

Trip Rates and Parking Requirements for Restaurants and Coffee Shops in Amman-Jordan



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Abstract: *The aim of this Study is to provide the parking requirements and vehicles trips models using linear regression, which is able to predict the trip - attracted to restaurants and coffee shops in Amman- Jordan.*

A total of thirteen restaurants and coffee shops were surveyed, where the number of vehicles which enter a restaurant or coffee shop during peak hour within a 15-minute time interval, during the period between 15th of May 2016 and 15th of July 2016, for two days of the week between (12:00 PM - 12:00 AM), were counted. Further, it relates the trip attraction of the restaurants and coffee shops as a function of the characteristics of the collected data. Utilizing the data collected the characteristics of the selected restaurants and coffee shops have been thoroughly studied, where the correlation and regression analysis were performed. The study showed that the multiple linear regression model with the independent variables of gross floor area, number of floors, quality of service, and number of employees, more certainly the gross floor area, with the R² value of 0.86, gives the best estimate of peak trip attraction and parking requirements. Also, a 2.36 parking spaces per 1,000 GSF determined in this study by simple linear regression with R² of 0.65.

Those models shall be of great use for estimating the trips attracted and parking requirements for a new or existing restaurants and coffee shops in Amman, and therefore helps to assess the traffic impact of the restaurants and cafes on the geometric design of roadways in the surrounding areas.

Keywords: *Parking requirements, trip and parking generation rates, restaurants and coffee shops, peak hour of generation*

I. INTRODUCTION

Jordan is rapidly developed and its road network expanded nowadays, as a result of the increasing commercial, tourism and industrial growth, in addition to the huge numbers of refugees and it has become the preferred destination for live and tourism within the Middle East. As a result, the number of restaurants and coffee shops in Amman increases to meet the increased demand.

As a result of all of that Jordan has become a top priority to evaluate and forecast the trip and Parking demands for existing attraction land uses, one of them is restaurant in type of a coffee shop.

This case study considers Trip Generation, which is an analytical process that provides a relationship between urban activity and travel. The number of trips to and from activities in an area is related to land use and socioeconomic characteristics. Trips that originate or terminate within each zone are known as trip ends from origins or destinations. For the development of transportation models, these trip ends are called productions and attractions.

Trip generation, as applied in regional transportation planning, is usually based on mathematical relationships between trip ends and socioeconomic or activity characteristics of the land use producing or attracting the trips. However, impact analysis of new developed sites often uses trip rates obtained from historical studies to estimate the number of trips that will be generated.

Trip generation analysis has two main functions: (1) to develop a relationship between trip end production or attraction and land use, and (2) to use the relationship developed to estimate the number of trips generated at some future dates under a new set of land-use conditions. To illustrate the process, consider two methods: cross classification and rates based on activity units.

Another useful used method is regression analysis, which has been applied to estimate each productions and attractions.

The ITE-handbook, most recent documentation of ITE (2012), is usually used as a source of information on trip rates but actually it is understood that the socio-economic characteristics of trip makers in the United States are not the same to those in Jordan. So, it is important to generate a local trip and parking generation manual for different land uses, such as restaurants and coffee shops, which accommodates the local trip maker's characteristics.

II. OBJECTIVE

The main issue that derived this research is the absence or shortage of parking lots in most of the restaurants and coffee shops in Jordan. And the absence of parking generation rates manuals for restaurants and coffee shops in Jordan. Hence, this study shall help urban planners in identifying the volume of parking required for restaurants and coffee shops and their characteristics.

The main objectives of this study are: (1) Generate regression models to evaluate and predict daily vehicle trips and parking rates within the day and peak hours, based on the specifications of restaurants and coffee shops such as: gross floor area (m²), total number of available parking spaces,

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and total number of staff (employees), (2) Compare the generated rates and models with other studies in different manuals such as the ITE manual, (3) Determine the required number of parking spaces by each restaurant and coffee shop, in order to improve the restaurants and coffee shops capacity and their services.

