Trip attraction model of selected zones in Baghdad city

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Abstract. The initiation of this analysis is to establish a mathematical model for predicting trip attraction for Bab al-moadam sector in Baghdad city that involving land use features. To achieve the study objective, the study area is divided into two zones. A conversation mechanism has been adopted to collect data. The data collection included all education centers, state institutions, shopping centers, and health centers, and their numbers were 21 educational centers, 10 centers belonging to state institutions, 5 shopping centers, 12 health centers. The trip attraction models for six purposes of trips (Educational, state institution, shopping, health, other trips, and the total trips) have been developed. These models have been built when the gathered data was fed to the (spss) software version 22 by using stepwise regression process. The results show that the attraction of trips is highly related to the number and diversity of vital centers in the region. we conclude from this study that educational trips depend on the number of students. Work trips depend on the number of employees. The number of stores is the most influencing factor on shopping trips. Health trips depend largely on the number of beds in addition to the number of patients in consulting clinics and emergency clinics. Other trips are it depends on other health trips, other educational trips and other work trips, the number of total trips that are attracted to the study area depend on the number of employees, the number of health staff, the number of visitor, and the number of students.

1. Introduction

The trip demand is the number of people or vehicles that travel in a specific segment of the transportation network over time and under different conditions of land use, social, economic, and environmental conditions. The number, form, and start of the trip (start and end of the trip) on the transportation network are typically determined by travel demand forecasting[1]. Modelling travel demand is usually accomplished in four steps. Trip generation is the first step of travel demand modelling. Trip generation estimates number of the trips start (production) or end (attraction) in a zone. Trip production represent the trip produced by household in the traffic analysis zone (TAZ), while trip attraction represents trips attracted by land use activities in TAZ[2]. Trip generation rates have an impact on the region's transportation network and infrastructure planning.

2. Research Objectives

The main objective of this study is to determine the generation of trips from the uses of the Bab Al-Moadam sector in the city Baghdad through fulfilling two objectives;
1- Identify and quantify the number of trips generated by the educational and health uses of the land, shopping centers, and state institution, as well as the number of visitors coming to the Bab Al Moadam

2- To relate the generation of trips with respect to land use and the characteristics of the selected site.

3. Research Methodology

In this study, the regression model is used for analyzing the Trip Attraction Rates for shopping, educational, health, state institutions, five shopping centers, twenty one educational centers, ten state institutions centers, twelve health centers are surveyed. The research method is summarized by the following points:

- **Phase 1 (Initial study):** Preliminary understanding of the trip attraction concept and regression model, literature review, Aim, objective, and overview of the study.
- **Phase 2:** Survey and data collection.
- **Phase 3:** Calculation and analysis of average trips attraction rate.
- **Phase 4:** Results and conclusion.

4. Location of The study area (Bab al-Moadam area)

Baghdad is the largest city and capital of the Republic of Iraq has the largest urban population in Iraq. It lies on the banks of the Tigris River the most important natural characteristic of the city’s which divides the city into two parts, Al-Rusafa on the left side of the river and Al-Karkh on the right side of it. It has an area of 204.2 square kilometers with a population of 8405000 inhabitants census of 2015. It has a special role among Iraqi cities for the following reasons:

1. It is a politician and administrative capital of Iraq
2. It has an ancient historical importance
3. Its central location gives importance to a considerable extent.

For all the above reasons, it plays as a center for commercial, business services, administrative, activity and, educational therefore, acts as the focal point for the national transport systems of Iraq [3]. Bab Al-Moadam is one of Baghdad’s most important central areas, located north of the city’s center, between the Al-Sarafiya and Al-Sinak bridges, and near the Bab Al-Sharqi district. Bab Al-Moadam is a historical area that has witnessed many changes over the ages and the effects of those ages are still evident on the area and there are many ancient buildings still. The Bab Al-Moadam area includes one of the bridges that connects Al-Karkh to Al-Rusafa across the Tigris River and is called the Bab Al-Moadam Bridge, which was built in 1977, with a length of 855 meters, between Al-Tala’a Square on Haifa Street (from Al-Karkh side) and the Iraqi militant square on Al-Rasheed Street (from Al-Rasafa side). Bab Al-Moadam is considered a very vital area in Baghdad because it includes many important institutions, where the area is divided into the Science District and the Medicine District (Amanat Baghdad ), where the Science District includes many colleges, institutes, and government institutions, including the Iraqi Ministry of Finance, Baghdad University College of Pharmacy, Al-Mustansiriya University College of Engineering and others Colleges, the science district also includes the large Bab al-Moadam garage, and it includes the al-Maktabat Street, which includes many libraries and also popular markets. As for the medicine district, it is located on the eastern bank of the Tigris River and includes the medicine district, the largest medical institution in the Middle East, as it includes many hospitals in various specialties, and it also includes the University of Baghdad, the College of Medicine, the University of Baghdad, the College of Dentistry, the Technical Medical Institute and the Medical Technical College, and the Bab al-Moadam area includes the Rafidain Bank and a bank Al-Nahrain Al-Islami. Because of the numerous car repair shops in the Bab Al-Moadam district, it is classified as an industrial zone. The Bab al-Moadam region was divided into two sections for this study: the Science Distract (sector 1) and the Medicine Distract (sector 2). Figures 1, figure 2, and figure 3 show how to choose a study area and how to divide it.
5. Sample size

