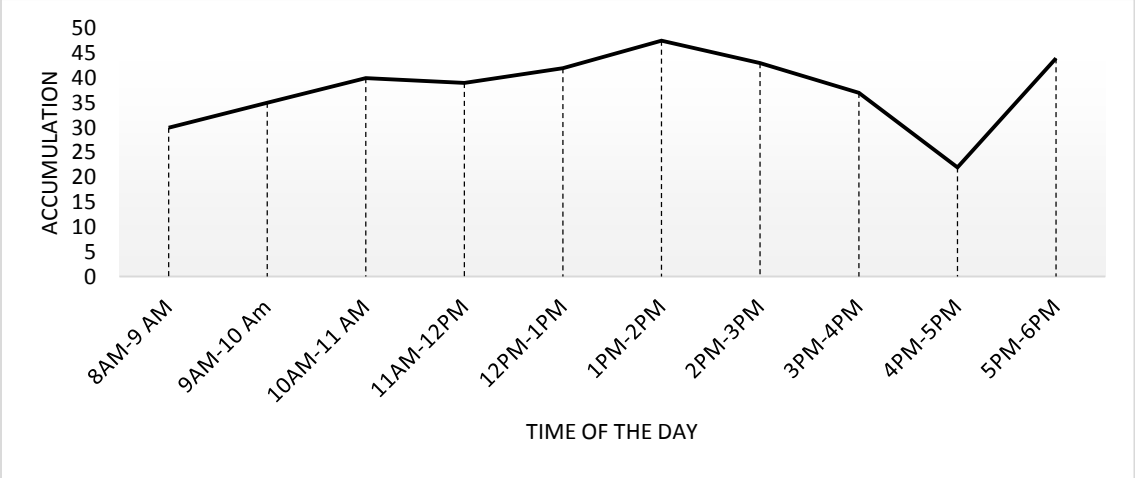

Figure 4. 11**:** Accumulation curve, Edna mall, June 12, 2019

Figure 4.11 shows the maximum demand is during the time interval between 1:00 pm to 2:00 pm. The result revealed that in this mall there is different things for recreation (i.e., 7D, play stations, pool house etc.) there is also popular restaurant though there is much demand in the mall therefore most of the customers will occupy the available space which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 10 of appendix A.

- Form table 10 average occupancy is 91.35% and the total parking load is the summation of all the values in column 6 which is equal to 2850 vehicle minutes or 47.5 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

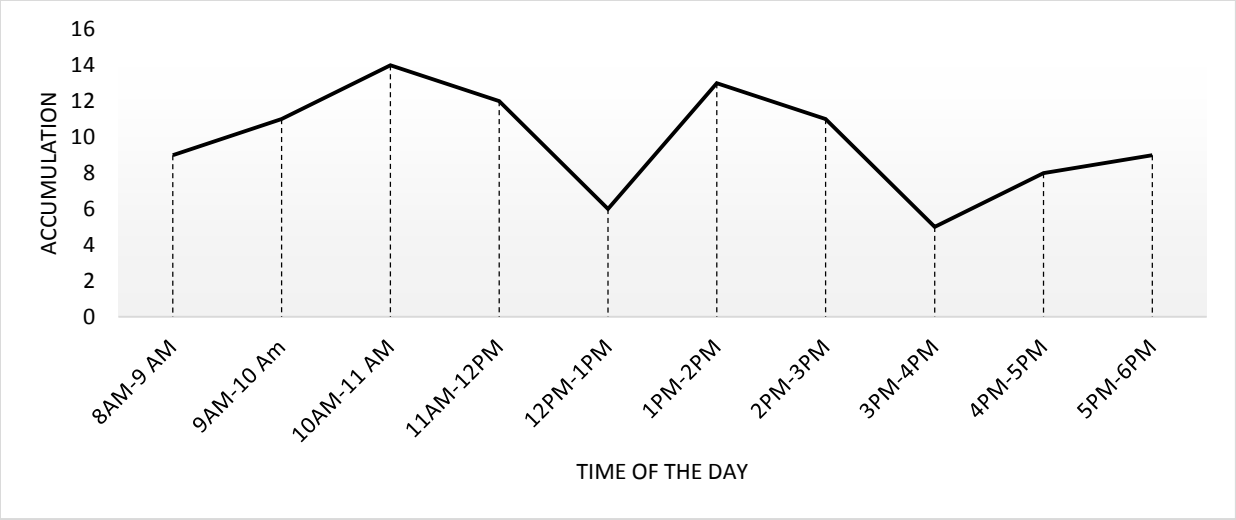

Figure 4. 12**:** Accumulation curve, Hibret Bank building, June 13, 2019

Figure 4.12 shows the maximum demand is during the time interval between 10:00 am to 11:00am. The reason behind is less capacity of the facility most of the space will be occupied early which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented table 11 of appendix A.

- Form table 11 average occupancy is 93.33% and the total parking load is the summation of all the values in column 6 which is equal to 840 vehicle minutes or 14 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

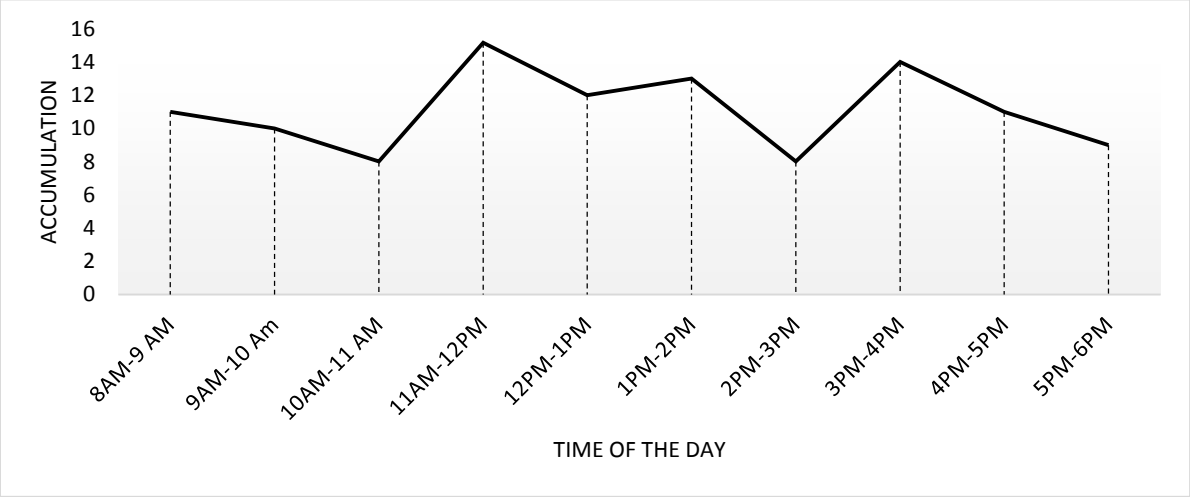

Figure 4. 13**:** Accumulation curve, Oasis building, June 19, 2019

Figure 4.13 shows the maximum demand is during the time interval between 11:00am to 12:00pm. It is because there is only small number of parking availability and it is occupied by the shop owners which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 12 of appendix A.

- Form table 12 average occupancy is 94.79% and the total parking load is the summation of all the values in column 6 which is equal to 910 vehicle minutes or 15.17 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

4.1.2 Parking data analysis at Megenaga

At Megenagna site all of off-street parking's are taken into consideration in and out survey is undertaken form June 20 to July 25 2019 in the time interval between 8am-6pm.

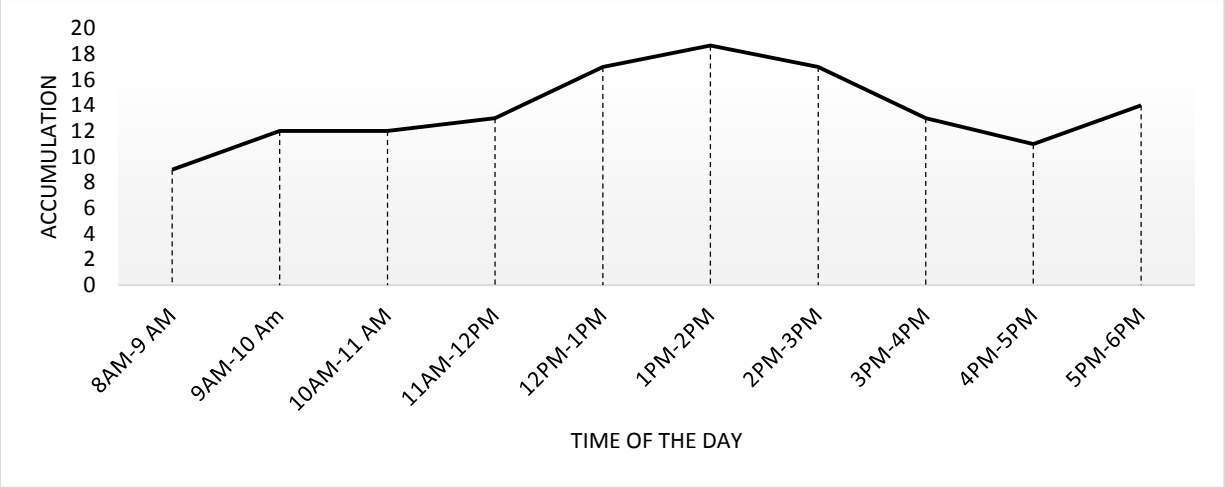

Figure 4. 14**:** Accumulation curve, Timugas tower, June 20, 2019

Figure 4.14 shows the maximum demand is during the time interval between 1:00 pm to 2:00 pm. The reason behind is the building right next to it/Beta engineering building didn't have car parking area and there are also different services in the building therefore the site is operating more than its capacity which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 13 of appendix A.

- Form table 13 average occupancy is 85.85% and the total parking load is the summation of all the values in column 6 which is equal to 1120 vehicle minutes or 18.67 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

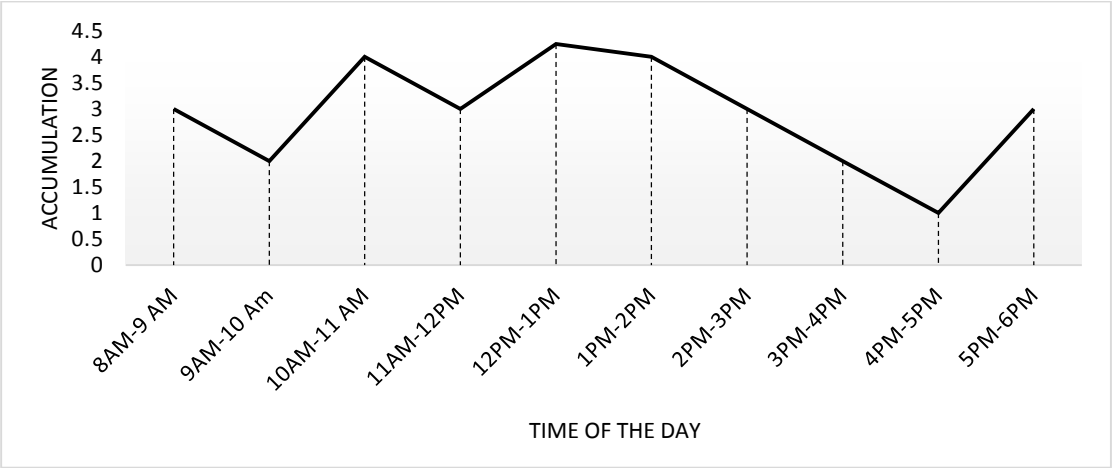

Figure 4. 15**:** Accumulation curve, Mehal hotel, June 26, 2019

Figure 4.15 shows the maximum demand is during the time interval between 12:00 pm to 1:00 pm the result reveals customers to use the bar will be available in this time which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 14 of appendix A.

- Form table 14 average occupancy is 85% and the total parking load is the summation of all the values in column 6 which is equal to 255 vehicle minutes or 4.25 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

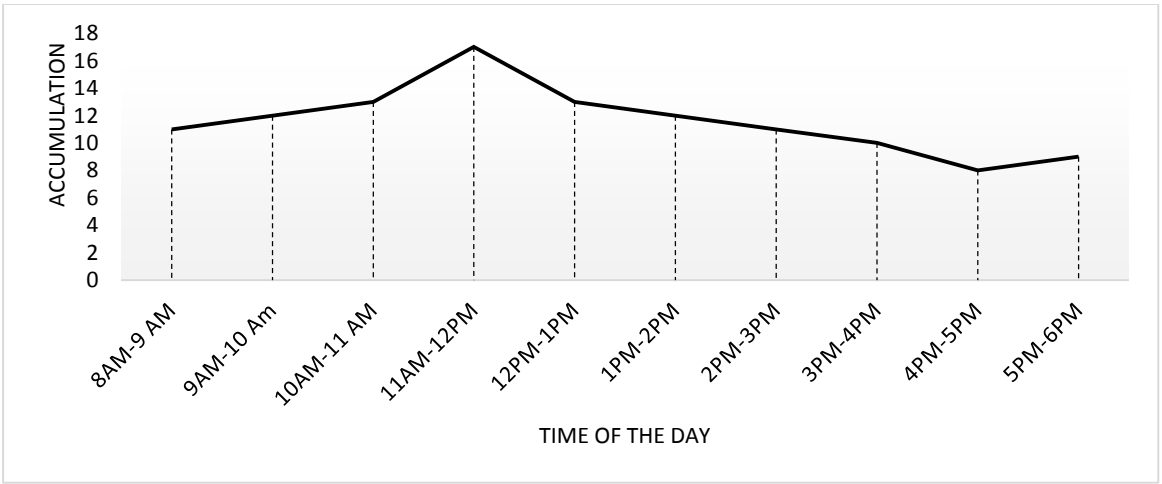

Figure 4. 16**:** Accumulation curve, Sileshi Sihen business center, June 27, 2019

Figure 4.16 shows the maximum demand is during the time interval between 11:00 am to 12:00 pm It is because most of the shop owners will came to their work at this time and from 2:00 am-3:00 am and the remaining place will be occupied by the customers which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 15 of appendix A.