III. LITERATURE REVIEW

The most commonly used approach to forecast travel demand is the "four-step process", namely: Trip Generation, Trip Distribution, Modal Choice, and Traffic Assignment. [1]

Parking planning in accordance with what other trip generation manuals or what other cities require may not only repeat the same problems, but also leads to failure in revealing the fact about where and how such requirements came from. In a survey for planning directors in 144 cities, Shoup found out that the most frequent implemented methods for setting parking requirements are to consult the Institute of Transportation Engineers (ITE) manual "and to survey nearby cities", where he highlighted that both of them cause serious troubles. Therefore, the question of the minimum parking issue will remain outstanding as it is not yet answered in response to the demand for vehicle trips for various land use and set of conditions. In USA, the ITE has published the trip generation manual in order to reveal the demand for vehicle trips according to various land uses, where for each land use, the "trip generation rate", is defined as "the number of vehicle trips that begin or end at a land use during a given period". [2]

Moreover, they published a parking generation manual for parking generation rates which is defined as the peak parking occupancy as a function of land use. In the said manual, parking requirement points out to the number of parking that might be used in a particular time, place and price. These manuals are considered the first and most popular references in USA providing vehicle trip rates according to specific land use within weekdays or peak hours. The last edition of the trip generation manual was the ninth version of that manual published in 2012, which was composed of more than 5,500 studies and divided into 172 land uses that covered ten fundamental classes: port and terminal, industrial, lodging, recreational, institutional, and medical, office, retail, and services (ITE, 2012). Nevertheless, the last parking generation manual was the ninth edition. At some stage in each period of time, ITE announced new variations of its manual in order to update vehicles trips rates to reveal changing individuals behaviors, and new regulations that can be changeable with time. [3]

Regarding to the rapid-food eating places in Amman, Al-Jabari, studied attracted cars to those restaurants, in which twelve fast-food restaurant were selected to build trip models for this land use. The statistics collection include parts, the primary one is a manual counting of automobiles coming into or leaving the restaurant; counted among three days within 15-minute duration. The second part included a collection of specific types of eating places that includes gross floor area, range of parking lots, personnel, land cost and availability of entertainments in the selected location, which had been used as independent variables for the evolved models inside the regression analysis. The end result viewed that the gross floor area is the key variable to estimate the attracted vehicle trips with R2 of 0.951. [4]

Al-Masaeid studied various land uses in Jordan in order to establish measurable models for evaluating car parking requirements of them as part of Jordan with 208 sites located in few cities in Jordan including Amman, Zarqa and Irbid. Those land uses incorporate thirty five flat buildings, seventeen shopping centers, forty two office buildings, fifty three hospitals, twenty one restaurants, and forty resorts. At the beginning, to evaluate the peak required parking accurately for the chosen land uses as they were, each chosen site shall contain a defined parking garage, and the parking is not allowed to be utilized by adjacent land uses. Additional standard was the locales of each area use shall be located in various urban areas. Clearly, this measure was embraced to build the space of conclusion. Finally, the parking garage for each site shall have a satisfactory parking supply. The accessibility of an adequate parking supply was evaluated through field study.

In view of hospitals, this takes a look at considers two types of hospitals: general hospitals and clinical centers. The principle contrast between the two types as associated with parking is the part of day by day workers and visitors to the number of beds. Contrasted and the general hospitals, clinical centers have a more prominent population/ bed. The prescribed parking requirements for general hospitals differed from 1.6 to 3.4 spaces/bed, whilst for clinical centers, the extent fluctuated from 2.5 to 3.4 spaces/bed.

The peak parking demands differed from 8 for hospitals having 15 beds to 97 for hospitals having 702 beds. The coefficient of linear correlation among the parking demand and the range of beds, is 0.83. [5]

Furthermore, Kattor et al. specified that the development of cities, the design of transportation facilities and services are highly dependent on travel demand forecasting. They managed a study and used multiple regression technique to introduce a trip attraction model to evaluate the trips attracted to any commercial facility in Kerala medium sized towns. In addition, this study included an analysis of trip attraction which is based on the features of the commercial nodes in Kerala medium sized towns. After the features of the selected commercial nodes were gathered, it was concluded that the best multiple regression model to estimate trips attracted in any of Kerala medium sized towns centers, is the percentage of office in the commercial node and the number of employees with the R2 and Adjusted R2 value of 0.99 and 0.99 respectively. [6]

IV. METHODOLOGY AND DATA COLLECTION

Trip rate examination and regression analysis methods were used as a part of the study. For that thirteen restaurants and coffee shops around Amman town were studied.

A. Traffic counts

The traffic counts of the "in and out vehicles" were collected for the twelve restaurants and coffee shops by manual count of the attracted and produced vehicle trips. Manual counting of vehicles' movement was carried for each restaurant and coffee shop for two days per week (Saturday and Tuesday) from (15th of May 2016 to 15th of July 2016), for the time period from (12.00 PM – 12.00 AM) with an interval of 15 minutes.