In this analysis, the interview and conversation methods were used to collect data. Data were obtained from 21 educational centers, and the educational center data was analyzed (number of students, number of employees, number of teachers, no.of car in garage). The data obtained is from ten state institutions’ centers (number of employees, no. of car in garage, number of visitors). 5 shopping malls were visited, and the information gathered was as follows: (market area, number of shops number of kiosks, number of employees, number of trips per day). The data were obtained from 12 medical centers (number of doctors, number of employees, number of beds, health staff, number of patients in...
consulting clinics and emergency, no of car in garage). The total number of students was 44742, the total number of employees was 11601, the total number of shopping trips was 5600, and the total number of health trips was 9070. The locations of educational centers, state institutions, shopping centers, and health centers are represented in Figures 4, figure 5, figure 6, figure 7, respectively.

Before constructing the model, a preliminary analysis of the results from the field survey was carried out. The results can aid in model development decision-making later on. Figure 8 illustrates the rise in the number of students in educational centers, which refers to an increase in educational trips. An rise in the number of government workers resulted in an increase in work trips in figure 9.
The number of beds in a hospital determines its capacity; the more beds, the higher the hospital's capacity, and therefore the attractiveness of visiting it. Figure 10 represents the hospitals in the study area, along with their respective bed numbers. Each market's area within the study area is represented in Figure 11.

6. Trip Attraction Model
A trip generation model may traditionally derived with a standard statistical technique, called Multiple Linear Regression (MLR)\[4\]. The regression modeling is the statistical process used to determine the relationship between two or more numbers of variables to generate a model that predicts one variable from the other(s) in order to present the data in the best fit. The goal of multiple linear regression is to develop the best model at a selected confidence level that satisfies the basic assumptions of regression analysis \[5\]. The conditions to achieve typical regression models are, as follows:

- High intercorrelation does not exist among predictor variables,
- Influential observation or outliers do not exist in the data,
- The distribution of error is normal, and
- The mean of error distribution is equal to zero-
- Errors have a constant variance $\sigma^2$(Homoscedasticity Hypothesis)-

The symbols of the variables taken into account in the analysis are expressed as follows:

1. **Dependent variables:**
   - $Y$: Attraction all trips per day.
   - $Y_1$: Attraction educational trips per day.
   - $Y_2$: Attraction work trips per day.
   - $Y_3$: Attraction shopping trips per day.
   - $Y_4$: Attraction health trips per day.
   - $Y_5$: Attraction other trips per day.

2. **Independent variables:**
   - $X_1$: No of students(No.).
   - $X_2$: No of employees(No.).
   - $X_3$: No of teachers(No.).
   - $X_4$: No of health staff(No.).
   - $X_5$: No of shops(No.).
   - $X_6$: No of kiosks(No.).
   - $X_7$: The number of floors of the hospital (No.).
   - $X_8$: No of beds(No.).
   - $X_9$: No of patients in consulting clinics(No.).
   - $X_{10}$: No of patients in emergency clinics(No.).
   - $X_{11}$: No of car in garage(No.).
   - $X_{12}$: Other trips Education (No.).
   - $X_{13}$: Other trips Work (No.).
   - $X_{14}$: Other trips health (No.).
   - $X_{15}$: The total number of visitors(No.).

SPSS program ver. 22 is used in the correlation matrix calculation for the independent data collection variables as represented in Table 1, Table 2, Table 3, Table 4, Table 5, Table 6.

**Table 1.** show the correlation matrix for the independent variables for the total model.

| Independent variable | Y  | X1   | X2   | X3   | X4   | X15  |
|----------------------|----|------|------|------|------|------|
| Y                    | 1  | 0.716| 0.041| 0.466| 0.037| 0.545|
| X1                   | 1  | -0.082| 0.681| -0.206| -0.106|
| X2                   | 1  | -0.07 | -0.019| -0.082|
| X3                   | 1  | -0.221| -0.101|
| X4                   | 1  | 0.037|
| X15                  | 1  |      |      |

The above table shown the correlation between dependent and independent variables and the extent of their correlation. we notice that the variable $Y$ is related to the variable $X_1$ with a strong correlation,
because the correlation coefficient is 0.761 (the closer the number is to 1 indicating the strong correlation between the two variable ), and this indicates the strong direct correlation at the level of significance 0.000, while the correlation coefficient y with the rest of the independent variables is less than X1. As for the correlation of the independent variables with each other, we notice a correlation X1 with X3 is stronger than the rest of the variables with a correlation coefficient coefficient of 0.681.

