

# Parking Demand and Supply Analysis: A Case Study of Arat-kilo to Piassa Road

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**Abstract:** *This study was intended to analyze the parking demand and supply of Arat kilo to Piazza road. The study establishes the peak parking demand rates by land use analysis for each land uses and compared with the ITE peak parking demand rate standards. The data were collected by on-site survey including counting of the parking volume in each time interval of the day and calculating of some parking statistical terms by using license plate survey. In addition to this some questionnaires were distributed to the drivers to strength the parking demand of the area. The results suggest that the street needs many more additional parking spaces in the case of both for the actual and ITE parking demand rates. Beside this the derived actual peak demand rates shows that there is a gap between the two standards and as a result, directly applying the ITE standards to the study area may not be appropriate as it may not be economical to the current growth of country. The research conclude that the main problem of parking in the area is lack of enough on-street, off-street and building parking space supplies, lack of parking policy and management system, absence of parking signs and marks results which results confusion for finding available parking spaces and lack of knowledge of users for parking usage and shared parking strategies.*

**Keywords:** Parking, ITE, Supply, Demand

## 1. Introduction

Parking is an essential component of the transportation system. Parking in Addis Ababa is very critical, most parking is done on the street and it clogs major transportation arteries. Parking demands exceed available supply. There has not been sufficient off-street parking available or developed over the last ten years of the master plan's implementation period. Off-street parking is usually found in private and government premises, or fuel stations. In few areas small underground parking is available under high rise buildings.

Addis Ababa has a large concentration of motorized vehicles. About 80 percent of the total vehicles in the country operate in the city. According to (Ministry of transport, 2011), in 2011, registered vehicles in the capital city have reached 202,123. It has 27.27 percent growth when compared with 2006 data that was 158,252. The number of paid parking places on street increased from 19 in 2003 to 72 in 2008. Management of parking spaces is left to registered parking operators' associations. Parking related jobs increased from 207 in 2003 to 1,244 in 2008. This number is expected to be growing at a rapid pace with the development of the socio-economic activity of the city and growing purchasing power of its people. This challenge demands proactive planning to accommodate the growth. According to studies there seems to exist no comparative parking strategy. "Neither the city's transport authority, nor Addis Ababa city roads authority nor urban land administration of Addis Ababa claim responsibility to the development of off-street parking." In addition, there is no responsible agency to claim for the development of parking of different forms-off-street parking, parking lot, underground garage, multi-story parking. Although now days one of the proposals of the revised master plan of the city is the provision of adequate parking spaces by developing proper off-street parking

facilities to reduce bottlenecks and congestion at critical road intersections and locations.

Arada sub-city which is one of the 10 sub-cities in Addis Ababa, with an area of 9.5km<sup>2</sup>, a population size of 212009 and a population density of 22316.7peoples/sq.km is getting many parking related problems. This is due to as the sub-city is center of old and the buildings are not properly maintained, the existing parking facilities are unable to serve their purposes properly. The road segment from Arat-kilo to piazza has been chosen for this study as the street is the most business and center of movement area.

### 1.1. Statement of the problem

Various social and economic problems are being faced by Addis Ababa. Still lack of sufficient transportation is a major difficulty although the city administration is said to be working on it with huge budget allocation to construct new roads.

The transportation fluidity problem is not expected to be solved with just the construction of new roads; the city administration needs to see related aspects to develop the sector. The existing parking service is inadequate and suffers from structural problems, mainly street parking. Consequently it has contributed to inefficient utilization of the road network, safety and congestion problems. Especially Arada sub-city is priority areas that need immediate parking lots as it is the center of old and there is a large concentration of vehicles in these areas that lack sufficient parking facilities compared with the traffic flow, to study these critical road section which is a road from Arat kilo to piazza has been selected for this thesis as it is center of various business activities and contain various land uses and buildings that are running out of services.

