Trip Generation Modeling for Selected Zone in AL-Diwaniyah City

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Abstract

The initiation of this study was made with the objective of building the predicted household trip generation models for Al-Diwaniyah city that involve the socioeconomic characteristics and land use trends. For the purpose of this study, the city was divided into 5 sectors with 70 zones, these zone covering an area of 52 square km. Home questionnaire forms were distributed through arrangements with the secondary, industrial, commercial schools administrations and some colleges and 3400 forms were distributed in the city for home interview purpose,. In fact a concentrated briefing to the respondents was demonstrated before the distribution of the forms. The questionnaires response rate was 74.65 %. The collected data was analysed and classified in order to qualify the social and economical features in each zone. The relationship between daily household trips and socioeconomic characteristics were developed using stepwise regression technique (Multiple Linear Regression ,MLR) after the collected data being feed to SPSS software, Results showed that trip production model mainly depends on family size, gender, the number of workers and the number of student in the family.

Key Word:- Trip Generation Model , Household Trip, Linear Regression , Al-Diwaniyah City.

الخلاصة :-

إن هدف هذه الدراسة هو بناء أفضل نموذج لتوليد الرحلات لمدينة الديوانية بالاعتماد على الخواص الاقتصادية والاجتماعية واستعمالات الأرض بالمدينة. ولغرض الدراسة قسمت المدينة إلى 5 قطاعات و70 منطقة وذلك لتغطية مساحة قدرها 52 كم^2، ووزعت 3400 استمارة على المدارس الإعدادية والصناعية والتجارية وبعض الكليات و كذلك طريقة مسح المقابلة البيتية في المدينةً. وقدم شرح مركز عن كيفية ملئ الاستمارات قبل ملئ الاستمارة و كانت نسبة

الاستجابة 74.65 % وتم تحليل و تصنيف البيانات لمعرفة الخصائص الاجتماعية والاقتصادية لكل قطاع. وتم إيجاد العلاقات بين الخصائص الاجتماعية والاقتصادية وخصائص الرحلة باستعمال طريقة الانحدار الخطي المتعدد للمدينة بعد إدخال البيانات في برنامج SPSS. أظهرت النتائج ان علاقة تولد الرحلات تعتمد على حجم الأسرة ,الجنس(ذكر أو أنثى), عدد العاملين, وعدد الطلبة في العائلة بصورة عامة.

1. Introduction

There are no comprehensive transportation planning studies, or traffic management schemes that are implemented for Al-Diwaniyah city, which taking into consideration the continuous growth in population, employment and car ownership, which made the daily performing of activities a burden that increases day after day. The immediate local solutions to traffic problems was made the situation even more worse, these solutions hide the actual need for a detailed study/research that investigates all the socioeconomic variables that affect of the need to travel. Transportation engineers are commonly faced the question of how to extract information from field or survey data. The process is to create a predicated statistical model that describes the behavior and relationship of the phenomenon under observation. In practice, it is not always easy to construct a model from field data, due to the fact that many phenomena are non-linear and/or collinear or they are not easy at all to derive a model valid for prediction.

2. Location of the Study Area

Al-Diwaniyah is the capital city of Al-Qadisiyah Governorate. The estimated population in 2010, was 359659 , which is living in 52 km² area (Directorate of Al-Diwaniyah Statistics). The area around Al Diwaniyah, which is well irrigated from the nearby Euphrates River, is often considered to be one of the most fertile parts of Iraq, and is heavily cultivated. The town is located on the main rail transport corridor between Baghdad and Basra, located 180 km south of Baghdad city, with 320 km to the north of Basra city. The geographical position of the city centre is on longitude (31^{o} $59^{/}$ $4.88^{//}$), and latitude (44^{o} $55^{/}$ $11.08^{//}$). It is divided by the Al-Diwaniyah River (branch of Euphrates River) into two parts: Al- Soub Al-Kabeer and Al- Soub Al- Sageer. Table (1) shows the growth in population for last 33 years.

3. Research Objectives

The following objectives were assigned for this study:

1- Collecting the socioeconomic and travel data that initiate the need to make a trip.
2- Establishing household trip generation statistical model for the city using Regression technique.