- Form table 15 average occupancy is 85% and the total parking load is the summation of all the values in column 6 which is equal to 1015 vehicle minutes or 17 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

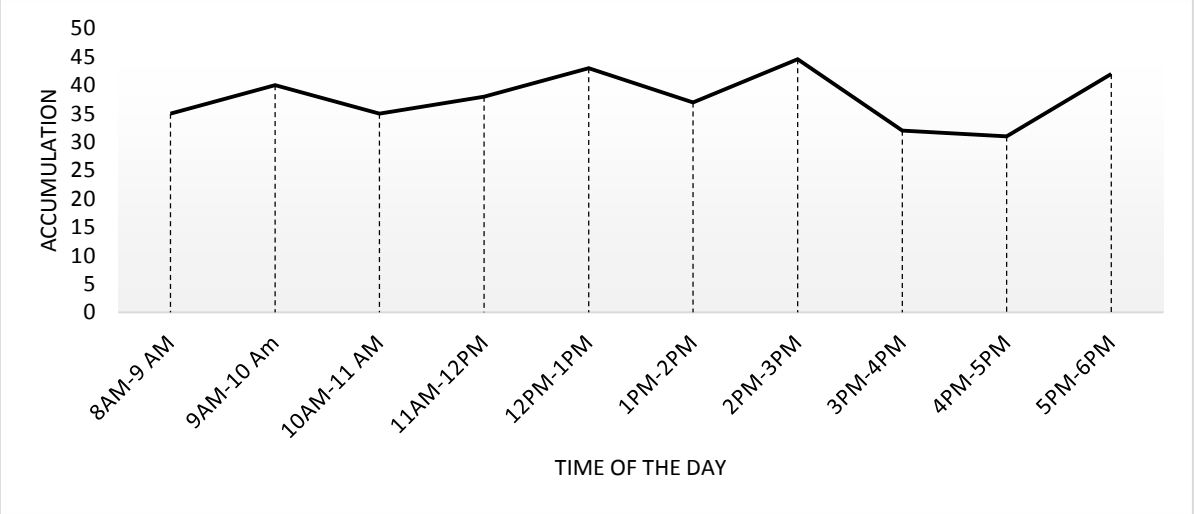

Figure 4. 17**:** Accumulation curve, Derartu Tulu building, July 3, 2019

Figure 4.17 shows the maximum demand is on the time interval between 2:00 pm to 3:00 pm. It is because there is restaurant in the building so the spaces will be occupied for lunch and also there are bank, shops, Game zone and offices in the building so shop owners and customers will occupies the space which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 16 of appendix A.

- Form table 16 average occupancy is 86.43% and the total parking load is the summation of all the values in column 6 which is equal to 2675 vehicle minutes or 44.58 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

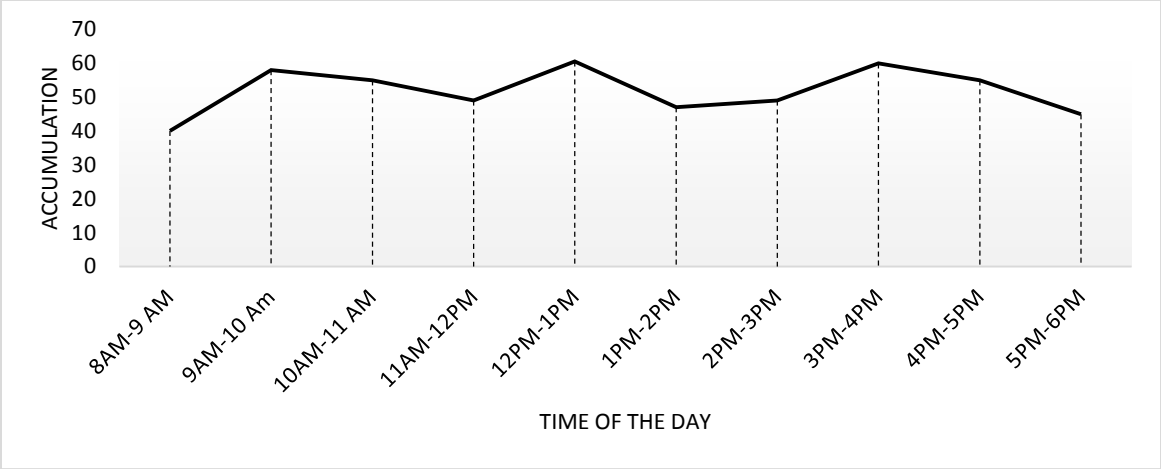

Figure 4. 18**:** Accumulation curve, Mulugeta Zeleke building, July 4, 2019

Figure 4.18 shows the maximum demand is during the time interval between 12:00 pm to 1:00 pm. The reason behind is there are different shops, pharmacy, offices in the building and there is no other off-street parking in the area which makes the demand high which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 17 of appendix A.

- Form table 17 average occupancy is 86.43% and the total parking load is the summation of all the values in column 6 which is equal to 3630 vehicle minutes or 60.5 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

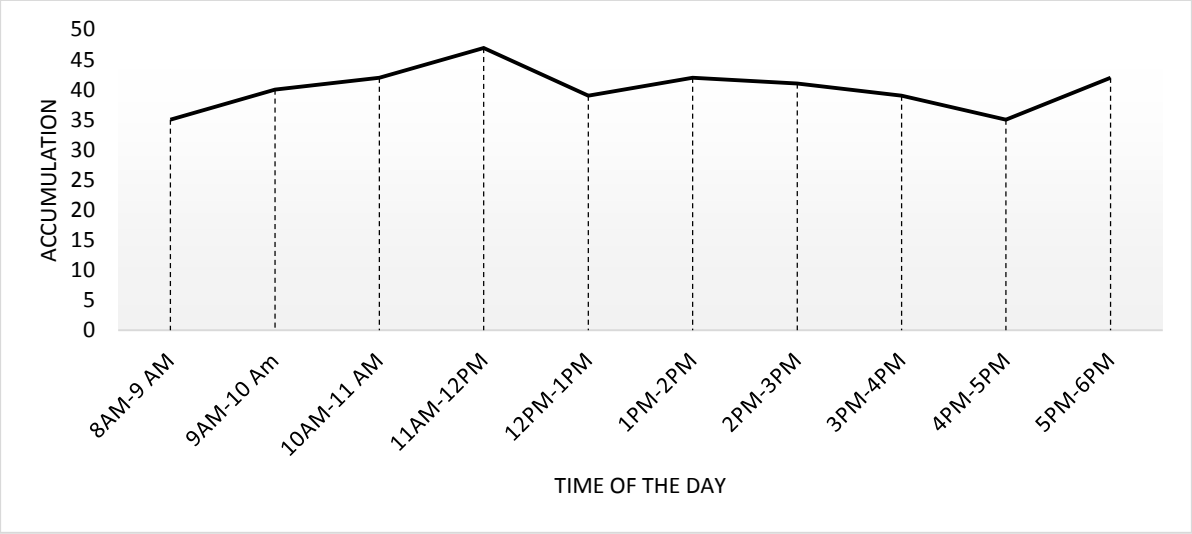

Figure 4. 19**:** Accumulation curve, Maraton Motor building, July 10, 2019

Figure 4.19 shows the maximum demand is during the time interval between 11:00 am to 12:00pm. The result reveals that there are restaurant, shops, offices and marathon motor garage in the building there is high demand which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented table 18 of appendix A.

- Form table 18 average occupancy is 85.26% and the total parking load is the summation of all the values in column 6 which is equal to 3325 vehicle minutes or 55.4 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

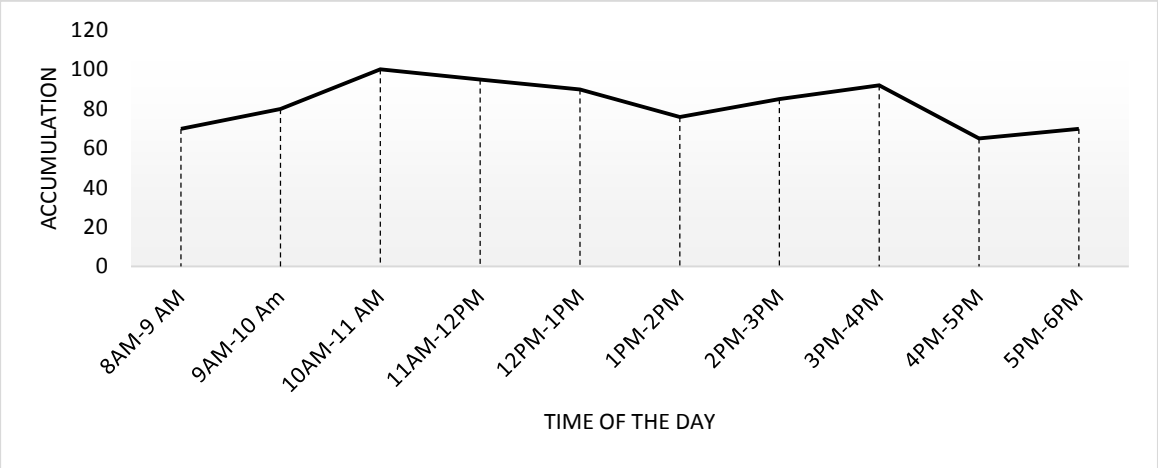

Figure 4. 20: Accumulation curve, Zefmush building, July 11, 2019

Figure 4.20 shows the maximum demand is during the time interval between 10:00 am to 11:00am. It is because of there is big supermarket, different shops restaurant in the building the demand is high at this time but it's much less than the allowable space capacity of the parking lot or the 85 percentile. Unlike other buildings there is less illegal on-street parking in front of this building which decreases traffic jam in the nearby intersection. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 19 of appendix A.

- Form table 19 average occupancy is 66.78% and the total parking load is the summation of all the values in column 6 which is equal to 6010 vehicle minutes or 100.17 vehicle hours which shows the parking space coverage of the area is considered to be ideal, since the parking space is used effectively.

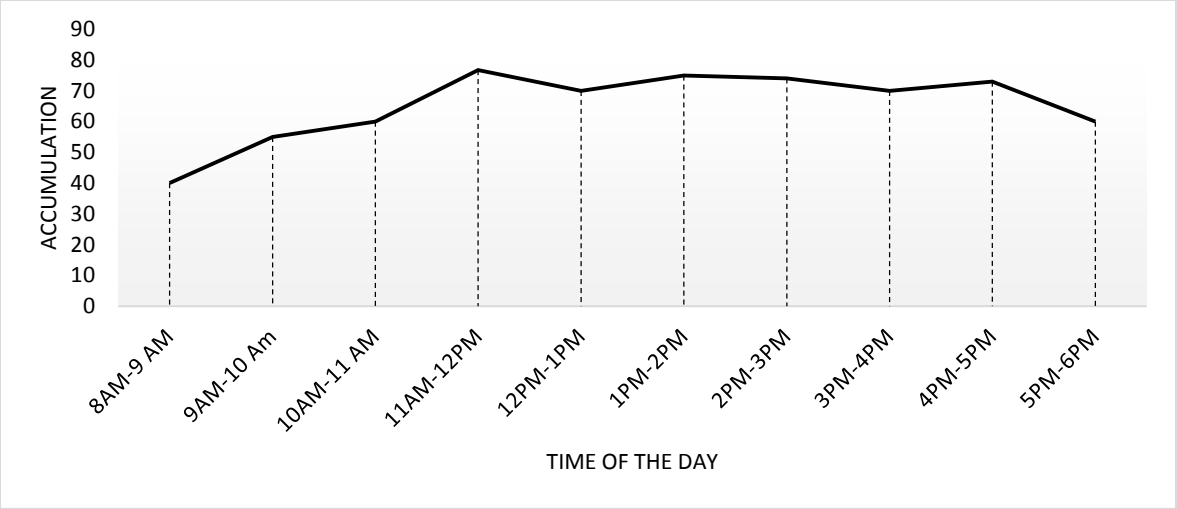

Figure 4. 21: Accumulation curve, Metebaber building, July 17, 2019

Figure 4.21 shows the maximum demand is during the time interval between 11:00 am to 12:00pm. This is due to most of the users of the parking are shop owners and also there is restaurant different mobile sales and maintenance shops, offices, internet cafes the demand is high in this building which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 20 of appendix A.

- Form table 20 average occupancy is 90.29% and the total parking load is the summation of all the values in column 6 which is equal to 4605 vehicle minutes or 76.75 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

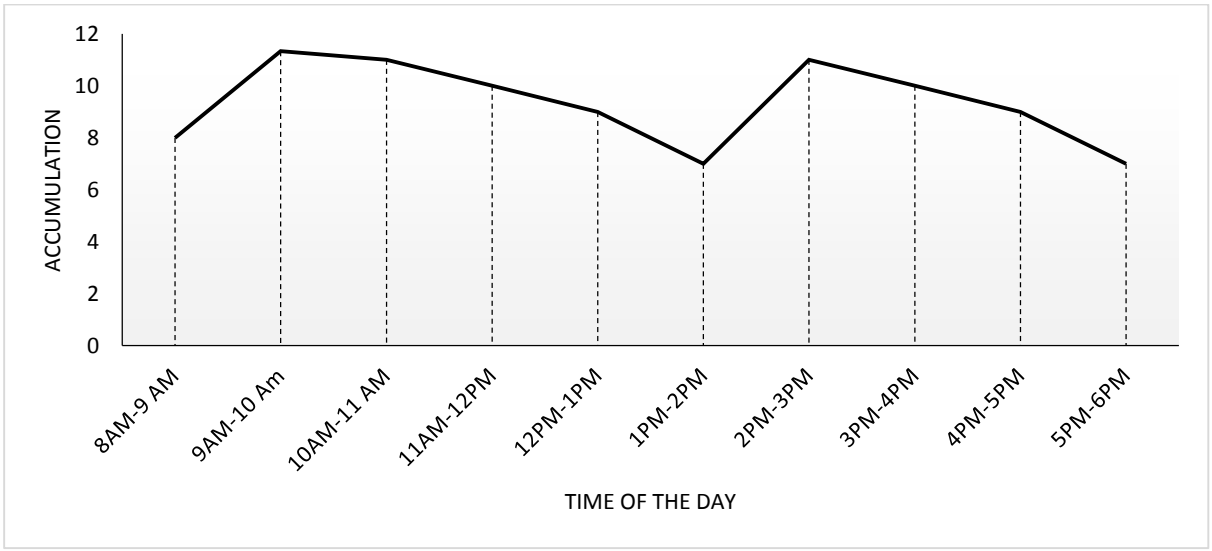

Figure 4. 22: Accumulation curve, Renaissance building, July 18, 2019

Figure 4.22 shows the maximum demand is during the time interval between 9:00 am to 10:00 am. The reason behind is the given parking is only allowed to the bank only and at this time most of the bank vehicles will be there which is much less than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 21 of appendix A.

- Form table 21 average occupancy is 20.61% and the total parking load is the summation of all the values in column 6 which is equal to 680 vehicle minutes or 11.33 vehicle hours which shows the parking space coverage of the area is considered to be ideal, since the parking space is used effectively.