With this limited parking spaces in the sub-city, the drivers cannot drop their customers at the specific location that customers want them to, the drivers are forced to drop passengers in the middle of the road, which is illegal, due to lack of on-street parking (terminal) spaces, this kind of problem has created disagreement between drivers and customers. And vehicles parks at business centers are boring of searching free parking spaces and as a result performing day today business activities become very difficult. Thus parking remains one of the critical issues that need to be addressed through the transport planning of the city. Comparative parking policy including parking norms and space standards and development of off street and on street parking facilities are commendable, a similar study recommended.

### 1.2 Objectives and significant of the study

Generally this thesis has a general objective of assessing and analyzing the parking demand and supply of the Arada sub-city (a case study of Arat kilo to piazza road) with their recommended solutions.

#### The specific objectives:

- To assess the adequacy of the existing parking supply.
- To make recommendations for additional parking or parking improvements.
- To study the efficiency of the existing parking capacity.
- To compare the actual demand rates of the study area with the ITE demand rates.

#### Significance of the study

Generally the research has the following advantages:

- It will give best solution to the current most problematic parking lots of the selected streets.
- It recommends the best parking management.
- Improves the Inefficient use of existing parking capacity.
- Improves the Economic, environmental and aesthetic impacts of parking facilities.
- To reduce traffic congestion through improved parking enforcement.

## 2. Research Methodology

This section outlines the approach that used to undertook the research phase of the study

### 2.1 Condition survey

Condition survey was performed for different sub-cities of the capital Addis in order to select the study area. The Arada sub-city has been selected for this research as it is the center of old and most of the buildings are running out of service. Within this sub-city Arat kilo to piazza road has been selected as a representatives of all streets as it is center of movement and contain varies services.

### 2.2 Site investigations

Site visits were undertaken throughout the selected streets various times across the day in order to observe peak versus non-peak conditions, parking hotspots and signage and

controls. Notes and photos were recorded with a geographical reference. The parking occupancies of different parking areas within one hour intervals for the selected week and weekend days were recorded.

The data were then plotted on the graph in order to determine the peak and non-peak hour occupancy of the day. It is important to determine which variables are to be observed and what their level of importance is to the research. A field observation procedure and protocol were determined so that the manner in which the team performed the observations remained constant. The aim of both of these subtasks was to improve the data quality from the field work so that the results will maintain a high level of validity.

Within the peak occupancy time interval and by using the license plate survey method parking terms like turnover rate, accumulation, occupancy, average turnover, parking volume, average duration and average occupancy were calculated as follows:

Note: To be more accurate a 15 minutes interval license plate survey method was applied.

### 2.3 Primary and secondary data collections

Primary data were collected from the different road users by using techniques like interviewing, questionnaires and actual site survey. Secondary data like traffic volumes, capacity of the parking lots, and other related data were collected from different city traffic bureaus.

The data collection methods that would be used to evaluate issue validity and perceptions to the City are presented. Analyzing data related to each issue results in a set of recommendations that can satisfy several diverse sets of stakeholders including the City, downtown business-owners, shoppers, office workers, residents, and, faculty, and staff and for the foreseeable future or until conditions change enough to warrant a new approach.

A small numbers of intercept surveys were conducted during the site investigation phase. These consist of asking people who are leaving or approaching their parked car a small number of questions designed to understand why they were parking in that location, whether the parking bay/location met their needs and their overall impression of parking in street. Time constraints limit the number of intercept surveys completed.

Generally two data collection methods were applied the first one is field survey and the second one geographical information system (GIS)

### 2.4 Determination of parking demand

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.

Parking demand were estimated based on specific land uses. The land uses that were identified actually are listed as shown below:

- Government office
- General office
- Bank
- Restaurant/clubs
- Residential units
- Hotel units
- Commercial centers
- Miscellaneous land use including library, convention center, youth hostel, theatre

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

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:

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

## 2.5 Determination of parking supply

For the supply survey, existing data that were provided by the City, recent aerial photography and on-the ground reconnaissance and verification were utilized to establish, as accurately as possible. For each numbered block all on-street parking spaces within each block's respective street faces, as well as all private or public parking lots spaces interior to each block (referred to as "off-street" parking), were counted as available spaces.