Table 2. show the correlation matrix for the independent variables for the educational model.

| Independent variable | Y1   | X1    | X2    |
|----------------------|------|-------|-------|
| Y1                   | 1    | 0.991 | 0.367 |
| X1                   |      | 1     | 0.397 |
| X2                   |      |       | 1     |

Table 3. show the correlation matrix for the independent variables for the Work model.

| Independent variable | Y2   | X2   | X3   | X4   | X11  |
|----------------------|------|------|------|------|------|
| Y2                   | 1    | 0.643| 0.032| 0.707| 0.327|
| X2                   |      | 1    | -0.07| -0.019| 0.520|
| X3                   |      |      | 1    | -0.221| 0.087|
| X4                   |      |      |      | 1    | -0.059|
| X11                  |      |      |      |      | 1    |

We notice from table 2 that Y1 has a very strong correlation with X1, which means that educational trips depend on the number of students because the correlation coefficient is 0.991 and the level of significance is 0.000. the correlation coefficient X1 with X2 has a correlation coefficient of 0.397. The variable Y2 is related to the health staff and the number of employees with a correlation coefficient of 0.707 and 0.643, as in table 3.
**Table 4.** The correlation matrix for the independent variables for the Shopping model.

| Independent variables | Y3 | X5 | X2 | X6 |
|-----------------------|----|----|----|----|
| Y3                    | 1  | 0.924 | 0.405 | -0.466 |
| X5                    | 1  | 0.386 | 0.556 |
| X2                    | 1  | 0.556 |
| X6                    |    |    |    | 1  |

**Table 5.** The correlation matrix for the independent variables for the Health model.

| Independent variables | Y4 | X7 | X8 | X9 | X10 | X2 | X11 |
|-----------------------|----|----|----|----|-----|----|-----|
| Y4                    | 1  | 0.45 | 0.882 | 0.784 | 0.942 | 0.831 | -0.09 |
| X7                    | 1  | 0.707 | 0.483 | 0.307 | 0.807 | -0.244 |
| X8                    | 1  | 0.632 | 0.79 | 0.98 | -0.128 |
| X9                    | 1  | 0.602 | 0.646 | 0.016 |
| X10                   | 1  | 0.725 | -0.086 |
| X2                    | 1  | -0.144 |
| X11                   |    |    |    |    |    |    | 1  |

**Table 6** show the correlation matrix for the independent variables for the Other model.

| Independent variable | Y5 | X13 | X14 | X15 |
|---------------------|----|-----|-----|-----|
| Y5                  | 1  | -0.117 | 0.939 | 0.649 |
| X13                 | 1  | -0.186 | -0.301 |
| X14                 | 1  | 0.416 |
| X15                 |    |    |    | 1  |
Table 4 shows the strong correlation between Y3 and X5 is very strong because the correlation coefficient is 0.924 with a significant level of 0.000, which indicates that shopping trips are closely related to the number of stores. Table 5 shows the strong correlation between Y4 and X8, X9, X10, X2, in addition to the correlation of the independent variable with each other. Figure 6 shows the weak correlation of the independent variables with each other, and the strong correlation is clear between Y5 and X14, which indicates that other trips depend heavily on other health trips.

7. Multiple Linear Regression Model Development

Trip multiple linear regression models are established by using the SPSS software version 22, the available linear regression methods are as follows:

- Enter
- Stepwise
- Remove
- Backward

The stepwise method is the preferable and usually the method that is applied to derive a simple prediction regression models for each independent variable [6]. The independent variable with the highest F-test is selected as the main variables inserted. The procedure is continued if at least one variable surpasses the standard. The method takes into account if the model will be enhanced through a second independent variable was added, etc. These checks whole variables to decide which of them has the F-value test and which matches the F-test chosen for inter criteria. Either probability of F value test or of F value test is used as inter criteria. In the analysis, F is used as a Probability equal to 0.05; this corresponds to a value F test of 3.48 [7].