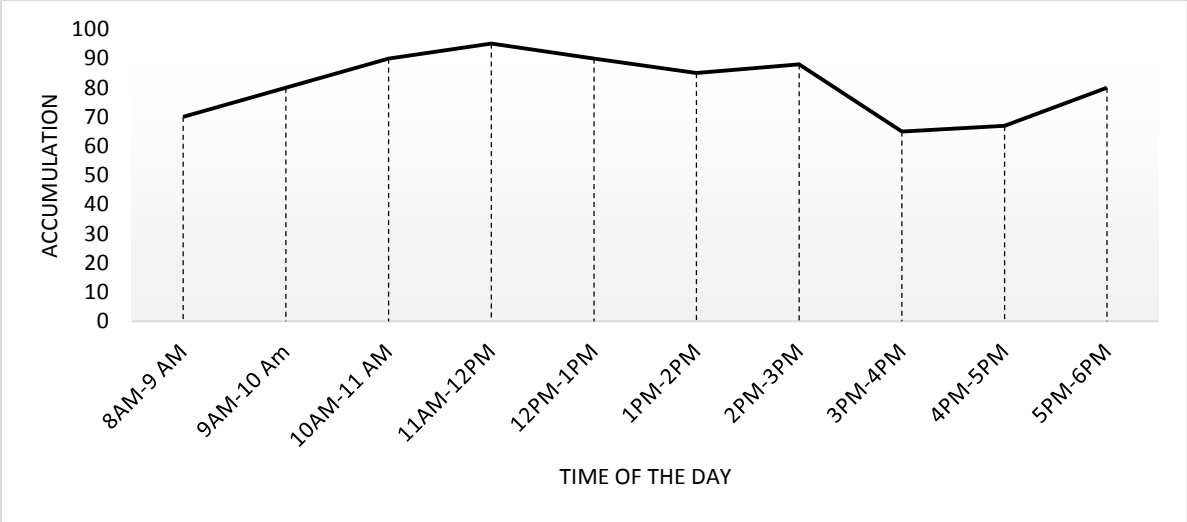

Figure 4. 23: Accumulation curve, Smart parking, July 24, 2019

Figure 4.23 shows the maximum demand is during the time interval between 11:00 am to 12:00pm. This is because there is different building nearby this parking site which didn't have parking (i.e., Beta engineering building, building in front of smart parking, Bethlehem plaza) and due to the better safety of this parking site its preferred by most of car owners but as identified by observation the stay time for most of the users of the parking is not much because of this the accumulation is less than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 22 of appendix A.

- Form table 22 average occupancy is 79.31% and the total parking load is the summation of all the values in column 6 which is equal to 5710 vehicle minutes or 95.17 vehicle hours which shows the parking space coverage of the area is considered to be ideal, since the parking space is used effectively.

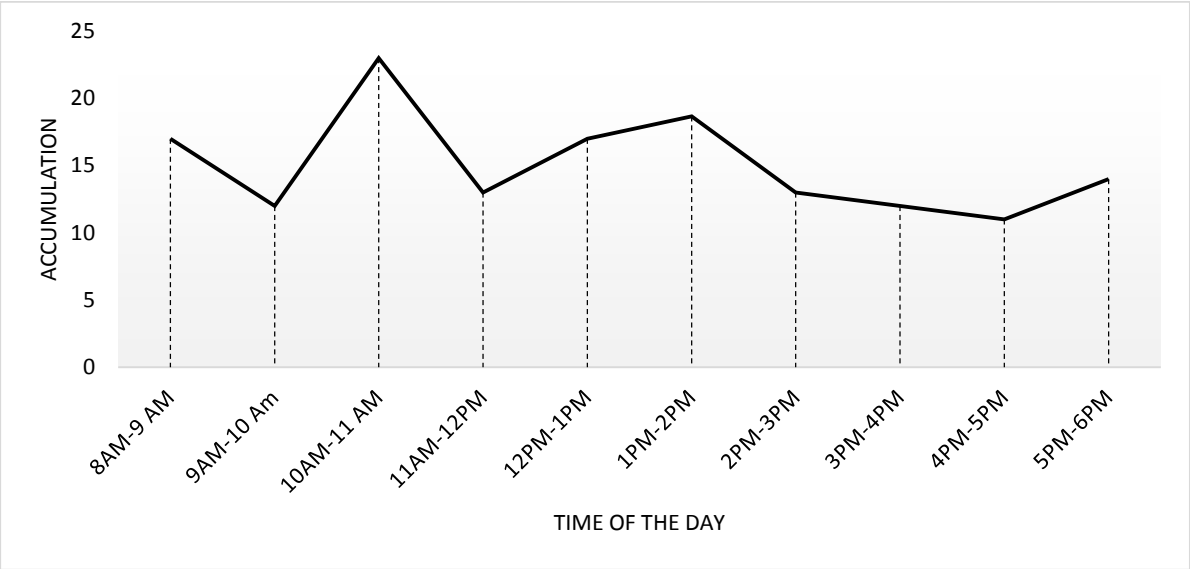

Figure 4. 24: Accumulation curve, Genet commercial center, July 25, 2019

Figure 4.24 shows the maximum demand is during the time interval between 10:00 am to 11:00am. The reason is due to small capacity of the parking and most of the users of the parking are the shop owners though at the early time all the spaces will be occupied which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented table 23 of appendix A.

- Form table 23 average occupancy is 92% and the Total parking load is the summation of all the values in column 6 which is equal to 1380 vehicle minutes or 23 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

4.1.3 Parking data analysis at Merkato

In this site 11 off-street parking areas are taken and in and out survey is made from July 31 to September 4 in the time interval between 8am-6pm.

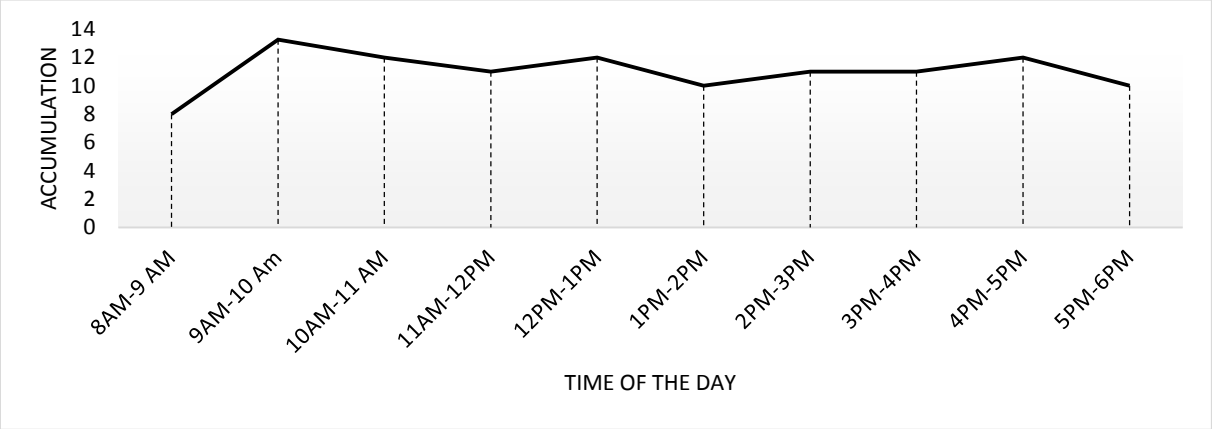

Figure 4. 25: Accumulation curve, Building in front of CBE building, July 31, 2019

Figure 4.25 shows the maximum demand is during the time interval between 9:00 am to 10:00am.The reason is due to small capacity of the parking and most of the users are the shop owners which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 24 of appendix A.

- Form table 24 average occupancy is 88.33% and the total parking load is the summation of all the values in column 6 which is equal to 795 vehicle minutes or 13.25 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

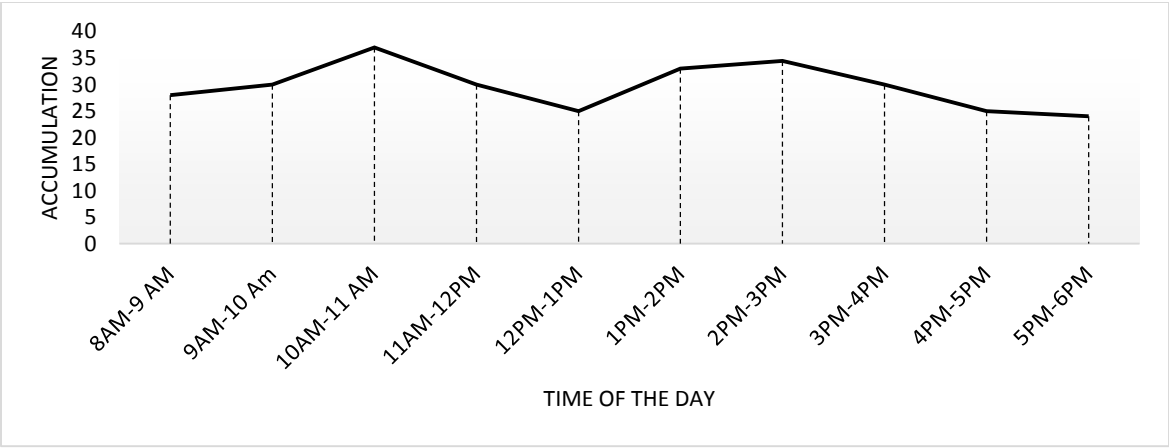

Figure 4. 26: Accumulation curve, CBE building, August 1, 2019

Figure 4.26 shows the maximum demand is during the time interval between 10:00am to 11:00am. The reason behind is most of the uses of the bank prefer this time because it's their free time at their work place which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 25 of appendix A.

- Form table 25 average occupancy is 86.04% and the total parking load is the summation of all the values in column 6 which is equal to 2065 vehicle minutes or 34.42 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

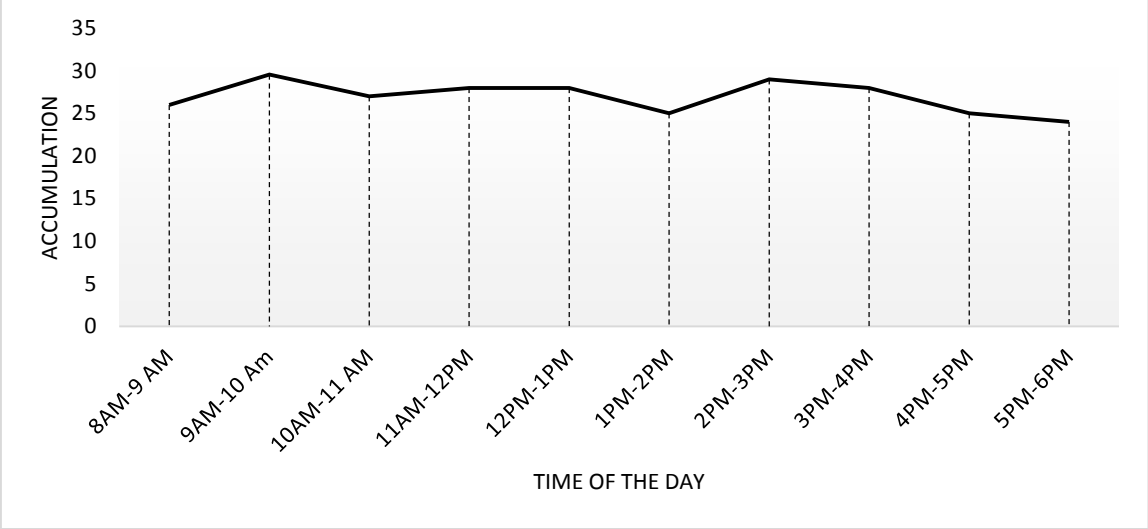

Figure 4. 27: Accumulation curve, Mares commercial center, August 7, 2019

Figure 4.27 shows the maximum demand is during the time interval between 9:00am to 10:00am the reason is because most of the users are shop owners which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 26 of appendix A.

- Form table 26 average occupancy is 92.45% and the total parking load is the summation of all the values in column 6 which is equal to 1775 vehicle minutes or 29.58 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

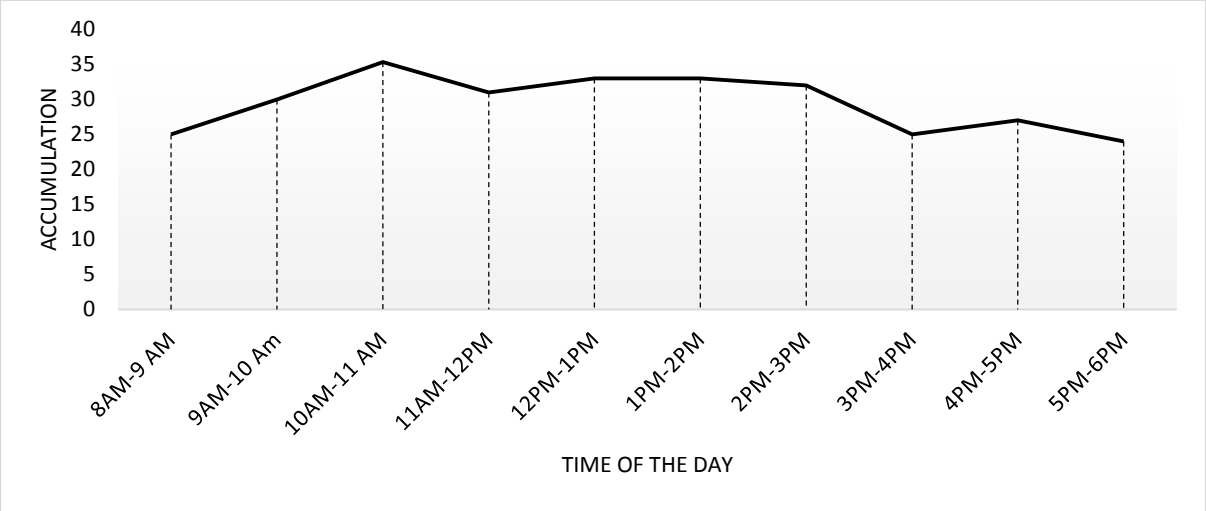

Figure 4. 28: Accumulation curve, Building right next to Addis Ababa Shopping center, August 8, 2019

Figure 4.28 shows the maximum demand is during the time interval between 10:00am to 11:00am the reason behind is most of the users of the parking are shop owners and they will occupy all the spaces available at this time which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented table 27 of appendix A.

- Form table 27 average occupancy is 88.33% and the total parking load is the summation of all the values in column 6 which is equal to 2120 vehicle minutes or 35.33 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

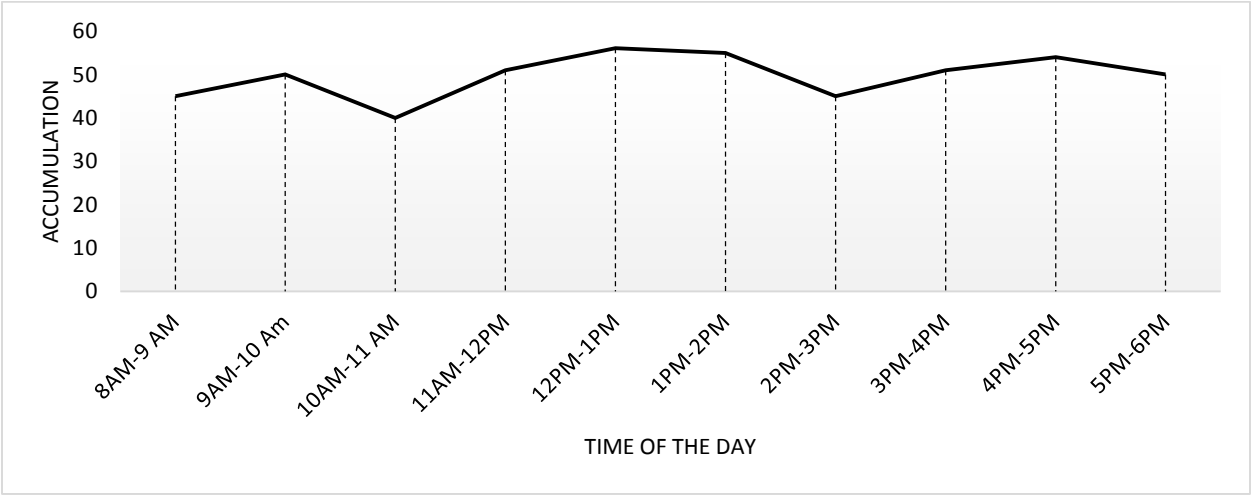

Figure 4. 29: Accumulation curve, Addis Ababa shopping center, August 14, 2019

Figure 4.29 shows the maximum demand is during the time interval between 12:00pm to 1:00pm.the reason is due to most of the users are shop owners which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented table 28 of appendix A.