The parking supply estimation is based upon the curb length of each zone minus areas where parking restrictions or dropped curbs and junctions prevent parking. The parking length is then divided by 5.9m (minimum length for car parking) to convert the length into an approximate number of parking space

## 3. Result and Analysis

### 3.1 Inventory of Existing Parking Facilities

The Arat kilo-piazza road is a 1.7 km long which starts near Meseret cafe around Arat-kilo round about and ends at piazza square near the corner of Anbessa shoes. The parking demand and supply analysis include both side of the road and the on-street, off-street and building parking supplies that passes along the main road. The road contains 25 parking lots of which 7 are on-street 15 are off-street and the remaining 3 are a combination of on-street, off-street and building parking facilities. The parking fees are ranges from 0.5birr to 3:00birr with related to the purpose of the service for 30 minutes of duration. Within this road segment there are different residential and commercial buildings, community commercial centers, shops, bar and restaurants. The study area is only main road and didn't include minor roads; along the road segment parking is allowed according to parking allowance signal. But there are considerably illegal parking's due to shortage of parking spaces mainly on the right side of the road around Cinema Empire and near Ras Mekonen Bridge. Double line parking around Cinema Empire shows inadequacy of parking spaces in that area. The road from Cinema Empire to Ras Mekonnen Bridge is the longest one sided parking space and the other side is completely restricted for parking due to inadequacy of road width. But there are many vehicles parked on this restricted places due to shortage of parking spaces which is considered to be illegal parking.

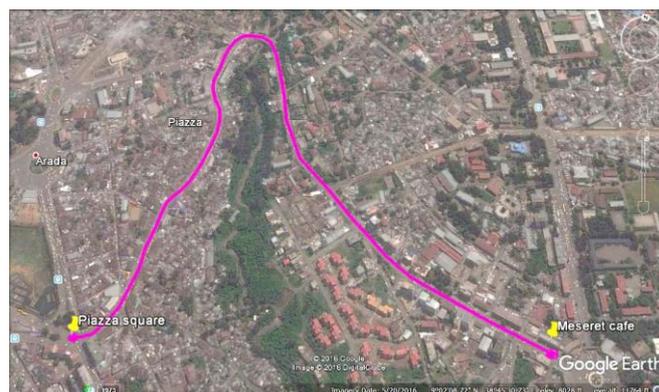


Figure 1: Location of the study area from Google maps

The inventory of existing parking facilities that includes detailed listing of the location and all other relevant characteristics of each legal parking facility, private and public, in the study area are listed below

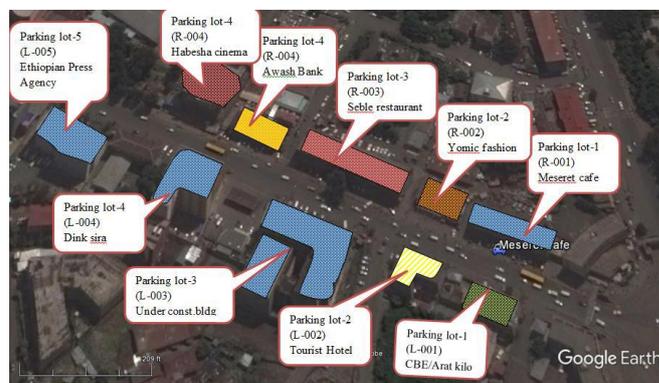
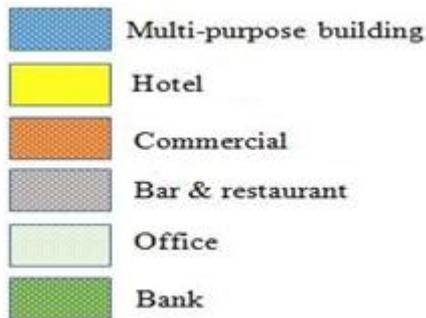


Figure 2: Parking lot locations at the right and the left side of the main road



**a) At the right side of the road**

**Parking lot-1: R-001 (at Meseret café)**

- It is a multi-purpose building which contains café and restaurants, commercial centers, business centers and residential apartment.
- Located at 9°02'00"N and 38°45'45.4"E
- Has a gross square footage area of 28881 with 12 off-street parking capacities.
- Angular parking facility