B. Physical Characteristics Data Collection

Physical characteristics are used to generate the travel models. This study will be based on independent and response factors.

In this study, the following variables were collected as independent ones: 1) Number of mentioned categories of items in the menu of each restaurant and coffee shop (I), 2) Number of employees in each restaurant and coffee shop (E), 3) Gross floor area in m2 (GFA), 4) Number of available parking in each restaurant and coffee shop (AP), 5) Number of floors in the restaurant and coffee shop (F), and 6) overall quality of the restaurant and coffee shop (Q).

The major response variable to formulate the model is Number of attracted vehicles within peak hour (Y). Table (1) summarizes the total number of daily trips and attracted vehicles during peak hour for all restaurants and coffee shops.

Table- I: Total number of daily and attracted trips during peak hour for all restaurants and coffee shops

Name of restaurant and coffee shop	No. of peak attracted trips (Y) in weekend	No. of peak attracted trips (Y2) in weekday	PM Peak hour
Lemon	37	30	17:30 - 18:30
Pastich	48	37	18:45 - 19:45
Zait & Zaater	53	44	19:45 - 21:45
Azkadenya	36	31	18:45 - 19:45
Vivid	28	25	16:30 - 17:30
In house	21	16	19:15 - 20:15
Chi Chi	22	28	19:30 - 20:30
Mijana	59	53	18:00 - 19:00
Zoka	33	29	19:00 - 20:00
Sofa lounge	38	33	20:45 - 21:45
Atay	27	21	21:00 - 22:00
Bianca	21	18	19:45 - 20:45
Java u	18	21	16:45 - 17:45

V. ANALYSIS AND DISCUSSION

As results, the total number of trips in Saturday is larger than in Tuesday. And the ratio of the common vehicle trips entered in afternoon hours forms 39% from the overall vehicle trips entered the restaurants and coffee shops through the day-time, as compared to 61% in evening hours. All of that are because most of customers preferred to book their seats in evening periods after completion of shopping and their weekend works. And it was noticed that the Peak period varies between (19:00 PM – 20.30 PM).

A. Modeling of Vehicles Trips

Regression analysis is the main technique used to develop models between response and independent variables. Two types of models will be developed, the first is single variable and the second is multivariable one. For simple linear regression, the developed models with R², F- values and P- values are mentioned in Table (2). This table shows that simple linear regression models for number of floors (F) and number of available parking spaces (AP) are not significant, because their F-values are less than 5.0 and P-values are larger than 0.05. Also, it shows that the best independent variable was the gross floor area, because it has the highest R² and F- value and the lowest P-value.

Table- II: Simple linear regression models

Variable	Single Linear Model	R ²	F-value	P-value
GFA	Y = 13.594 + 0.0132 * GFA	0.65	20.39	0.0009
Q	Y = 1.133 * Q	0.60	16.52	0.0019
I	Y = 0.172 + 3.047 * I	0.52	11.70	0.0057
E	Y = 16.74 + 1.314 * E	0.35	5.97	0.033
F	Y = 13.42 + 10.25 * F	0.21	2.86	0.1187
AP	Y = 34.49 + -0.0311 * AP	0.00012	0.0013	0.972

Multiple regressions were conducted using SPSS, stepwise regression model approach.

The developed model that involves all independent variables is:

$$Y = -39.98 + 0.00697 * GFA + 4.18 * F + 0.503 * AP + -0.015 * I + 0.896 * E + 0.473 * Q \dots\dots\dots (1)$$

With R² = 0.88, F-value = 7.31 and P-value = 0.0144

By the analysis of variance (ANOVA), it can be found that the P-values and T-values for many independent variables are not significant. So, it could be a high correlation between variables. In order to estimate the correlation between the independent variables with each other, a correlation matrix had been developed. It is found that, correlation coefficient are high (the most close to 1) in the case of number of categories items (I) and the quality (Q), then the lower significant one with peak attracted trips (Y) was eliminated. In addition to elimination of number of available parking spaces (AP) which is not a significant factor.

So that the developed model related to rest independent variables is:

$$Y = 0.0083 * GFA + 2.434 * F + 0.782 * E + 0.36 * Q \dots\dots\dots (2)$$

With, R² = 0.856, F-value = 11.92 and P-value = 0.0019

Based on the ANOVA table of the previous model, it is found that model (2) is the most significant model could be used to predict the peak attracted trips for restaurants and coffee shops in Jordan.