- Form table 28 average occupancy is 93.47% and the total parking load is the summation of all the values in column 6 which is equal to 3365 vehicle minutes or 56.08 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

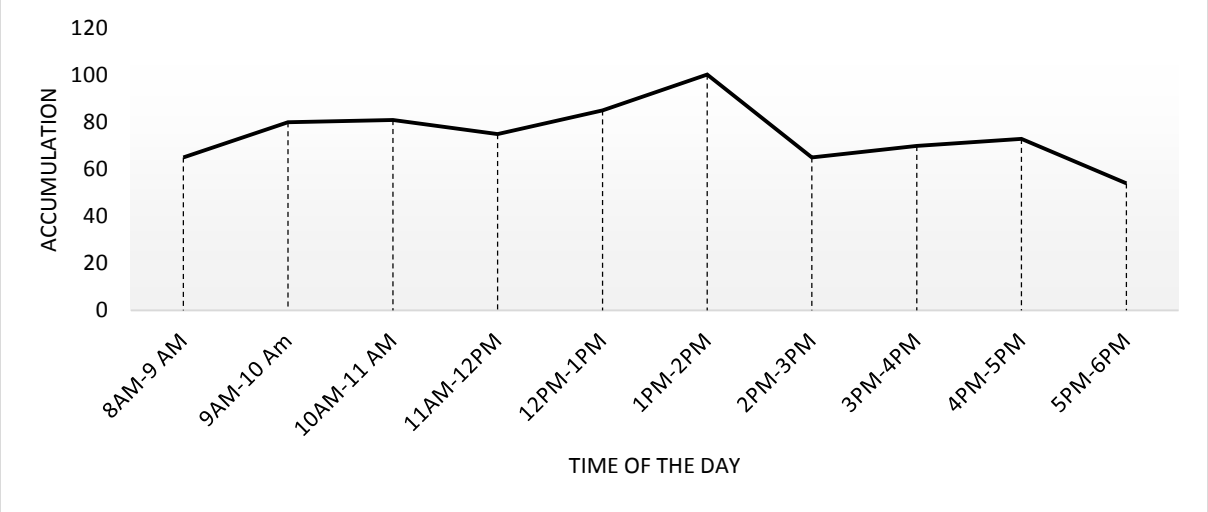

Figure 4. 30: Accumulation curve, Amanuel parking at Dubai tera, August 15, 2019

Figure 4.30 shows the maximum demand is during the time interval between 1:00pm to 2:00pm. the reason is most of the shop owners are free from their work at this time for lunch and it is less than 85 percentile of the capacity of the parking. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 29 of appendix A.

- Form table 29 average occupancy is 83.54% and the total parking load is the summation of all the values in column 6 which is equal to 6015 vehicle minutes or 100.25 vehicle hours which shows the parking space coverage of the area is considered to be ideal, since the parking space is used effectively.

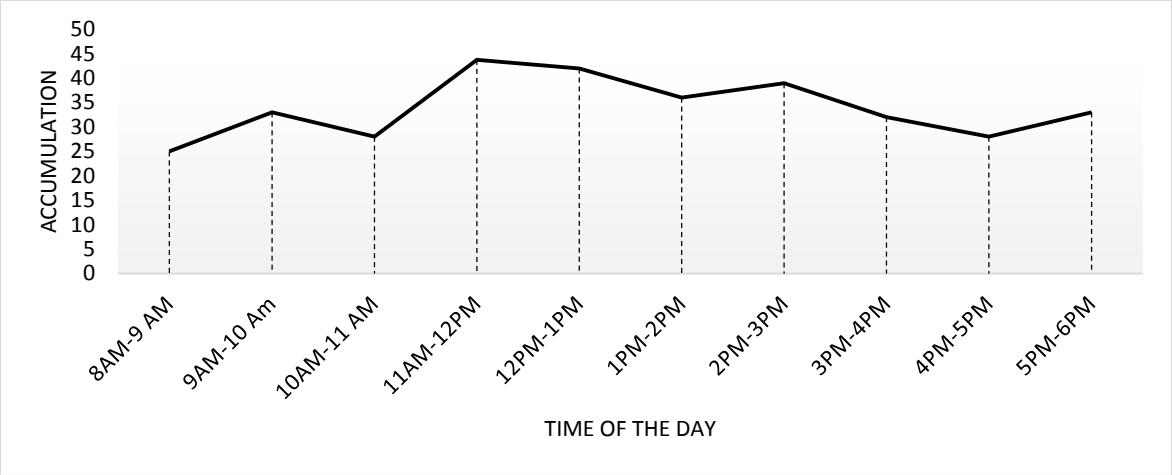

Figure 4. 31: Accumulation curve, Building right next to Yedeget mesealal commercial center, August 21, 2019

Figure 4.31 shows the maximum demand is during the time interval between 11:00am to 12:00pm.This is due to it's a lunch time and most of vehicle owners are free at this time which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 30 of appendix A.

- Form table 30 average occupancy is 87.5% and the total parking load is the summation of all the values in column 6 which is equal to 2625 vehicle minutes or 43.75 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

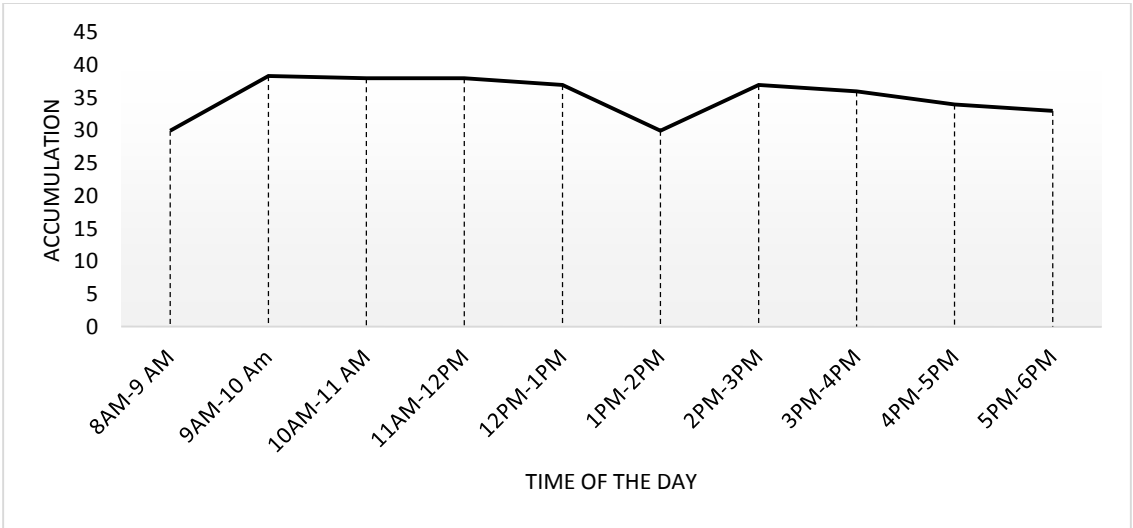

Figure 4. 32: Accumulation curve, Yedeget Meselal commercial center at Dubai tera, August 22, 2019

Figure 4.32 shows the maximum demand is during the time interval between 9:00am to 10:00am.The reason is due to small capacity of the parking and most of the users are the shop owners which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 31 of appendix A.

- Form table 31 average occupancy is 85.19% and the total parking load is the summation of all the values in column 6 which is equal to 2300 vehicle minutes or 38.33 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

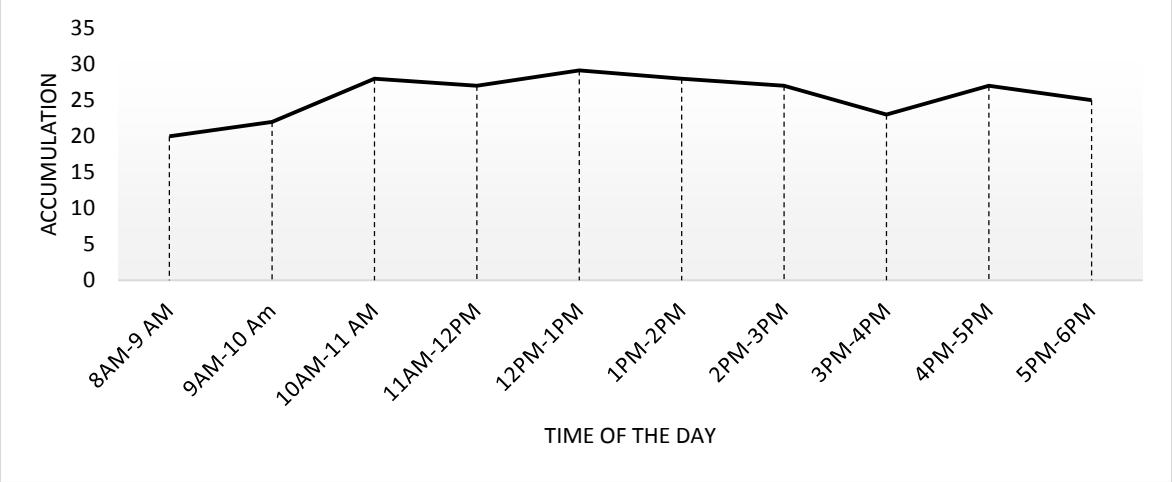

Figure 4. 33: Accumulation curve, Jakal Parking August 28, 2019

Figure 4.33 shows the maximum demand is during the time interval between 12:00pm to 1:00pm the reason behind is most of the spaces will be occupied by shop owners and it is not allowed to park in this building without shop owners which is less than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 32 of appendix A.

- Form table 32 average occupancy is 83.33% and the total parking load is the summation of all the values in column 6 which is equal to 1750 vehicle minutes or 29.17 vehicle hours which shows the parking space coverage of the area is considered to be ideal, since the parking space is used effectively.

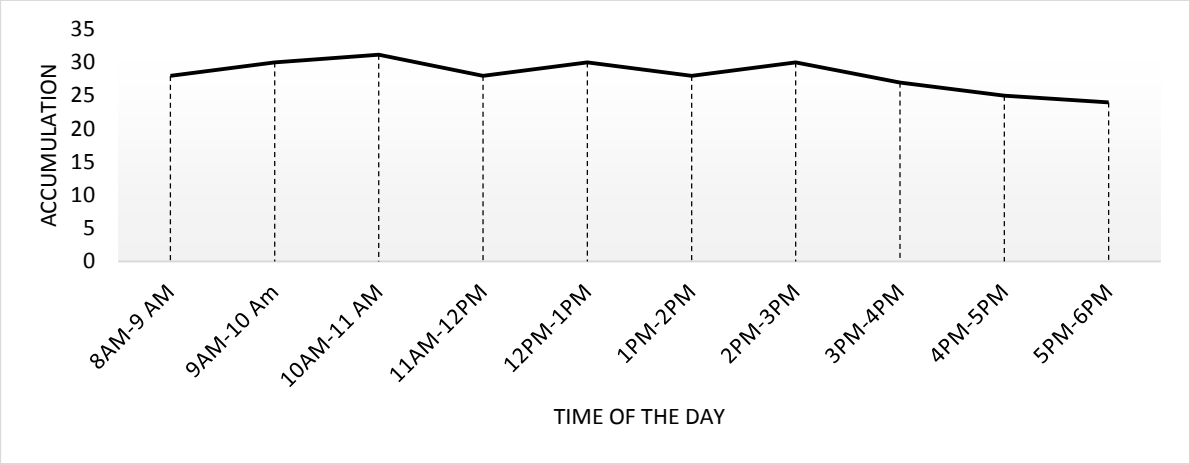

Figure 4. 34: Accumulation curve, Edget Beandenet commercial center August 29, 2019

Figure 4.34 shows the maximum demand is during the time interval between 10:00am to 11:00am. It is because the space is occupied by shop owners and customers which is more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 33 of appendix A.

- Form table 33 average occupancy is 89.05% and the total parking load is the summation of all the values in column 6 which is equal to 1870 vehicle minutes or 31.17 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

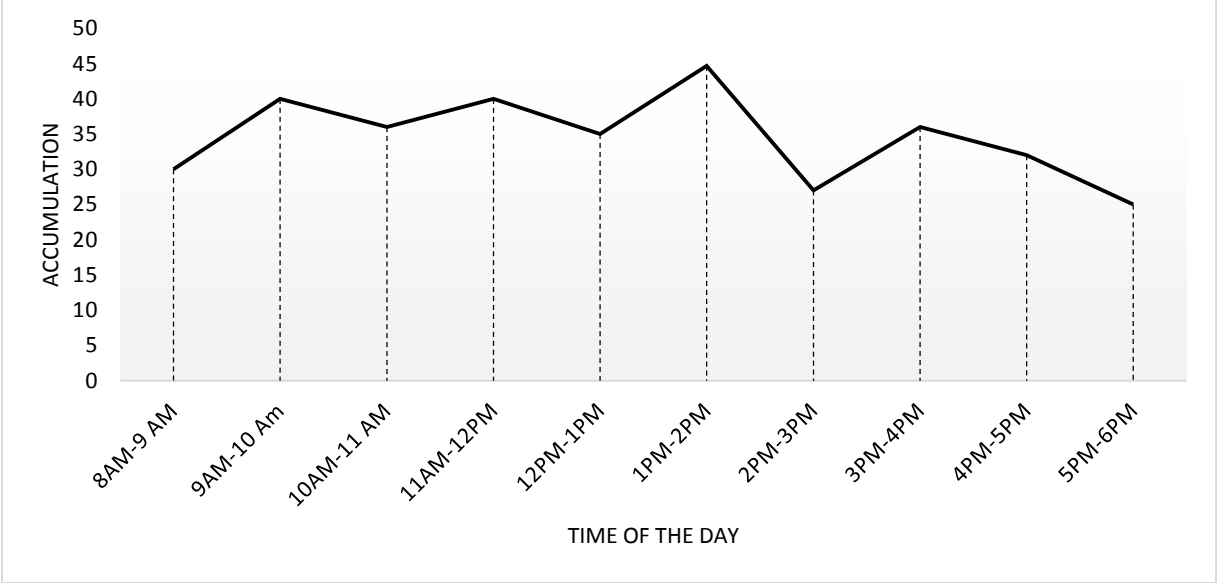

Figure 4. 35**:** Accumulation curve, Tiret commercial center September 4, 2019

Figure 4.35 shows the maximum demand is during the time interval between 1:00pm to 2:00 pm. this is because its commercial building and most of shop owners have car which makes the demand more than the allowable space capacity of the parking lot or the 85 percentile. The in and out survey detail and statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented in table 34 of appendix A.