**Parking lot-2: R-002(at Yomik fashion)**

- A small commercial center
- Located at 9°02'0.6"N and 38°45'44.1"E
- Has a gross square footage area of 1824 with an off-street Parking capacity of 5.
- Perpendicular parking facility

**Parking lot-3: R-003 (at Seble restaurant)**

- A multi-purpose building which contains café and restaurants, commercial centers, and business centers
- Located at 9°02'1.7"N and 38°45'42.1"E
- Has a gross square footage area of 29988 with an off-street Parking capacity of 20.
- Angular parking facility

**b) At the left side of the road**

**Parking lot-1 L-001(CBE/Arat Kilo branch)**

- Bank area
- Located at 9° 1' 59.2644" N and 38° 45' 45.1836" E
- Has a gross square footage area of 3079 with an off-street parking capacity of 6.
- Perpendicular parking facility

**Parking lot-2 L-002(at Tourist hotel)**

- Hotel and recreational area
- Located at 9° 1' 59.7792" N and 38° 45' 43.7436" E
- Has a gross square footage area of 2985 with 66 numbers of rooms and an off-street parking capacity of 7.
- Angular parking facility

**Parking lot-3 L-003(at near to Total gas station)**

- Under construction building
- Located at 9° 1' 59.7036" N and 38° 45' 42.7032" E
- Has a gross square footage area of 7500 with an off-street parking capacity of 11.
- Perpendicular parking facility

**3.2 Summary of existing Parking supply**

**a) On the right side of the road**

*1. On-street parking supply*

**Table 1:** On-street parking supply at the right side of the road

Street name and well known places	Existing parking spaces
Habesha cinema	10
Buna bank (Diber bldg.)	8
Yegna guada bar and restaurant	8
Sheger pastry	8
Total	34

*2. Off-street parking supply*

**Table 2:** Off-street parking supply at the right side of the road

Street name and well known places	Existing parking spaces
Meseret cafe	12
Yomik fashion	5
Seble restaurant	20
Awash bank	12
Kaldis coffee	10
Buna bank (Diber bldg.)	10
Denver cafe	8
Book light	8
Licha zone	5
Ethiopian household and office furniture	10
Total	100

*3. Building parking supply*

**Table 3:** Building parking supply at the right side of the road

Building name	Existing parking spaces
Kaldis coffee	6
Buna bank (Diber bldg.)	12
Total	18

**Total supply = on-street + off-street + building supply = 34+100+18=152 parking spaces**

**A. At the left side of the road**

*1. On-street parking supply*

**Table 4:** On-street parking supply at the left side of the road

Street name and well known places	Existing parking spaces
Mega books	8
Channel five	12
Ras Mekonen bridge-CBE(Piazza branch)	145
Total	165

*2. Off-street parking supply*

**Table 5:** Off-street parking supply at the left side of the road

Street name and well known places	Existing parking spaces
CBE(Arat Kilo branch)	5
Tourist Hotel	7
Near Total	11

Dink Sira complex	8
Ethiopian Press Agency	12
Bilo's pastry	13
Arada Sub-city land administration	14
Mega Books	10
Total	80

3. Building parking supply

Table 6: Building parking supply at the left side of the road

Building name	Existing parking spaces
Dink Sira complex	16
Total	16

Total supply=on-street + off-street + Building supply =165+80+16=261 parking spaces

Table 7: Total parking supply at the right and left side of the road

Direction of parking spaces	On- street parking	Off-street parking	Building parking	Total
At the right side of the road	34	100	18	152
At the left side of the road	165	80	16	261
Total	199	180	34	413

Generally the street has a total of 152+261=413 parking spaces which is the sum of parking spaces at the right and at the left of the street

3.3 Survey data and Analysis

A summary of results from the parking surveys of on-street, off-street and building parking lots at the right and at the left side of the road are summarized below:

1) At the right side of the road

Parking lot-1: R-001/Meseret café

The number of vehicles parked at an hourly interval on July 11th 2016 for R-001(at Meseret café) is realized as shown in the chart below:

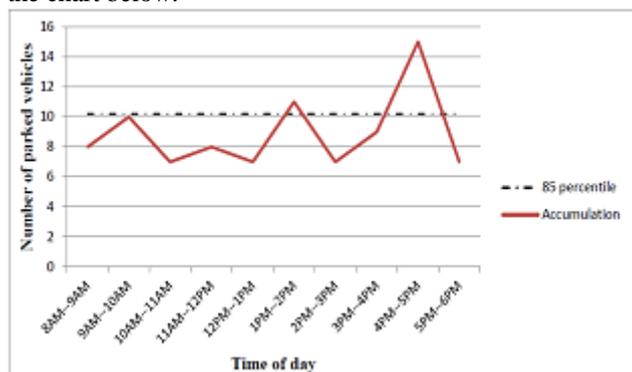


Figure 3: Accumulation curve, R-001 at Meseret café, July 11, 2016.

It shows the maximum demand is on the time interval between 4:00pm to 5:00pm. This is due to most customers are free from their work and park their vehicles within this time interval to get access for café, internet services and photo shops.

Recognizing the accumulation curve of the off- street parking spaces, are being utilized with in the allowable limit or capacity the whole day, except from 1:00pm to 2:00pm and 4:00pm to 5:00pm which is the peak flow more than the capacity of the streets.

The statistical terms used to analyze the parking space supplies of the area at the peak hour of the day are presented below:

Procedure of analysis is tabulated only for parking lot-1, result of other site are presented by table to ignore redundancy of procedure.

Table 8: license plate survey data result, R-001 on Monday July 11, 2016 from 4:00PM-5:00PM

Columns 1 to 5 are the input data. The parking status in every bay is coded first. If a vehicle occupies that bay for that time interval, then it has a code 1.This is shown in columns 6,7,8 and 9 of the table corresponding to the time intervals 15,30,45 and 60 seconds.

- Turnover is computed as the number of vehicles present in that bay for that particular hour. For the 6th bay, it is counted as 3.similarly, for the first bay, one vehicle is present throughout that hour and hence turnover is 1 itself. This is being tabulated in column 10 of the table. Average turnover =sum of turnover/total number of bays=1.42.
- Accumulation for a time interval is the total of number of vehicles in the bays 1 to 12 for that time interval. Accumulation for first time interval of 15 minutes=1+0+0+1+1+1+1+0+1+1+1+1=9
- Parking volume=sum of the turnover in all the bays=17 vehicles
- 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=  $\frac{(9+9+10+8) \times 15}{17} = 31.8$  minutes/vehicle.
- Occupancy for that time interval is accumulation in that particular interval divided by total number of bays. For first time interval of 15 minutes, occupancy=  $(9 \times 100) / 12 = 75\%$ .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. Average occupancy=  $\frac{(0.75+0.75+0.833+0.6667) \times 100}{4} = 75\%$
- Parking capacity =number of bays × number of hours=12\*1=12 vehicles hours.
- Parking load=total number of vehicles accumulated at the end of each time interval\*time=  $\frac{(9+9+10+8) \times 15}{60} = 9$  vehicles hours.
- Efficiency=  $\frac{\text{parking load}}{\text{total number of bays}} = \frac{9 \times 100}{12} = 75\%$ .

From the result average parking duration of 31.8 minute/vehicles indicates most vehicles are parked for long period of time, it shows that almost two vehicle is parked within an hour. From the turnover result of 1.42vehicles/hour, it is possible to say that the rate of usage

of parking space is poor or the frequency of space availability is low.

Occupancy of 75% and parking load of 9 vehicles hours shows the parking space coverage of the area is considered to be ideal, since the parking space is used effectively.

### 3.4 Expected parking demand

#### 3.4.1 Parking demand generators

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

#### 3.4.2 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 dividing this number by the GSF of each land use obtained by using online Google earth software as shown below for parking lot-1/Meseret café.