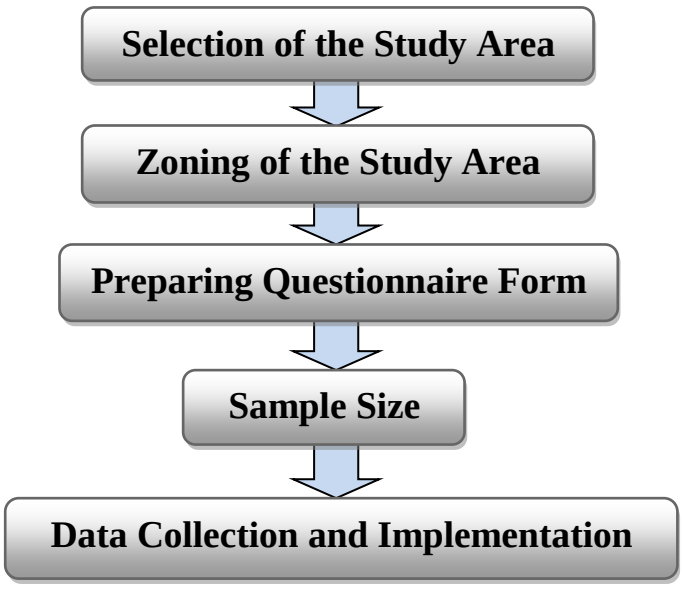
3- Establishing relationships between the different factors that affect the need to transport and make comparison with the other studies.

Table (1) Population Growth of Al-Diwaniyah City (Directorate of Al-Diwaniyah Statistic)

Year	Population
1977	113183
1987	185009
1997	231267
2005	284097
2007	289993
2010	359659

4. Research Methodology

To achieve the research objectives, a general flowchart to cover the requirements of data collection was planned as illustrated in Figure (1). Taking into consideration the security conditions in AL-Diwaniyah city, the data collection method used mixed between home interview survey and questionnaire. A proper questionnaire sheet was designed to include almost all the factors that might affect the need for transport as shown in Figure (2). These questionnaires were distributed by hand to scholars in secondary schools and colleges.