- Form table 34 average occupancy is 89.33% and the total parking load is the summation of all the values in column 6 which is equal to 2680 vehicle minutes or 44.67 vehicle hours which shows the parking space coverage of the area is high and considered to be full.

4.2 Expected parking demand at Megenagna

4.2.1 Parking demand generators

People move around this site uses parking spaces to get different facilities. These people are the parking generators that are demand to the study area in addition of the usual demand like shop owners and residents. The parking generators on this sites are people come to jewelry, to cinema house, for entertainment and governmental offices.

4.2.2 Actual versus ITE peak demand rates

The actual peak demand rates were calculated by determining the highest number of parked vehicles during an observation period and divide this number by the GSF of each land use obtained by using online Google earth software as shown in figure 4.36 for M-3 Sileshi Sihen Business center.

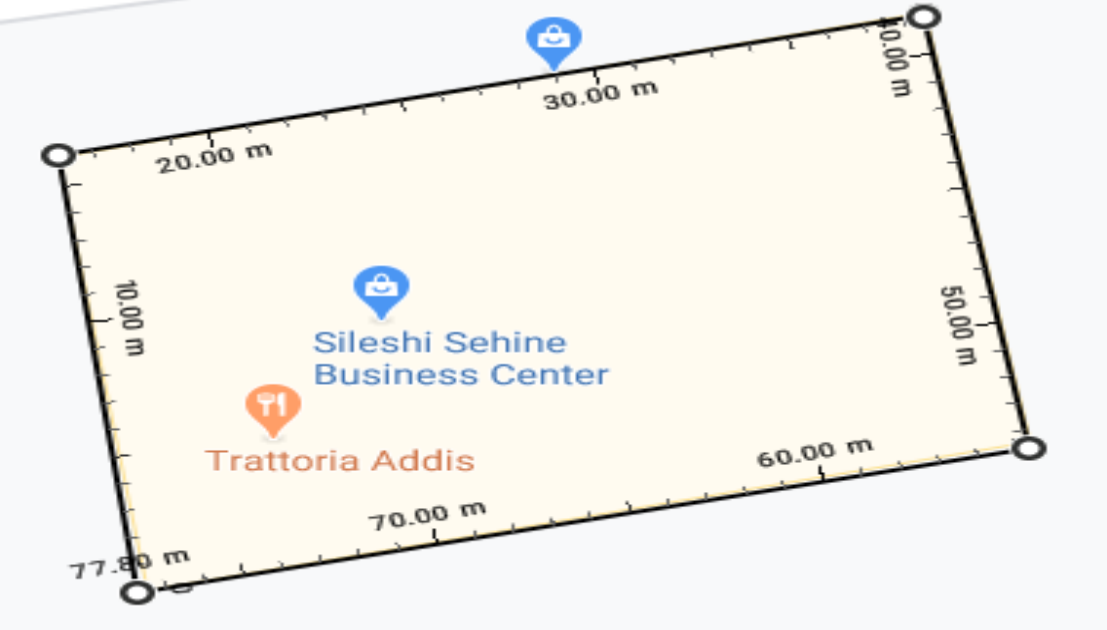

Figure 4. 36: land use area measurement on google map for M-3 Sileshi Sihen business center

From figure 4.36 Google map area output only surface area is obtained. To change it into Gross square footage it was multiplied by the number of stories which is attached in appendix B

column 4

$5{,}548.18 * 12 = 66{,}578.16\ ft^2$ …….. eq. 4.1

The actual demand rate is calculated by the peak demand divided by the Gross square footage area of each land uses and expressed in terms of per one thousand rates.

$\frac{15*1000}{66{,}578.16} = 0.23/1000gsf$ ……....eq. 4.2

Results of other actual peak demand rates are compared with the ITE standard peak demand rates presented in table 4.2 to ignore redundancy of procedure.

Table 4. 2: Actual versus ITE peak demand rates at Megenaga

Land uses	Land use type	Size (ft^2)	Unit	Actual demand rate	ITE demand rate	Actual vs ITE
M-1	Commercial	44267.65	GSF	0.47/1000gsf	2.84/1000gsf	Below
	Bank	2475.70	GSF	0.47/1000gsf	4/1000gsf	Below
M-2	Hotel	4,224.15	Room	0.71/room	0.89/room	Below
M-3	Commercial	62,972.25	GSF	0.23/1000gsf	2.84/1000gsf	Below
	Restaurant	1453.13	GSF	0.23/1000gsf	5.55/1000gsf	Below
	Bank	2152.78	GSF	0.23/1000gsf	4/1000gsf	Below
M-4	Commercial/office	121,503.44	GSF	0.33/1000gsf	2.84/1000gsf	Below
	Restaurant	3,767.36	GSF	0.33/1000gsf	5.55/1000gsf	Below
	Bank	9,472.24	GSF	0.33/1000gsf	4/1000gsf	Below
M-5	Commercial	47,587,94	GSF	1.11/1000gsf	2.84/1000gsf	Below
	Restaurant	6,996.54	GSF	1.11/1000gsf	5.55/1000gsf	Below
M-6	Commercial	72300.09	GSF	0.61/1000gsf	2.84/1000gsf	Below
	Restaurant	5059.03	GSF	0.61/1000gsf	5.55/1000gsf	Below
M-7	Commercial	244,306.12	GSF	0.40/1000gsf	2.84/1000gsf	Below
	Restaurant	6996.54	GSF	0.40/1000gsf	5.55/1000gsf	Below
M-8	Commercial/office	112,899.28	GSF	0.66/1000gsf	2.84/1000gsf	Below
	Restaurant	1722.22	GSF	0.66/1000gsf	5.55/1000gsf	Below
	Bank	1345.48	GSF	0.66/1000gsf	4/1000gsf	Below
M-9	Bank	161,253.6	GSF	0.27/1000gsf	4/1000gsf	Below
M-10	Commercial	48,473.81	GSF	0.47/1000gsf	2.84/1000gsf	Below

4.2.3 Parking demand calculations using actual and ITE peak demand rates

The Institute of Transportation Engineers (ITE) produces a periodic report titled Parking Generation, which is the accepted national standard in determining parking demand for a development. ITE standards are based on parking demand studies submitted to ITE by a various parties, including public agencies, developers and consulting firms.

The study includes the ITE rates as guidelines to benchmark how the study area existing supplies compare to its land uses. While recognizing that every community's needs are different. In table 4.3 it shows what ITE would recommend as the number of spaces needed in the study area with adjustment for the areas mixed-use characteristics.

Rates from ITE are used to determine the average peak period parking demand. The average peak period demand is the parked cars observed at the peak period divided by the quantity of the independent variable, such as building area or employees, expressed as a rate. To estimate the average peak period demand in the study area, the rstudy used the City's land use data from Google earth map to determine the square footage of each land use in Megenaga, and multiplied that square footage (or other independent variable, such as residential units or employees) by the actual and ITE average peak period demand.

Table 4. 3: Actual versus ITE peak demand rates at Megenaga

Land uses	Land use type	Area (ft^2)	Actual peak rates	ITE demand rate	Actual demand	ITE demand
M-1	Commercial	44,267.65	0.47/1000gsf	2.84/1000gsf	21	126
	Bank	2,475.70	0.47/1000gsf	4/1000gsf	2	10
M-2	Hotel	4,224.15	0.71/room	0.89/room	9	11
M-3	Commercial	62,972.25	0.23/1000gsf	2.84/1000gsf	15	179
	Restaurant	1,453.13	0.23/1000gsf	5.55/1000gsf	1	8
	Bank	2,152.78	0.23/1000gsf	4/1000gsf	1	9
M-4	Commercial/office	121,503.44	0.33/1000gsf	2.84/1000gsf	41	345
	Restaurant	3,767.36	0.33/1000gsf	5.55/1000gsf	2	21
	Bank	9,472.24	0.33/1000gsf	4/1000gsf	4	38
M-5	Commercial	47,587.94	1.11/1000gsf	2.84/1000gsf	53	136
	Restaurant	6,996.54	1.11/1000gsf	5.55/1000gsf	8	39
M-6	Commercial	72,300.09	0.61/1000gsf	2.84/1000gsf	45	206
	Restaurant	5,059.03	0.61/1000gsf	5.55/1000gsf	4	29
M-7	Commercial	244,306.12	0.40/1000gsf	2.84/1000gsf	98	694
	Restaurant	6,996.54	0.40/1000gsf	5.55/1000gsf	3	39
M-8	Commercial/office	112,899.28	0.66/1000gsf	2.84/1000gsf	75	321

	Restaurant	1,722.22	0.66/1000gsf	5.55/1000gsf	2	10
	Bank	1,345.48	0.66/1000gsf	4/1000gsf	1	6
M-9	Bank	161,253.6	0.27/1000gsf	4/1000gsf	44	646
M-10	Commercial	48,473.81	0.47/1000gsf	2.84/1000gsf	23	138
		Total			**452**	**3,011**

4.2.4 Additional parking space required

The additional parking spaces required for Megenagna site is shown in table 4.4

Table 4. 4: Additional parking required by Actual and ITE demands at Megenagna

Sl. No.	**Name of the parking location**	**Capacity/number of cars**	**Actual demand**	**ITE demand**	**Additional parking spaces required**	
					Actual	**ITE**
M-1	Timugas Buld'g	22	23	136	1	114
M-2	Mehal Hotel	5	9	11	4	6
M-3	Sileshi sihen Business center	20	17	196	-	176
M-4	Derartu tulu Building	60	47	404	-	344
M-5	Mulugeta Zeleke Building	70	61	175	-	105
M-6	Maraton motor	65	49	235	-	170
M-7	Zefmesh buliding	150	101	733	-	583
M-8	Metebaber Building	85	78	337	-	252
M-9	Renaissance Building	55	44	646	-	526
M-10	Genet Commercial center	25	23	138	-	113
Total		**557**	**452**	**3,011**	**5**	**2,454**

Based on the above analysis current observed/actual demand requires a minimum of **5** additional parking spaces where as the ITE standard recommends an additional parking space of 2,454**.** By considering that the ITE is a high standard manual and it follows the high standard living style of most developed countries, it may not be appropriate directly applying it to our country.

4.3 Analysis from users' perspectives based on personal interview

From the users of the facilities, 300 sample were selected using equation 3.1. Further 100 users were selected from each site for interviews. On the upcoming section the analysis from the users perceptive are shown in detail below.

1. Demography of respondents

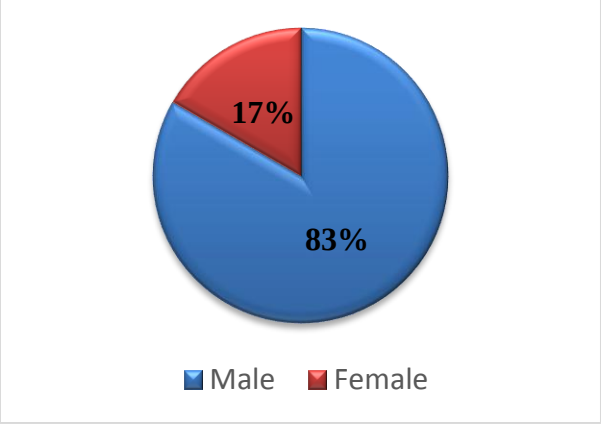

Figure 4.37a

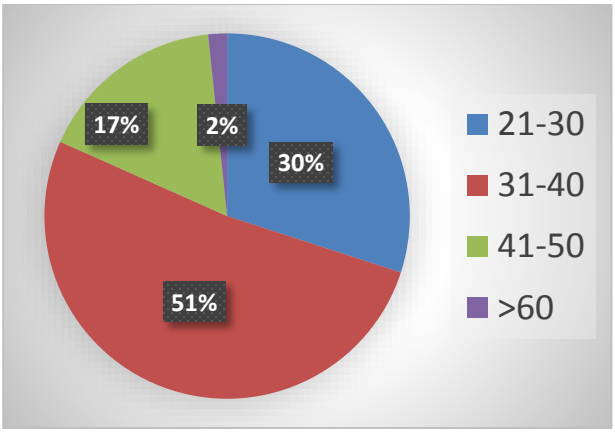

Figure 4.37b

Figure 4. 37: Demographic condition of respondents

All the data collected on sex distribution of respondents in the study areas shows that male dominate the study areas. This shows that men take more responsibilities of their families and are engaged in economic activities and also shows the disparity level between male and female in transport operations. Figure 4.37b shows the distribution of respondents by age for the study areas. The figure shows that the age of drivers (between ages 21 and above) demonstrates self confidence that is remarkably stable and influenced by events of good driving skills. Cumulatively, the age group between 31 and 40 years shows that the population sampled are in their youthful stage which indicate high productivity and high efficiency.

2. Occupation of the Respondents

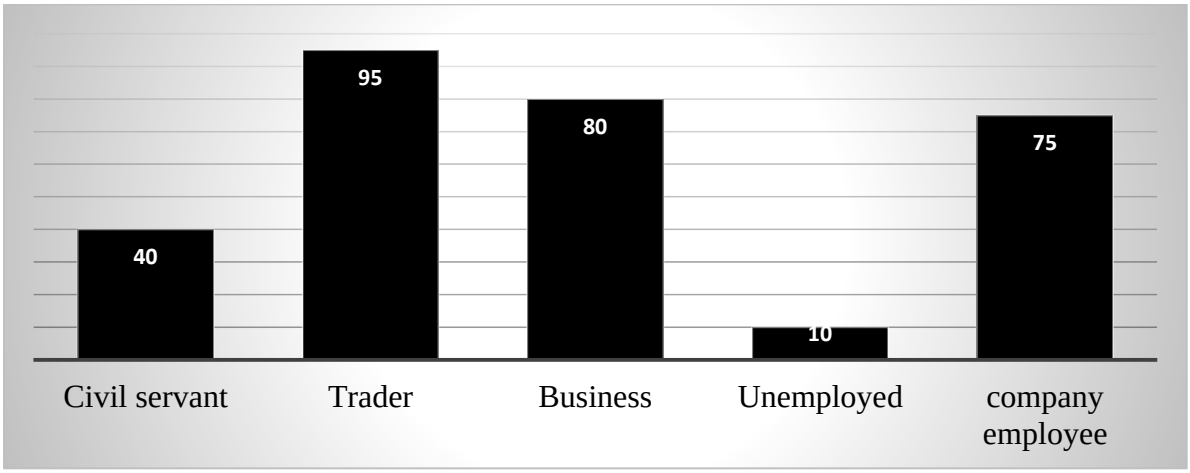

Figure 4. 38: occupation of the respondents

Result from figure 4.38 implies that traders and business owners are classified to the patronize car parks in Addis Ababa due to the presence of financial institutions, plazas, shopping malls, trading and international corporations headquarters.