Area Output

894,400 m<sup>2</sup>  
0.001 km<sup>2</sup>  
0.221 Acres  
0.089 Hectares  
9627,240 Feet<sup>2</sup>

Figure 4: Land use area output for parking-lot 1/Meseret café

From the above Google earth area output only surface area is obtained. To change it into Gross square footage it was multiplied by the number of stories. i.e.

$$9627.24 \times 3 = 28881 \text{ft}^2.$$

The actual demand rate was 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.

$$\frac{13 \times 1000}{28881}$$

$$= 0.45/1000 \text{gsf}$$

Results of other parking lots are presented by table Results of other actual peak demand rates at the right and left side of the road compared with the ITE standard peak demand rates are presented by table below to ignore redundancy of procedure.:

Table 9: Actual versus ITE peak demand rates at the right side of the road

Land uses	Land use type	Size	Unit	Actual demand rate	ITE demand rate	Actual vs ITE
R-001	Commercial	6906	GSF	0.45/1000gsf	2.84/1000gsf	Below
	Residential	6	Dwelling	0.83 per unit	1.23/unit	Below
R-002	Commercial	1824	GSF	2.19/1000gsf	2.84/1000gsf	Below
R-003	Commercial/Office	29988	GSF	0.53/1000gsf	2.84/1000gsf	Below
R-004	Bank	7703	GSF	1.95/1000gsf	4/1000gsf	Below
R-005	Cinema	250	Seats	0.044/seat	0.26/seat	Below
	Restaurant High-Turnover (Sit-Down) Family Restaurant (no bar/ lounge)	18885	GSF	0.58/1000gsf	5.55/1000gsf	Below
	Commercial/Office	9443	GSF	1.16/1000gsf	2.84/1000gsf	
R-006	Restaurant	3775	GSF	4.2/1000gsf	5.55/1000gsf	Below
	Commercial/Office	7551	GSF	1.06/1000gsf	2.84/1000gsf	Below
R-007	Bank	11102	GSF	2.7/1000gsf	4/1000gsf	Below
	Commercial/Office	22205	GSF	1.35/1000gsf	2.84/1000gsf	Below
R-008	Commercial/Office	16581	GSF	0.66/1000gsf	2.84/1000gsf	Below
R-009	Commercial/Office	9892	GSF	1.2/1000gsf	2.84/1000gsf	Below
	Bank	2473	GSF	2.4/1000gsf	4/1000gsf	Below
R-010	Commercial/office	1500	GSF	2.6/1000gsf	2.84/1000gsf	Below
R-011	Restaurant	1785	GSF	2.8/1000gsf	5.55/1000gsf	Below
R-012	Restaurant	3424	GSF	2.63/1000gsf	>>	Below
R-013	Restaurant	4425	GSF	1.13/1000gsf	>>	Below
	Residential/apartment	24	Unit	0.2/unit	1.23/unit	Below
R-014	Commercial/office	17340	GSF	0.46/1000gsf	2.84/1000gsf	Below
R-015	Commercial/office	8584	GSF	2.44/1000gsf	2.84/1000gsf	Below
	Restaurant	8570	GSF	2.9/1000gsf	5.55/1000gsf	Below
	Cinema	805	Seats	0.026/1000gsf	0.26/seat	Below

		seats				
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**Table 10:** Actual versus ITE peak demand rates at the left side of the road

Land uses	Land use type	Size	Unit	Actual demand rate	ITE demand rate	Actual vs ITE
L-001	Bank	3079	GSF	1.62/1000gsf	4/1000gsf	Below
L-002	Hotel	66	Room	0.15/room	0.89/room	Below
L-003	Commercial/Office	7500	GSF	1.2/1000gsf	2.84/1000gsf	Below
L-004	Commercial/Office	5368	GSF	1.49/1000gsf	2.84/1000gsf	Below
	Bar and restaurant	2147	GSF	3.26/1000gsf	15/1000gsf	Below
L-005	Commercial/Office	4000	GSF	2.5/1000gsf	2.84/1000gsf	Below
L-006	Commercial/Office	3283	GSF	2.13/1000gsf	2.84/1000gsf	Below
	Restaurant	1641	GSF	4.3/1000gsf	5.55/1000gsf	Below
L-007	Government office	6599	GSF	1.97/1000gsf	3.65/1000gsf	Below
L-008	Commercial/Office	4377	GSF	2.51/1000gsf	2.84/1000gsf	Below
L-009	Restaurant/club High- Turnover (Sitdown) Restaurant with bar/lounge	2100	GSF	2.6/1000gsf	16.3/1000gsf	Below
L-010	Commercial/Office	105964	GSF	1.42/1000gsf	2.84/1000gsf	Below

### 3.4.3 Parking demand calculations using actual and ITE peak demand rates

The Institute of Transportation Engineers (ITE) produces a periodic 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 variety of parties, including public agencies, developers and consulting firms.