| Trip type    | Model                                                                 | R²(The correlation multiple coefficient) | Adj R²(Adjusted multiple correlation coefficient) | S.E.E(Standard estimation error) |
|--------------|------------------------------------------------------------------------|------------------------------------------|--------------------------------------------------|----------------------------------|
| Total trips  | 66.485+0.849X1+0.865X16+0.925X4+0.94X2                                | 0.962                                    | 0.958                                            | 316.40711                       |
| Educational trips | -117.545+0.854X1                                                   | 0.983                                   | 0.982                                            | 192.00841                       |
| Work trips   | -7.606+0.896X4+0.92X2+0.855X3                                      | 0.989                                   | 0.988                                            | 39.98896                        |
| Shopping trips | 995.808+2.848X5                                                  | 0.854                                   | 0.805                                            | 95.77492                        |
| Health trips | 274.418+0.829X10+0.506X9+0.448X8                                   | 0.982                                   | 0.976                                            | 80.95005                        |
| others Trips | 6.455+0.149X14+0.48X15+0.339X13                                    | 0.981                                   | 0.977                                            | 47.36590                        |
Model validation is strictly an aggregate set of comparisons, and represents the final step in the model development process. The comparison of the applied model in the base year with the observed data serves to indicate how well the model is replicating the existing travel patterns. At each step in the travel model development process, each model component is subjected to a series of validation tests following estimation of the model parameters coefficients, constants of the model's ability to accurately simulate existing travel behavior. Data-splitting is the act of partitioning available data into two portions for model validation purposes. The first portion of the data, called fitting sample, is used to fit the model and the latter, called validation sample, is used to evaluate its performance. The fitting sample is as large as 75% of the original sample and is extracted from the original sample through a simple random sampling without replacement. The remaining data is used as a validation sample. That is, the split is purely random and there is no data duplication [8]. Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17 show the resulting plots between observed and predicted (Y) values for total, educational, state institution, shopping, health, other trips respectively.

The graphic plotting of observed and estimated trip is a most useful method of evaluating the overall performance of a regression equation. If the points which result from the plot of the estimated with observed trip end tend to stand nearby the line drawn at 45°, then the resulted model is considered satisfactory. Figure 12 shows the measured trips and the expected trips per day for total model, and we note in the drawing that the line approaches 45, which means that the model is acceptable, and we note that also in figure 13, which indicate the acceptability of the educational model as well. Likewise, the value of $R^2$, as it approaches 1, the model is good. In the educational model, we note the value of $R^2$ 0.99 and the overall model of 0.95. this is a good indicator for both models.
Work model and shopping model are also acceptable as in Figures 14 and figures 15. Figure 16 and figure 17 show that the medical model and the other model are also acceptable and this is evident by the line and the value of $R^2$. 
9. Conclusion

1. The rate of attraction for excursions is determined by the diversity of the vital centers in the area.
2. Each of the models determines the incoming traffic into the study area based on the use of the land in addition to the general model that determines the incoming traffic into the area.
3. In the study, regression models were also developed to determine the attraction factors in educational and health centers, state institutions, and shopping centers because they are the main attraction centers in the Bab al-Moadum area.
4. Land use in the Bab al-Moadum area is the main reason for the high attraction of excursions.
5. In educational trips, the number of students is the variable that effectively affects the increase in these trips. Educational trips are of a high percentage compared to the rest of the trips in the study area due to the diversity and number of educational centers in the region.
6. The number of employees, health staff and the number of teachers are the most independent variables affecting the increase in work trips, because of the large number of educational centers, state institution and health centers in the region, these trips, in addition to educational trips, also constitute a high percentage of the trips attracted to the study area.
7. The shopping model in this study depends largely on the number of stores compared to the rest of the factors involved in the analysis, as it was found that the number of stores significantly affects the attraction of trips to shopping centers.
8. The independent variables that greatly affect health trips are the number of patients in emergency, the number of patients in consulting clinics and the number of beds, because these factors cause the trips to greatly attract hospitals, these factors reflect the hospitals capacity. The greater the hospitals capacity, the more attracted trips to it.
9. Other trips depend on other health trips, work trips and other educational trips, because the people coming to Bab Al-moadam area are not only student, employees, or patients, but they are also accompanying patients or visitors to state institutions or educational centers.
10. The overall model for attracting trips in the study area depends on the following independent variables (number of employees, health staff, number of visitors, number of students).

10. Applications

In this research, the bab al-moadam area was fully studied in terms of characteristic and uses of the land. Models were made for all types of trekking attraction in the region, and the study was comprehensive for all trips. The models that are made in the spss program can be applied on the ground. In addition, this study can be relied upon in developing future studies for the region. These models can be applied to areas that have the same characteristics as the study area.

11. Recommendations

1- Increase the sample size in future studies to obtain more reliable results.
2- Include all the factors affecting trip attraction and generate a multiple regression model.
3- Study the attraction of trips in other types of land uses (commercial, industrial, etc.) to determine the attraction of trips in them.
4- Encouraging the study of the attraction of trips in the vital areas of Baghdad and Iraq in general in future research because it is very little.

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