3. Educational status of the respondents

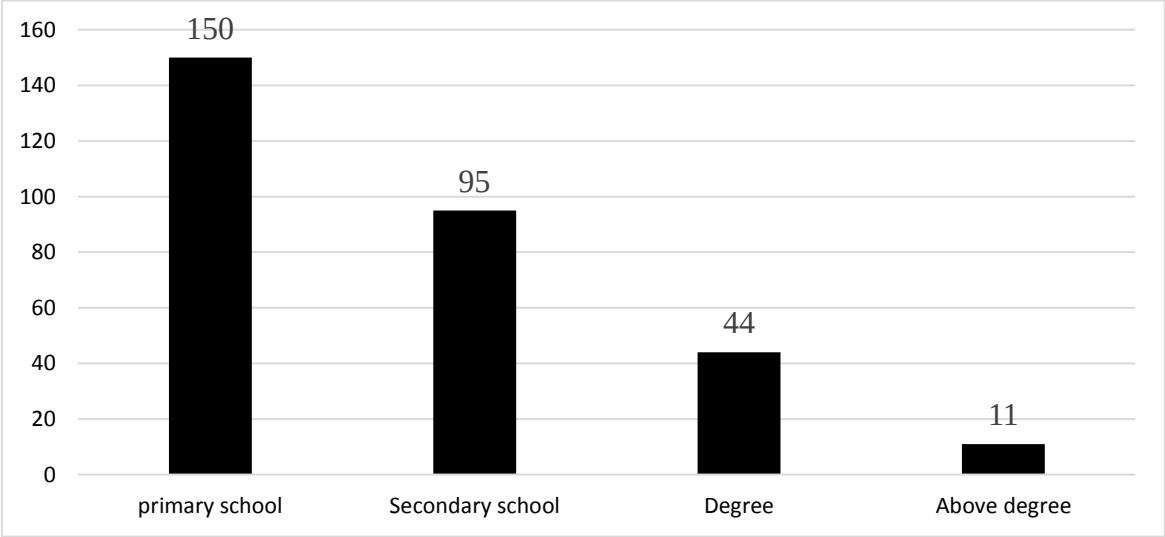

Figure 4. 39: Educational status of the respondents

Figure 4.39 shows that most of the drivers in the study areas have at least primary education followed by secondary education. This implies that an average person in this area has one form of education or the other due to the administrative, educational, commercial, industrial setting and relevance of the area.

4. Driving experience in the City

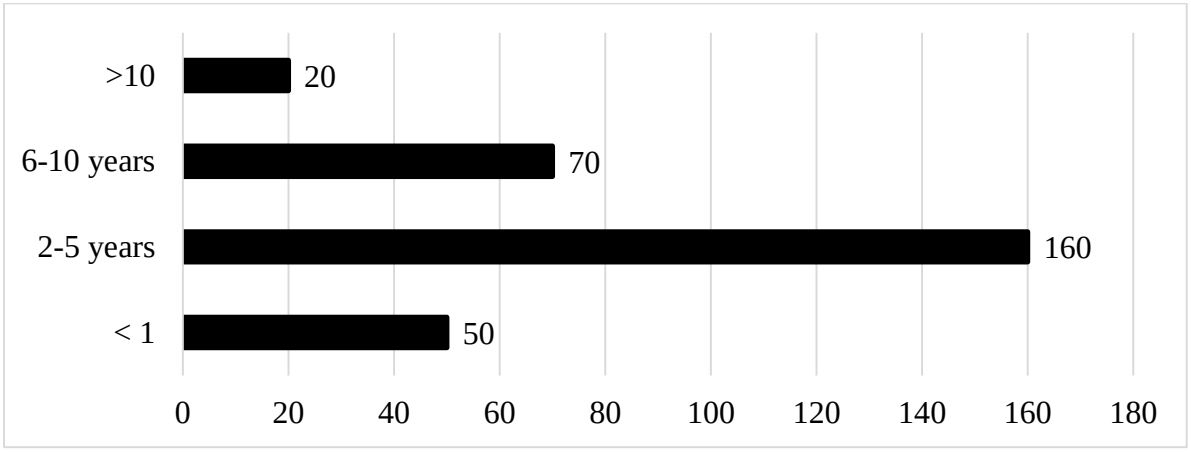

Figure 4. 40: Driving experience in the city

The analysis from figure 4.40 reveals that inexperience driving is associated with less ability to accurately perceive specific road situations, poor estimations of safe turning speeds, traffic gaps, and stopping distances, as well as slowed or inappropriate responses to traffic situations. Driving experience of drivers is very important because it reduces accidents. It also shows the level of responsibility of self-control and obeying traffic rules and parking regulations towards other drivers and the society in large.

5. Trip Purpose

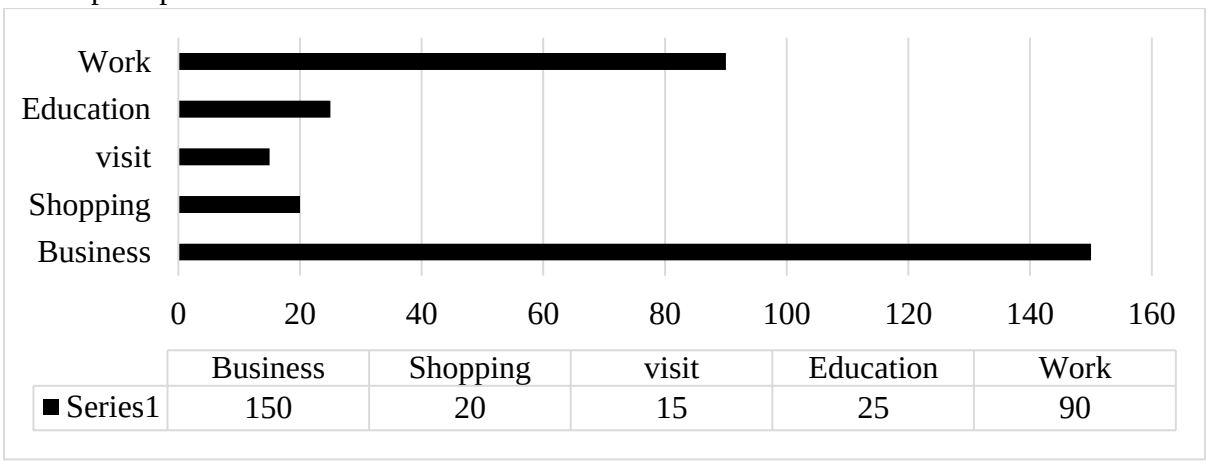

Figure 4. 41: Trip purpose

(Joseph, 2016) states that the number of trips made per day increases the chances of traffic congestion on roads especially during trips to churches, offices, markets, shops, sport centers and other places which often generate enormous parking demand. As observed by (Olorunfemi, 2013)

the greater the number of attractions (shops, offices, work places etc.) in an area the more traffic that will be attracted. This assertion has really manifested in this study coupled with inadequate traffic management and parking spaces that have resulted to traffic congestion experienced in Addis Ababa city.

6. Awareness of the parking facilities

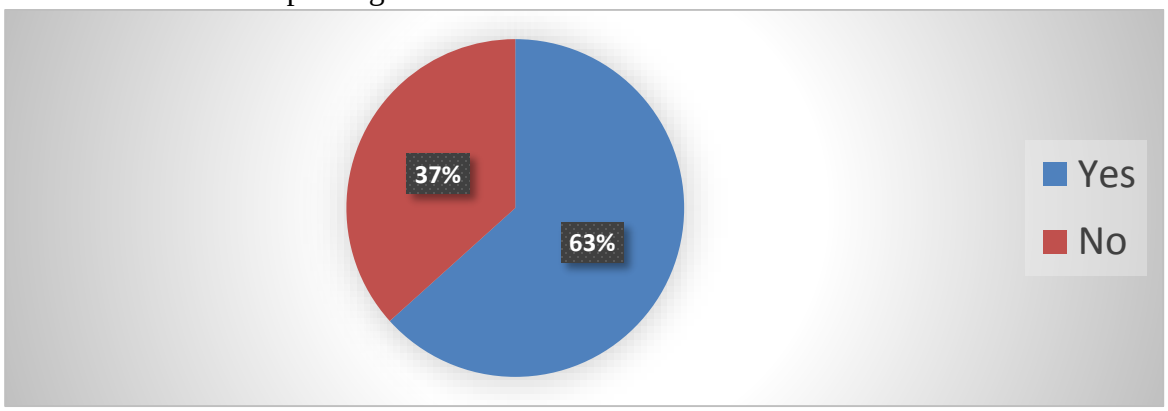

Figure 4. 42: Awareness of the parking facilities

The analysis from figure 4.42 shows that most of the users have the awareness of the parking facilities before. Anyone who drives a car needs no introduction to the difficulties of finding a parking space in areas which are intensively used for business, commercial or residential purposes. An area having a Central Business District (CBD), a region or community shopping center, an industrial park, an airport, a civic center, stadium or other busy area is usually subjected to extensive parking problems.

7. Parking duration

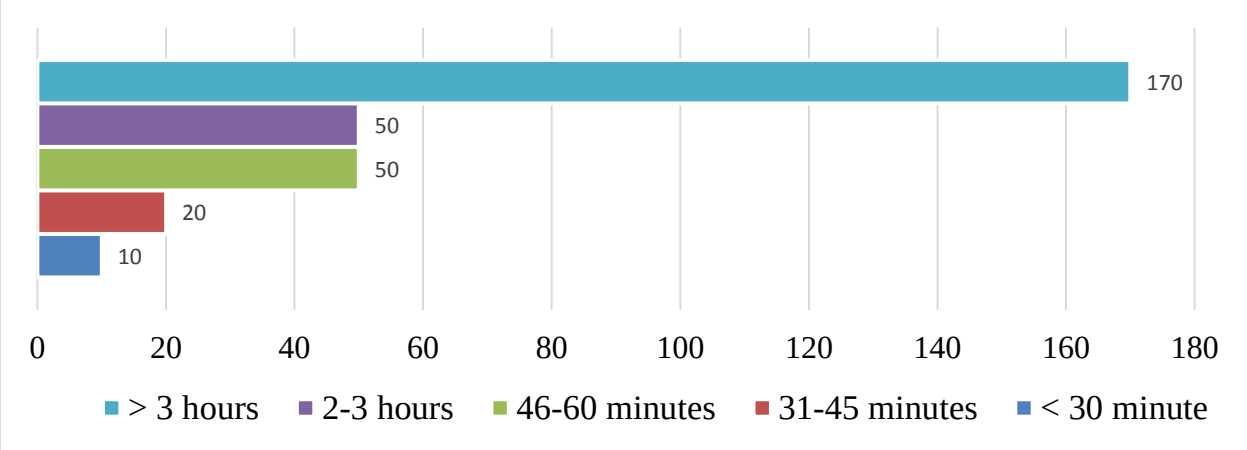

Figure 4. 43: Parking duration

Figure 4.43 revealed that most of the users are long time parking people because most of the users of the parking facilities are shop owners once they go to their office they will stay there for a long time and most of short time parkers will rather prefer on-street parkers instead of off-street parking facilities.

8. Parking Frequency

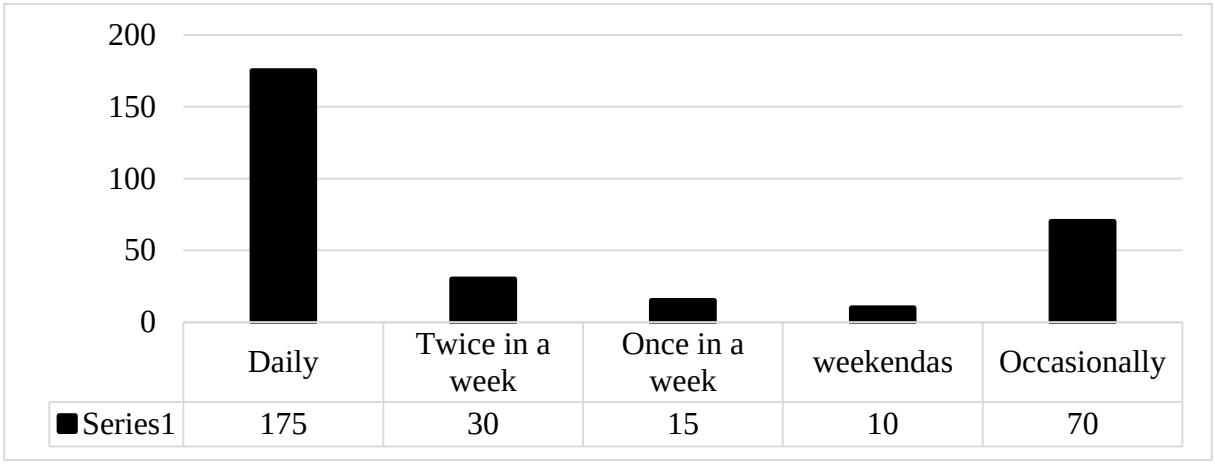

Figure 4. 44: Parking Frequency

Findings revealed that in Addis Ababa city 58.3% of respondents engage in daily use of car parks (business and work trip) daily. It has been widely stressed in the literature among authors such as (Rui Wang and Quan Yuan., 2013) that trips to business and work generates more traffic than any other activities in the area of the city.

9. Reason of to use the facility

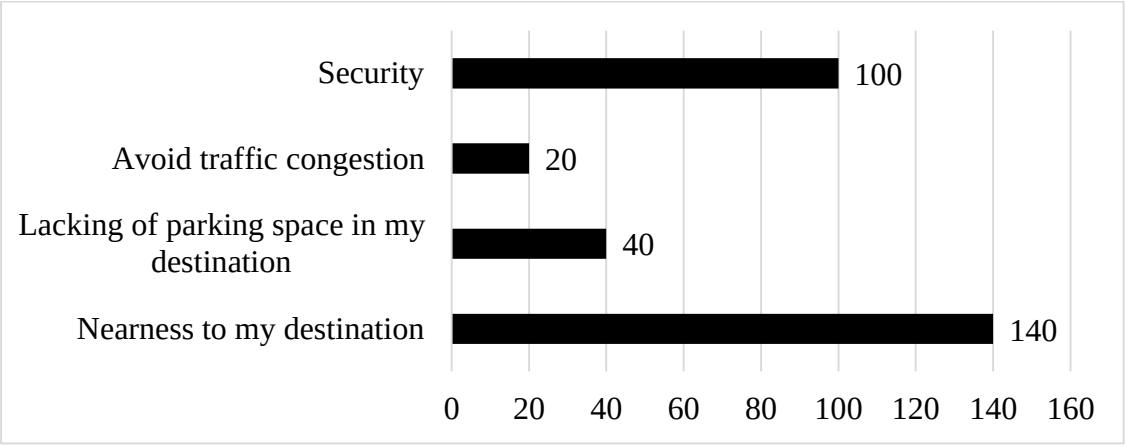

Figure 4. 45: Reason of parking

The analysis from the figure 4.45 shows that 140 respondents chose the off-street parking facility due to nearness of the facilities for their destination and security is the other main reason to select these facilities for parking.