The researcher includes the ITE rates as guidelines to benchmark how the study area existing supply compares to its land uses. While recognizing that every community's needs are different, below 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 researcher used the City's land use data from Google earth map to determine the square footage of each land use in Arat-kilo-piazza road, and multiplied that square footage (or other independent variable, such as residential units or employees) by the actual and ITE average peak period demand.

There for the current observed/actual demand requires a minimum of  $146+40=186$  additional parking spaces where as the ITE standard recommends an additional parking space of  $703+266=969$  which is the sum of parking spaces both at the right and left side of the road. 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 in our country. So taking the average of the two /577 parking spaces are better.

## 3.5 Parking survey/questionnaire

### 3.5.1 Study population size

The study area has a total of 25 parking lots from which 13 are mixed-use building 4 commercial, 3office, 1bank, 2 café

& restaurant and 1 hotel with a total of 413 parking spaces and a peak actual demand of 459. The study population is total parking peak demand from each land use group selected by stratified sampling.

### 3.5.2 Sample Size

The sample size was determined using the formula for population proportion.

$$n = \frac{\frac{Z^2 p(1-p)}{e^2}}{1 + \left(\frac{Z^2 p(1-p)}{e^2 N}\right)}$$

Where: Z = The Z- score corresponding to the 95% confidence level which is 1.96.

e = margin of error/confidence interval

N=population size

Assumption for calculating the sample size:

- Population size=120
- Confidence level = 95%
- 5% margin of error/confidence interval
- 50% proportion for general level of accuracy is appropriate.

Taking the above assumption 'n' becomes 100.

From the questionnaires distribute to strength the parking demand of the area the following analysis are formulated:

Majority of the respondents were from the questionnaires collected majority of the respondents were male and young/ the age between 25 to 35 years. About half of the respondents were residents of the area and more than half of the respondents use private cars and parks in the area 5 to 7 days a week with average parking duration of one to two hours within a day in a certain parking lot. This indicates that as the customers uses the parking lots frequently for a long period they need off-street parking facilities to afford for long-term usages. Majority of the respondents use on-street parking facilities due to lack of sufficient parking facilities and they say it's difficult to find parking spaces within the street. Even though the current parking fee is almost fair and appropriate, some of the drivers are not willing to pay it. In the future most of the drivers want for building parking rather than on-street parking facility.

Customers also reported that absence of parking marks and signs are creating inefficient utilization of parking spaces due to confusion of the availability of parking spaces and whether a certain parking space is restricted or not. In addition to these customers are also suggests the parking meter technology which enables to give information about the availability of parking spaces in each parking lot and makes parking fee simple by smart card system.

## Conclusions and Recommendations

### 4.1 Conclusions

This research sought to understand the parking demand and supply characteristics for Arat kilo to piazza road. The actual weekday and weekend site survey from the 8:00AM morning to 6:00PM afternoon was made to calculate the peak demand of the area in addition with some questionnaires distributed to support the demand. The license plate survey was also made to support the actual parking space supply of the area.

The study area has a total of 413 parking spaces from which 199 are on-street 180 are off-street and 34 are building parking spaces with average turnover of 1.82 vehicles/hr., average parking duration of 34.24 minute/vehicles and average occupancy of 86.4%.

From the result average parking duration of 34.24 minute/vehicles indicates most vehicles are parked for long period of time, it shows that almost two vehicles are parked within an hour. From the turnover result of 1.82vehicles/hour, it is possible to say that the rate of usage of parking space is fair or the frequency of space availability is moderate.

Average occupancy of 86.4% shows the parking space coverage of the area is high and considered to be full. Since someone looking for a space will not find an empty one easily and may need to circle as few times before one becomes available.