B. The Required Parking rate

This study found the required parking rate for each restaurant and coffee shop, depending on created models, which were resulted from regression analysis. Where they show the number of needed parking depends on peak attraction. This may be beneficial in enhance the services in restaurants and coffee shops by raising each one capacity.

Table (3) display the required parking rate per gross floor area (in 100 square meter unit) -which is the most significant factor that affect the peak attracted trips and parking demand-, which is 2.36.

Table- III: Required parking rate per gross floor area (in 100 square meter unit)

Name of Restaurant and Coffee shop	Required parking rate per GFA in 100 m ²
Lemon	2.50
Pastich	2.00
Zait & Zaater	1.91
Azkadenya	2.38



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Vivid	2.55
In house	3.00
Chi Chi	2.31
Mijana	1.68
Zoka	2.64
Sofa lounge	2.36
Atay	2.55
Bianca	2.60
Java u	2.19
Average	2.36

VI. CONCLUSION AND RECOMMENDATIONS

A. Conclusions

The main conclusions and findings in this research are the followings:

- Peak hour of trips for the restaurants and coffee shops in Amman is during the period between (19:00 PM – 20:30 PM).
- Gross Floor Area is the most significant independent variable that affects peak attracted trips for restaurants and coffee shops in Amman.
- Similar to many studies such as ITE and Dubai manuals, the relationship between the parking demands of restaurants and coffee shops and gross floor area was linear.
- The best developed model used to predict the peak attracted trips and peak parking demand for restaurants and coffee shops in Amman is the significant multiple linear model, but for planning, in other hand the size, represented by GFA of the building is the best independent variable to use in predicting the peak attracted trips and required parking rates for restaurants and coffee shops in Amman.
- The required peak parking rates according to gross floor area in 100 m² for each restaurant and coffee shop is 2.36.

B. Recommendations

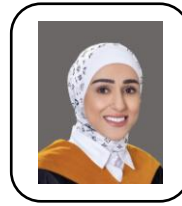
- Most of selected restaurants and coffee shops were located Amman, it is recommended to study restaurants and coffee shops located in other cities in Jordan.
- The traffic counts in this research were studied two days for three months; it is recommended to increase the duration of counts for a long one year in minimum, to cover the differences during the various seasons, and compare the outcomes with this study.
- For the planning works and to assess vehicles' counting, it is recommended to install sensors in the most important places. This can reduce the difficulties while counting vehicles, as well save time, cost and increase the quality of the gathered data, so more accurate results can be achieved.

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AUTHOR PROFILE



Eman A. Shehadeh I am a Civil Engineer holding MSc Degree in Civil Engineering/ Highway and Transportation Engineering from Jordan University of Science and Technology with Honors Grade (Graduated in 2017). I have obtained my BSc Degree in Civil Engineering from The Hashemite University with a "Very Good" Grade in 2010. I have 7 Years' experience in Civil Engineering accumulated while working in Construction Contracting companies, Engineering Consulting firms and as a TA/ Lab Supervisor at a University.

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1. Hashem R. Al-Masaeid, Taisir S. khedaywi, **Eman A. Shehadeh**, and Rana A. Al-Shafi, "Trip and Parking Generation of Hospitals and Medical Clinic Centers in Jordan", paper submitted for publication, 2017.
2. **Eman A. Shehadeh**, "Integration of GIS, Traffic volume, Vehicular speed, and road grades, Related Air Pollution in Amman", paper submitted for publication, 2019.

My presentations are:

1. Taisir S. khedaywi, Hashem R. Al-Masaeid, and **Eman A. Shehadeh**, "Parking Requirements for Medical Clinic Centers in Amman", Presented at the Poster Session of The "8th International Conference on Engineering, Project and Production Management (EPPM 2017)" which was held during the period 19 – 21 September, 2017 in Amman, Jordan.
2. **Eman A. Shehadeh**, Bara' AbuAdess, Ahmed Sharab, and Nabil Ayoub, "Examining the Performance of Hot Mix Asphalt in Road Pavement Engineering Using Zeolite", Presented at the Poster Session of "Arab Artificial Intelligence Summit (AAIS 2019)" which was held during the period 29 – 30 October, 2019 at the King Hussein bin Talal Convention Center – Dead Sea, Amman, Jordan.

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