10. Effect of off- street parking

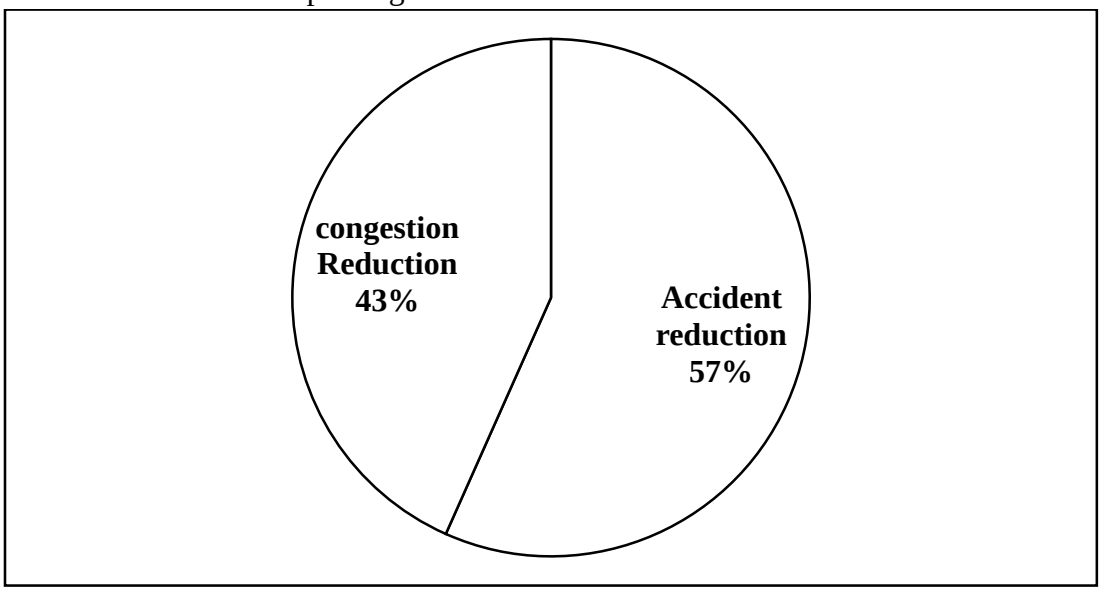

Figure 4. 46: Effect of off-street parking

A large percentage of congestion in urban areas (8 to 74%) is caused by automobiles in search for a parking place. Shoup (2006) studied this problem and identifies a set of conditions under which car users are more inclined to drive around and look for an off street -parking place. From the above analysis most of the users of off-street parking responds that the effect of off-street parking is accident reduction because on-street parking is more exposed for accidents and 43% responds revealed off-street parking contributes for the reduction of traffic congestion.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on greater demand requirement for parking facilities, 3 central business districts of the capital city (i.e. Megenagna, Bole and Merkato) were chosen for detailed analysis. From the stated locations; 11, 13 and 11 off-street parking sites are selected for further analysis. The peak demand varies along the time of the day therefore, the morning peak is 8:00 am - 9:00 am, the mid-day peak is 1:00 pm-2:00 pm the reason being during morning peak is most of the shop owners will come to their offices and during mid-day its lunch time and most of the car owners will be free from their work. From parking performance analysis from 'Bole', 'Megenagna' and 'Mekato' revealed that 76.9%, 72.7% and 81.82% of off-street car parking's are operating more than their capacity respectively.

From users perspective most of the trips made to the study areas are business trips followed by work trips this is because the study areas are commercial centers of the city. Findings also revealed that in Addis Ababa city 58.3% of respondents engage in daily use of car parks (business and work trip) which have an impact in the increasing of the demand in the study areas. Most of the users in the study areas are long time parking people which are 56.7% as most of the users of the parking facilities are shop owners go to their office will stay there for a long time and most of short time parking people will rather prefer on-street parking facilities instead of off-street parking facilities. Most of the users prefer off-street parking's because of the nearness to their destination followed by safety.

From the analysis results from tables 3.1, 3.2 and 3.3 the illegal on-street parking are 30.8%, 63.3% and 54.4% for Bole, Merkato and Megenagna sites respectively. The demand estimation was conducted by land use analysis. The analysis indicates that additional 2,454 parking spaces is required to afford the existing demand.

5.2 Recommendations

Based on the analysis found from the off-street parking system of Addis Ababa the following points are recommended to bring a significant improvement for the car parking facilities.

As found from the analysis almost all of the off-street parking's given by the city administration for the youths temporarily are operating under their capacity and one of the reason behind is lack of awareness of the location of parking. Therefore, this problem can be minimized by developing a standardized parking signs and other information systems throughout the areas that makes the drivers easy to find parking spaces and direct them to the parking supply availability in the nearest location. The traffic management office of the city should work on building more smart parking's in the city because the current functional parking in Megenagna has a great impact in reduction of demand in the nearby parking areas in fact there is an undergoing construction of smart parking in Merkato around Anuwar mosque.

The city administration should give opportunities for private investors to invest in car parking facilities. The government should develop parking policy and strategy at national level that come to improve the parking usage of the areas such as CBDs can bring an effective and efficient usage of parking spaces.

Construction Permit and Control Office, and all local Planning Authorities should cooperate each other to specify and enforce the provision of parking space in conjunction with new building and road side parking. Even though, there is proclamation on the building permit procedures, it is found that most of the buildings that are required to provide parking facility were functioning for other purposes especially in Merkato. Therefore, particularly Construction Permit and Control Office should take action for the implementation of the law so as to reduce the scarcity of parking. To increase the utilization of building car parks and to reduce the illegal on-street car parking, it is effective to adopt the car park sharing scheme which allows the use of building car parks within the designated zones (within walking distance; approximately 200m based on interview surveys). In this scheme, the car park user well be allowed to park in any building within a particular zone and the management of the buildings share will the income generated from parking fees.

FUTURE STUDY AREAS

- Derivation of parking demand rates in national level.
- Forecasting and analysis of future parking demand in central business districts based upon possible development scenarios.
- Impact assessment of smart parking in the case of Addis Ababa city.

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APPENDIX A: In and out survey result for the peak hours

Table 1: In and out survey data result new bright tower on Thursday May 9, 2019 from 9:00am to 10:00am.

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	3	2	12	75.00	60
10	4	1	15	93.75	75
15	2	3	14	87.50	70
20	5	3	16	100.00	80
25	3	4	15	93.75	75
30	4	4	15	93.75	75
35	2	3	14	87.50	70
40	2	2	14	87.50	70
45	2	5	11	68.75	55
50	5	4	12	75.00	60
55	4	2	14	87.50	70
60	4	6	12	75.00	60
Total					820

Table 2: In and out survey data result Awelo Business Center on Wednesday May 15, 2019 from 11:00am to 12:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	4	3	14	40.00	70
10	10	0	24	68.57	120
15	7	1	30	85.71	150
20	6	2	34	97.14	170
25	5	7	32	91.43	160
30	3	1	34	97.14	170
35	0	3	31	88.57	155
40	3	1	33	94.29	165
45	2	2	33	94.29	165
50	0	1	32	91.43	160
55	0	0	32	91.43	160
60	2	1	33	94.29	165
Total					1810

Table 3: In and out survey data result Berehane Adere mall on Thursday May 16, 2019 from 9:00am-10:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	7	1	32	88.89	160
10	0	2	30	83.33	150
15	6	2	34	94.44	170
20	1	1	34	94.44	170
25	2	4	32	88.89	160
30	3	1	34	94.44	170
35	2	3	33	91.67	165
40	0	3	30	83.33	150
45	3	3	30	83.33	150
50	1	3	28	77.78	140
55	0	0	28	77.78	140
60	2	1	29	80.56	145
Total					1870

Table 4: In and out survey data result Medehanialem mall on Wednesday May 22, 2019 from 1:00pm-2:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	14	3	91	75.83	455
10	11	9	93	77.50	465
15	9	0	102	85.00	510
20	7	5	104	86.67	520
25	6	0	110	91.67	550
30	10	3	117	97.50	585
35	4	2	119	99.17	595
40	0	0	119	99.17	595
45	4	4	119	99.17	595
50	3	6	116	96.67	580
55	0	4	112	93.33	560
60	9	4	117	97.50	585
Total					6595

Table 5: In and out survey data result Sheger House building on Thursday May 23, 2019 from 12:00pm-1:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	3	1	19	95.00	95
10	0	1	18	90.00	90
15	3	2	19	95.00	95
20	3	4	18	90.00	90
25	2	0	20	100.00	100
30	0	3	17	85.00	85
35	4	2	19	95.00	95
40	3	5	17	85.00	85
45	1	1	17	85.00	85
50	2	5	14	70.00	70
55	4	2	16	80.00	80
60	0	1	15	75.00	75
Total					1045

Table 6: In and out survey data result Golden Parking on Monday Wednesday May 29, 2019 from 11:00am-12:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	6	12	24	24.00	120
10	7	1	30	30.00	150
15	10	11	29	29.00	145
20	12	0	41	41.00	205
25	6	3	44	44.00	220
30	15	6	53	53.00	265
35	11	2	62	62.00	310
40	0	0	62	62.00	310
45	3	3	62	62.00	310
50	4	7	59	59.00	295
55	6	9	56	56.00	280
60	5	6	55	55.00	275
Total					2885

Table 7: In and out survey data result Ephrem, Dagmawi and his friends parking on Thursday May 30, 2019, 2016 from 12:00pm to 1:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	2	1	30	60.00	150
10	3	3	30	60.00	150
15	0	2	28	56.00	140
20	5	2	31	62.00	155
25	3	2	32	64.00	160
30	1	1	32	64.00	160
35	4	2	34	68.00	170
40	2	4	32	64.00	160
45	1	3	30	60.00	150
50	7	5	32	64.00	160
55	6	0	38	76.00	190
60	3	5	36	72.00	180
Total					1925

Table 8: In and out survey data result Morning Star mall on Wednesday June 5, 2019 from 11:00am to 12:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	7	5	28	93.33	140
10	0	0	28	93.33	140
15	4	2	30	100.00	150
20	3	3	30	100.00	150
25	4	4	30	100.00	150
30	0	1	29	96.67	145
35	3	2	30	100.00	150
40	4	5	29	96.67	145
45	3	2	30	100.00	150
50	3	7	26	86.67	130
55	6	5	27	90.00	135
60	7	5	29	96.67	145
Total					1730

Table 9: In and out survey data result parking at the back of Mamas kitchen on Thursday June 6, 2019, 2016 from 1:00pm to 2:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	13	3	50	55.56	250
10	17	3	64	71.11	320
15	10	4	70	77.78	350
20	11	4	77	85.56	385
25	9	0	86	95.56	430
30	3	10	79	87.78	395
35	8	7	80	88.89	400
40	10	10	80	88.89	400
45	13	11	82	91.11	410
50	10	9	83	92.22	415
55	4	12	75	83.33	375
60	8	6	77	85.56	385
Total					4515

Table 10: In and out survey data result Edna mall on Wednesday June 12, 2019, 2016 from 1:00pm to 2:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	13	3	47	90.38	235
10	9	10	46	88.46	230
15	8	9	45	86.54	225
20	11	6	50	96.15	250
25	5	12	43	82.69	215
30	8	2	49	94.23	245
35	7	6	50	96.15	250
40	4	8	46	88.46	230
45	5	2	49	94.23	245
50	6	6	49	94.23	245
55	3	5	47	90.38	235
60	5	3	49	94.23	245
Total					2850

Table 11: In and out survey data result Hibret Bank building on Thursday June 13, 2019 from 10:00am to 11:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	6	2	15	100.00	75
10	5	5	15	100.00	75
15	1	6	10	66.67	50
20	6	1	15	100.00	75
25	1	1	15	100.00	75
30	3	4	14	93.33	70
35	4	3	15	100.00	75
40	0	2	13	86.67	65
45	2	1	14	93.33	70
50	1	2	13	86.67	65
55	2	0	15	100.00	75
60	2	3	14	93.33	70
Total					840

Table 12: In and out survey data result of Oasis building on Wednesday June 19, 2019 from 11:00am to 12:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	6	2	16	100.00	80
10	4	4	16	100.00	80
15	0	0	16	100.00	80
20	1	1	16	100.00	80
25	3	4	15	93.75	75
30	2	3	14	87.50	70
35	5	3	16	100.00	80
40	3	4	15	93.75	75
45	2	3	14	87.50	70
50	4	3	15	93.75	75
55	3	3	15	93.75	75
60	1	2	14	87.50	70
Total					910

Table 13: In and out survey data result Timugas tower on Thursday June 20, 2019 from 1:00pm to 2:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	7	1	17	77.27	85
10	3	2	18	81.82	90
15	3	0	21	95.45	105
20	2	1	22	100.00	110
25	3	5	20	90.91	100
30	1	3	18	81.82	90
35	0	2	16	72.73	80
40	4	5	15	68.18	75
45	3	0	18	81.82	90
50	2	1	19	86.36	95
55	1	1	19	86.36	95
60	2	0	21	95.45	105
Total					1120

Table 14: In and out survey data result Mehal Hotel on Wednesday June 26, 2019 from 12:00pm to 1:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	1	0	4	80.00	20
10	0	0	4	80.00	20
15	2	2	4	80.00	20
20	1	1	4	80.00	20
25	1	0	5	100.00	25
30	2	2	5	100.00	25
35	1	2	4	80.00	20
40	2	1	5	100.00	25
45	0	0	5	100.00	25
50	2	3	4	80.00	20
55	1	2	3	60.00	15
60	1	0	4	80.00	20
Total					255

Table 15: In and out survey data result Sileshi Sihen Business Center on Thursday June 27, 2019 from 11:00am to 12:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	5	3	11	55.00	55
10	3	4	10	50.00	50
15	4	0	14	70.00	70
20	6	2	18	90.00	90
25	5	4	19	95.00	95
30	4	3	20	100.00	100
35	3	3	20	100.00	100
40	2	3	19	95.00	95
45	2	4	17	85.00	85
50	5	3	19	95.00	95
55	4	5	18	90.00	90
60	2	2	18	90.00	90
Total					1015

Table 16: In and out survey data result of Derartu Tulu building Wednesday July 3, 2019 from 2:00pm to 3:00pm.