The peak demands vary along the day with respect to the purpose of the service. Mostly the peak demand is seen in the morning between 2:00AM to 3:00AM, in the lunch time between 6:00AM to 7:00 and in the afternoon between 10:00AM to 12:00PM.

Parking spaces within the area are used by shoppers, cinema house customers, café, bar and restaurant users, bank customers and government and private office workers, who at certain times will compete for the available spaces. The availability and parking fees of the area varies significantly between different roads within the study area based on the facility going on. And the parking fee is ranges from 0.5 birr to 2.00birr per 30 minutes time interval. Most of the parking lots serve parallel and perpendicular parking directions. Even if this type of parking is more scalable or requires little parking space than parallel and angular parking facilities, it causes obstruction and accident to the road traffic.

The demand estimation was done by land use analysis. The actual demand rate indicates the community around this area needs additional 186 parking spaces whereas the ITE standard recommends 969 parking spaces to afford the existing demand.

To support the current parking demand and supply of the area some questionnaires which contain 15 questions with a sample size of 100 was distributed to the drivers. From the questionnaires collected majority of the respondents were male and the age between 25 to 35 years. About half of the respondents were residents of the area and more than half of the respondents use private cars and parks in the area 5 to 7 days a week with average parking duration of one to two hours within a day in a certain parking lot. Majority of the respondents use on-street parking facilities and they say it's difficult to find parking spaces within the street. Even though the current parking fee is almost fair and appropriate, some of the drivers are not willing to pay it. In the future most of the drivers want for building parking rather than on-street parking facility.

Generally the available parking spaces are not balanced with the current demand of the area this and the following other problems are observed in the study area

- Absence of constructed off-street parking facilities
- old buildings are running without installed parking spaces
- Lack of parking signs that guides the users easily to where parking space is available.
- Lack of parking policy and management.

### 4.2 Recommendations

The following measurements are recommended for the study:

- The government should develop parking policy and strategy in national level that used to improve the parking usage of the area and brings an effective and efficient usage of parking spaces.
- As new building development occurs, ensure that the parking needs are addressed according to the standards and the government should take appropriate measurements for those that are not constructed based on the standards.
- The government should construct and widely spreads smart parking facilities as being started in some selected areas of the city. This type of parking space is not located on road side, in which any member of the public can park. It should be constructed with the mandate of specific regulations (e.g. maximum stay hours or minutes, payment of fee etc) and can be operated by public or private sector or organization. This type of parking lot is best fitted at the road from parking lot-1(at Meseret café) to parking lot 13(at licha zone near Ras Mekonnen bridge) It promises to provide accessibility for people to visit downtown or any places within the city because the people are confidence of where to park.
- Working with parking stakeholders, it should be ensured that on-street and off-street parking options are well coordinated, quick turnover for retail/restaurant uses while off-street parking options are used for employee parking and other long-term needs.

- Develop a timeline and funding sources to upgrade parking meter technology and equipment, such as installing meters able to accept credit and debit cards, multi-space meters and other improvements to enhance the customer experience. This technology also allows for better monitoring of peak hour usage so rates can be adjusted to reflect demand and enforcement issues can be eased.
- Make the best use of all available spaces, using shared parking and limited use strategies. This includes using of parking spaces with the nearest available parking spaces whenever the current parking space supply is full.
- Continuously educate the public on availability and location of parking to meet the need for more information about parking options and to adapt angular parking facilities as it is the gentler turn allows easier and quicker parking, narrower aisles, and thus higher density than perpendicular parking.
- Develop a standardized parking signs and other information systems throughout the area that makes the drivers easy to find parking spaces and direct them to the parking supply available in the nearest location this finally facilitate the parking usages of the area.
- Off-street parking facilities/spaces should be provided at designated areas of the study area. Insufficient off-street parking facilities results in on-street parking which reduces the effective width of roads, thus leading to obstruction of traffic flow.
- Parking restrictions are to be enforced at Ras Mekonnen bridge to Piazza Round about where only one sided on-street parking is allowed, and traffic police will need to be empowered to do so

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