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	10	3	45	75.00	225
10	13	2	56	93.33	280
15	9	2	45	75.00	225
20	11	3	46	76.67	230
25	6	5	39	65.00	195
30	7	4	41	68.33	205
35	12	0	50	83.33	250
40	11	4	45	75.00	225
45	9	2	45	75.00	225
50	10	4	44	73.33	220
55	8	4	42	70.00	210
60	6	7	37	61.67	185
Total					2675

Table 17: In and out survey data result Mulugeta Zeleke building on Thursday July 4, 2019 from 4:00pm-5:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	9	0	39	55.71	195
10	8	2	45	64.29	225
15	11	4	52	74.29	260
20	10	7	55	78.57	275
25	12	5	62	88.57	310
30	8	3	67	95.71	335
35	7	4	70	100.00	350
40	1	7	64	91.43	320
45	10	7	67	95.71	335
50	9	6	70	100.00	350
55	4	6	68	97.14	340
60	6	7	67	95.71	335
Total					3630

Table 18: In and out survey data result Marathon Business center on Wednesday July 10, 2019 from 11:00am to 12:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	6	0	42	64.62	210
10	10	6	46	70.77	230
15	7	4	49	75.38	245
20	5	5	49	75.38	245
25	3	7	45	69.23	225
30	11	3	53	81.54	265
35	9	3	59	90.77	295
40	7	3	63	96.92	315
45	3	1	65	100.00	325
50	5	5	65	100.00	325
55	6	7	64	98.46	320
60	6	5	65	100.00	325
Total					3325

Table 19: In and out survey data result Zefmush building on Thursday July 11, 2019 from 10:00am to 11:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	13	1	62	41.33	310
10	11	4	69	46.00	345
15	11	0	80	53.33	400
20	9	1	88	58.67	440
25	7	2	93	62.00	465
30	8	3	98	65.33	490
35	8	2	104	69.33	520
40	4	3	105	70.00	525
45	10	2	113	75.33	565
50	12	3	122	81.33	610
55	9	0	131	87.33	655
60	8	2	137	91.33	685
Total					6010

Table 20: In and out survey data result Metebaber building on Wednesday July 17, 2019 from 11:00am to 12:00pm.

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	7	1	46	54.12	230
10	9	2	53	62.35	265
15	10	2	61	71.76	305
20	6	2	65	76.47	325
25	8	0	73	85.88	365
30	7	1	79	92.94	395
35	7	2	84	98.82	420
40	9	5	88	103.53	440
45	6	7	87	102.35	435
50	3	0	90	105.88	450
55	7	2	95	111.76	475
60	9	4	100	117.65	500
Total					4605

Table 21 : In and out survey data result Renaissance building on Thursday July 18, 2019 from 9:00am to 10:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	5	5	9	16.36	45
10	3	2	10	18.18	50
15	2	0	12	21.82	60
20	4	1	15	27.27	75
25	0	3	12	21.82	60
30	5	2	15	27.27	75
35	0	2	13	23.64	65
40	3	3	13	23.64	65
45	0	4	9	16.36	45
50	2	0	11	20.00	55
55	1	4	8	14.55	40
60	3	2	9	16.36	45
Total					680

Table 22: In and out survey data result Smart parking on Wednesday July 24, 2019 from 11:00am to 12:00pm.

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	7	0	72	60.00	360
10	10	4	78	65.00	390
15	9	2	85	70.83	425
20	5	5	85	70.83	425
25	6	1	90	75.00	450
30	8	2	96	80.00	480
35	5	2	99	82.50	495
40	8	0	107	89.17	535
45	4	4	107	89.17	535
50	7	8	106	88.33	530
55	6	3	109	90.83	545
60	7	8	108	90.00	540
Total					5710

Table 23: In and out survey data result Genet Commercial center on Thursday July 25, 2019 from 10:00am to 11:00am.

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	5	1	19	76.00	95
10	4	2	21	84.00	105
15	0	2	19	76.00	95
20	5	1	23	92.00	115
25	4	2	25	100.00	125
30	2	2	25	100.00	125
35	0	1	24	96.00	120
40	0	0	24	96.00	120
45	2	2	24	96.00	120
50	1	2	23	92.00	115
55	1	0	24	96.00	120
60	2	1	25	100.00	125
			Total		1380

Table 24: In and out survey data result Building in front of CBE building on Wednesday July 31, 2019 from 9:00am to 10:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	4	1	14	93.33	70
10	2	2	14	93.33	70
15	2	3	13	86.67	65
20	4	3	14	93.33	70
25	1	1	14	93.33	70
30	4	3	15	100.00	75
35	3	4	14	93.33	70
40	2	1	15	100.00	75
45	0	3	12	80.00	60
50	3	2	13	86.67	65
55	1	4	10	66.67	50
60	2	1	11	73.33	55
			Total		795

Table 25: In and out survey data result CBE building on Thursday August 1, 2019 from 10:00am to 11:00am.

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	5	0	30	75.00	150
10	2	4	28	70.00	140
15	3	3	28	70.00	140
20	1	2	27	67.50	135
25	6	0	33	82.50	165
30	3	1	35	87.50	175
35	4	2	37	92.50	185
40	3	0	40	100.00	200
45	1	3	38	95.00	190
50	2	1	39	97.50	195
55	3	3	39	97.50	195
60	0	0	39	97.50	195
Total					2065

Table 26: In and out survey data result Mares commercial center on Wednesday August 7, 2019 from 9:00am to 10:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	4	1	21	65.63	105
10	5	0	26	81.25	130
15	3	0	29	90.63	145
20	0	1	28	87.50	140
25	3	1	30	93.75	150
30	4	2	32	100.00	160
35	3	2	33	103.13	165
40	1	1	33	103.13	165
45	0	2	31	96.88	155
50	2	1	32	100.00	160
55	2	3	31	96.88	155
60	0	2	29	90.63	145
Total					1775

Table 27: In and out survey data result Building right next to Addis Ababa Shopping center on Thursday August 8, 2019 from 10:00am to 11:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	6	1	28	70.00	140
10	0	1	27	67.50	135
15	3	0	30	75.00	150
20	4	1	33	82.50	165
25	3	0	36	90.00	180
30	0	0	36	90.00	180
35	3	1	38	95.00	190
40	4	2	40	100.00	200
45	0	2	38	95.00	190
50	2	1	39	97.50	195
55	3	3	39	97.50	195
60	2	1	40	100.00	200
Total					2120

Table 28: In and out survey data result Addis Ababa shopping center on Wednesday August 14, 2019 from 12:00pm to 1:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	10	1	49	81.67	245
10	5	2	52	86.67	260
15	4	2	54	90.00	270
20	4	4	54	90.00	270
25	3	2	55	91.67	275
30	7	4	58	96.67	290
35	2	2	58	96.67	290
40	0	0	58	96.67	290
45	4	3	59	98.33	295
50	5	6	58	96.67	290
55	3	1	60	100.00	300
60	2	4	58	96.67	290
Total					3365

Table 29**:** In and out survey data result Amanuel parking at Dubai tera, on Thursday August 15, 2019 from 1:00pm to 2:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	12	0	82	68.33	410
10	9	4	87	72.50	435
15	7	3	91	75.83	455
20	11	0	102	85.00	510
25	3	7	98	81.67	490
30	10	5	103	85.83	515
35	5	7	101	84.17	505
40	5	0	106	88.33	530
45	8	7	107	89.17	535
50	7	7	107	89.17	535
55	3	2	108	90.00	540
60	5	2	111	92.50	555
Total					6015

Table 30: In and out survey data result Building right next to Yedeget mesealal commercial center, on Wednesday August 21, 2019 from 11:00am to 12:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	8	1	37	74.00	185
10	4	6	35	70.00	175
15	3	0	38	76.00	190
20	7	0	45	90.00	225
25	4	3	46	92.00	230
30	2	4	44	88.00	220
35	5	2	47	94.00	235
40	0	3	44	88.00	220
45	3	2	45	90.00	225
50	4	1	48	96.00	240
55	4	3	49	98.00	245
60	0	2	47	94.00	235
Total					2625

Table 31: In and out survey data result Yedeget Meselal commercial center on Thursday August 22, 2019 from 9:00am to 10:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	4	0	34	75.56	170
10	0	5	29	64.44	145
15	7	4	32	71.11	160
20	6	1	37	82.22	185
25	1	3	35	77.78	175
30	5	2	38	84.44	190
35	4	2	40	88.89	200
40	5	1	44	97.78	220
45	0	2	42	93.33	210
50	4	2	44	97.78	220
55	0	1	43	95.56	215
60	0	1	42	93.33	210
		Total			2300

Table 32: In and out survey data result Jakal parking on Wednesday August 28, 2019 from 12:00pm to 1:00pm

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	4	1	25	71.43	125
10	5	0	30	85.71	150
15	3	1	32	91.43	160
20	3	5	30	85.71	150
25	6	2	34	97.14	170
30	0	4	30	85.71	150
35	4	3	31	88.57	155
40	0	2	29	82.86	145
45	0	3	26	74.29	130
50	4	3	27	77.14	135
55	3	2	28	80.00	140
60	1	1	28	80.00	140
		Total			1750

Table 33: In and out survey data result Edget Beandenet commercial center on Thursday August 29, 2019 from 10:00am to 11:00am

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	4	1	23	65.71	115
10	3	2	24	68.57	120
15	4	0	28	80.00	140
20	3	1	30	85.71	150
25	1	1	30	85.71	150
30	3	0	33	94.29	165
35	3	1	35	100.00	175
40	0	2	33	94.29	165
45	4	2	35	100.00	175
50	0	1	34	97.14	170
55	3	3	34	97.14	170
60	2	1	35	100.00	175
			Total		1870

Table 34: In and out survey data result Tiret commercial center on Wednesday September 4, 2019 from 1:00pm to 2:00pm.

Time (minutes)	**In** (No. of vehicles)	**Out** (No. of vehicles)	**Accumulation** (No. of vehicles)	**Occupancy** (%)	**Parking load** (veh-minute)
5	7	1	38	76.00	190
10	5	2	41	82.00	205
15	0	2	39	78.00	195
20	6	2	43	86.00	215
25	3	2	44	88.00	220
30	1	0	45	90.00	225
35	5	4	46	92.00	230
40	3	1	48	96.00	240
45	3	5	46	92.00	230
50	4	2	48	96.00	240
55	1	0	49	98.00	245
60	2	2	49	98.00	245
			Total		2680

APPENDIX B: Data for demand estimation at Megenagna site

Sl. No.	Name of the parking location	Area (ft^2)	Number of story
M-1	Timugas Buld'g	44,267.65	12
M-2	Mehal Hotel	2,475.70	5
M-3	Sileshi sihen Business center	4,224.15	12
M-4	Derartu tulu Building	62,972.25	16
M-5	Mulugeta Zeleke Building	1,453.13	8
M-6	Maraton motor	2,152.78	8
M-7	Zefmesh buliding	121,503.44	7
M-8	Metebaber Building	3,767.36	9
M-9	Renaissance Building	9,472.24	12
M-10	Genet Commercial center	47,587.94	7

APPENDIX C: In and out survey data collection sheet

Location:	Name of parking:
Date:	Recording Time:

Time (min)	In	Out
5		
10		
15		
20		
25		
30		
35		
40		
45		
50		
55		
60		

APPENDIX D: Parking inventory data collection form

Sl. No.	Name of the parking location	Capacity/number of cars	Type of parking	Illegal on-street parking

APPENDIX E: Structured interview questionnaires

1. Name/Location of parking
2. Sex Male ☐
   Female ☐
3. Age Less than 20 ☐
   21-30 ☐
   31-40 ☐
   41-50 ☐
   Above 60 ☐
4. Occupation Civil servant ☐
   Trader ☐
   Business ☐
   Unemployed ☐
   Company employee ☐
   Other specify_____
5. Educational status no formal education ☐
   Primary school ☐
   Secondary school ☐
   Degree ☐
   Above degree ☐
6. How long have you been driving in Addis Ababa
   Less than a year ☐
   2-5 years ☐

6-10 years ☐

Above 10 years ☐

7. Trip purpose

Business ☐

Shopping ☐

Visit ☐

Education ☐

Work ☐

Other specify_____

8. Are you aware of this parking facility before

Yes ☐

No ☐

9. How often do you park here

Daily ☐

Twice in a week ☐

Once in a week ☐

Weekends ☐

Occasionally ☐

Others specify_____

10. How long do you always park

Less than 30 minutes ☐

31-45 minutes ☐

46-60 minutes ☐

2-3 hours ☐

Above 3 hours ☐

11. Why do you park here

Nearness to my destination ☐

Lacking of parking space in my destination ☐

Avoid traffic congestion ☐

Security ☐

Others specify_____

12. What is the effect of off-street parking in this area

Accident reduction ☐

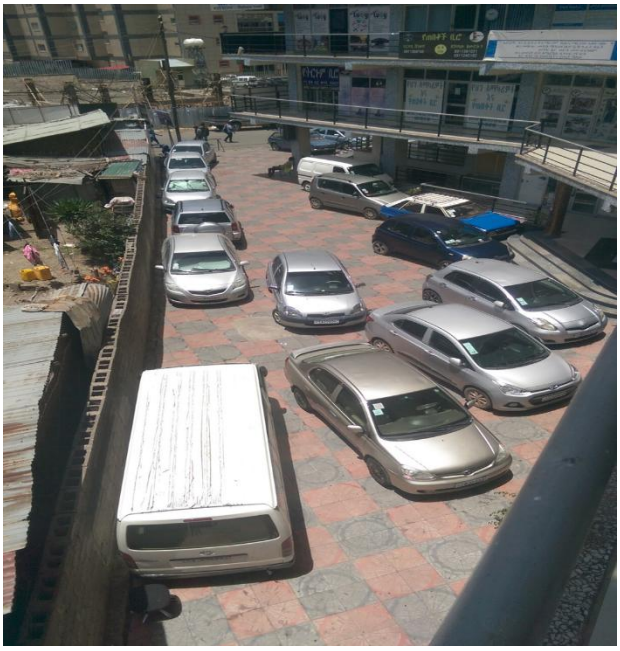
Congestion reduction ☐

Others specify_____

13. Mention some the challenges you face while parking here_____

_____

APPENDIX F: Parking facilities and Conditions in the selected Central Business Districts



Parking at Genet commercial center at Megenaga

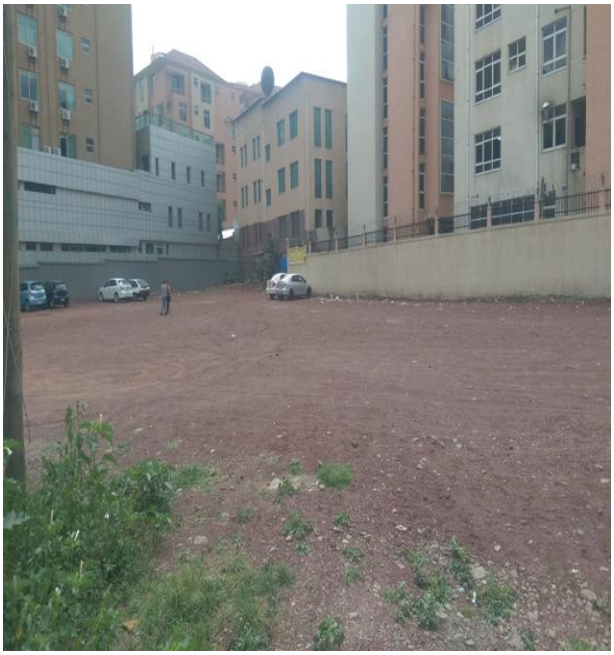
smart parking at Megenaga

Parking at Bole at the back of mamas Kitchen

Golden parking at Bole

Parking at zefmesh

Illegal on-street parking at Megenaga



Ephrem, Dagmawi and their friends parking at bole

Illegal on street parking at bole