Fig(1) Work Plan Flow Chart

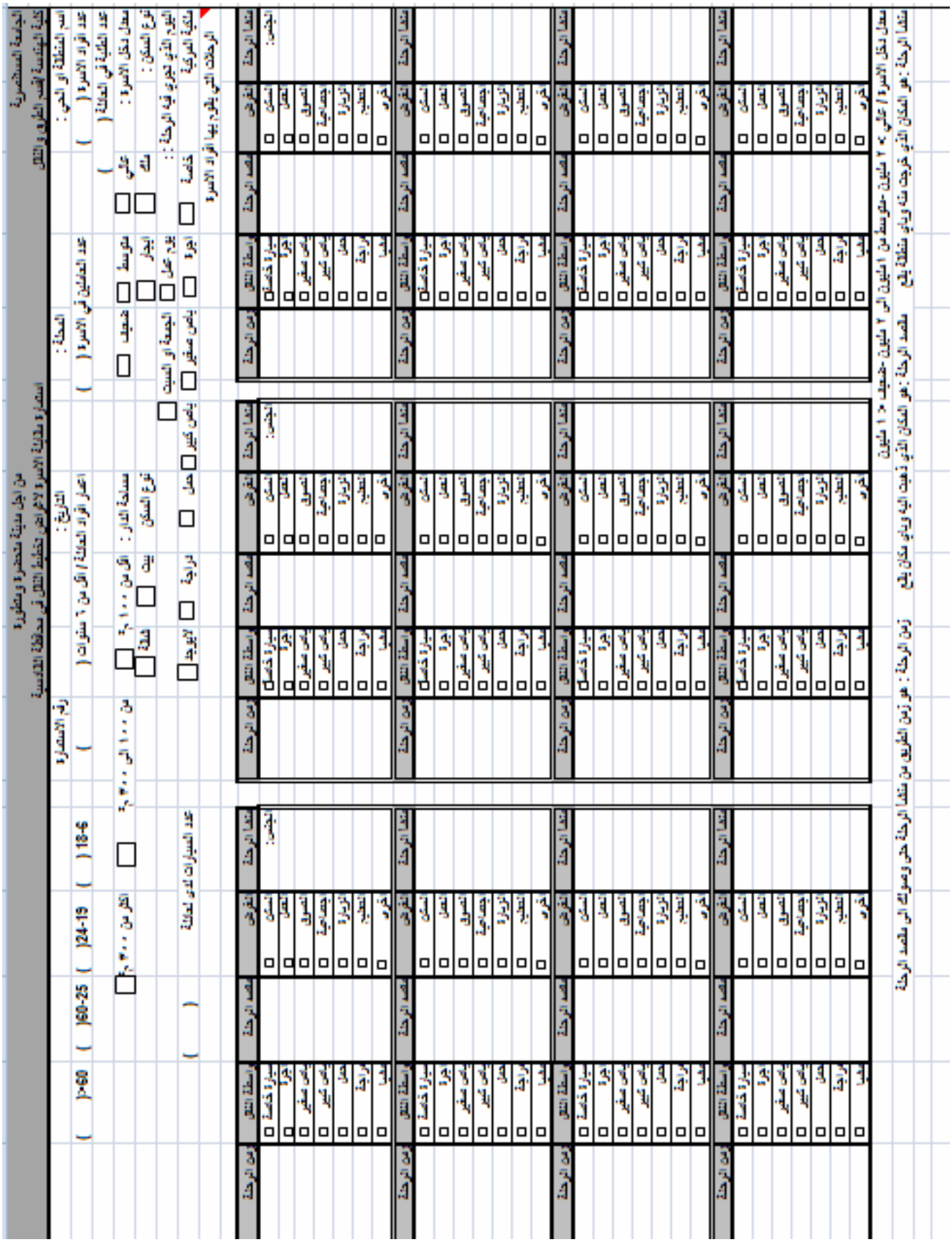


Figure (2) Home Interview Form for Al-Dewaniyah City

4.1 Selection of the Study Area.

The selected study area is defined first. The imaginary line representing the boundary of the study area is termed as the 'external cordon'. The area which inside the external cordon line that determines the travel pattern to a large extent is subdivided into zones.

The selection of the external cordon line for an urban transportation study should be done carefully due to weight of age to the following factors ***Kadiyali* [2009]:**

1- The external cordon line should circumscribe all areas which are already build- up and those areas which are considered likely to be developed during the period of study.

2- The external cordon line should contain all areas of systematic daily life of the people oriented towards the city centre and should in effect be the 'commuter-shed'.

3- The external cordon line should be continuous and uniform in its course so that movements cross it only once. The line should intersect roads where at safe and convenient to carry out traffic surveys.

4- The external cordon line should be compatible with previous studies of that area of studies planned for the future.

Taking into consideration the above mentioned parts, the chosen external cordon line is as illustrated in Figure (3).

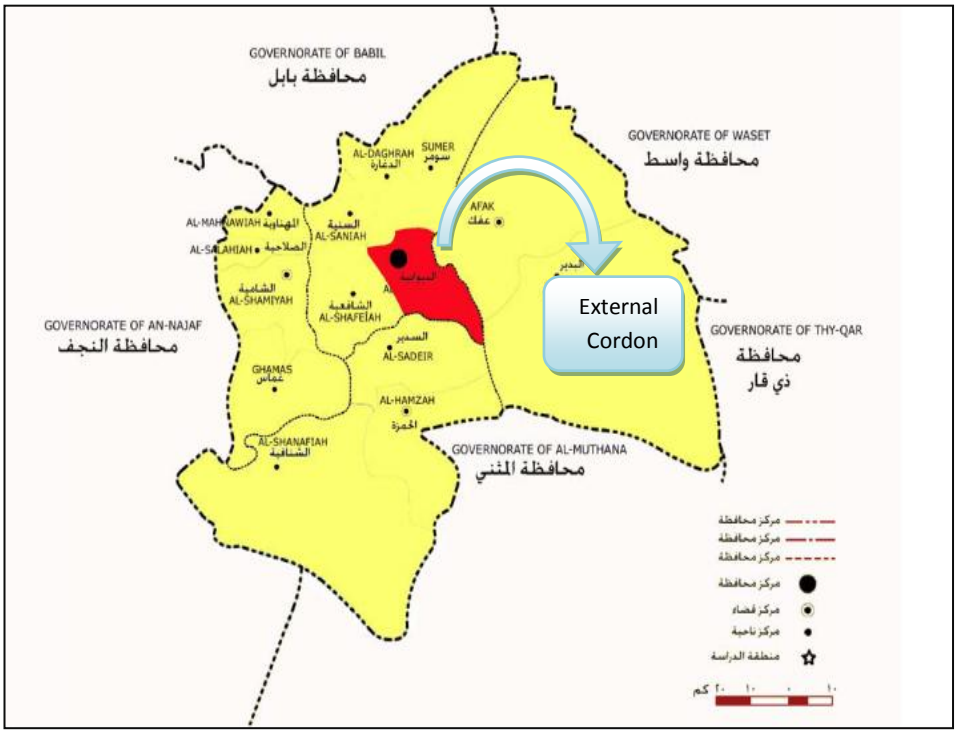


Figure (3) External Cordon of the Study Area (Directorate of Al-Diwaniyah Municipality).

4.2 Zoning the Study Area

To facilitate the data collection in transportation planning processes, the area under consideration is divided into a number of zones. Generally, zoning establishes the following purposes ***Kadiyali*** **[2009]**:-

1. Better understanding of the structures of the area in terms of land use and activity.
2. Simplifying the collection and presentation of data.
3. Reducing the computation, time and storage needed for data processing.

The selection of these zones is based on some criteria like**,** homogeneous socioeconomic characteristics.

The study area was divided into 5 sectors based on the division of the Municipal Council of Al-Diwaniyah city as shown in Table (2) and Figure (3). Fig (4) shows the 70 zones in the 5 sectors.

Table (2) Zones for the Study Area.

Sector No.	Description
1	12 zones, located to the right side of the river.
2	18 zones, located to the left side of the river.
3	20 zones, located to the right side of the river.
4	3 zones, located to the left side of the river.
5	17 zones, located to the right side of the river.

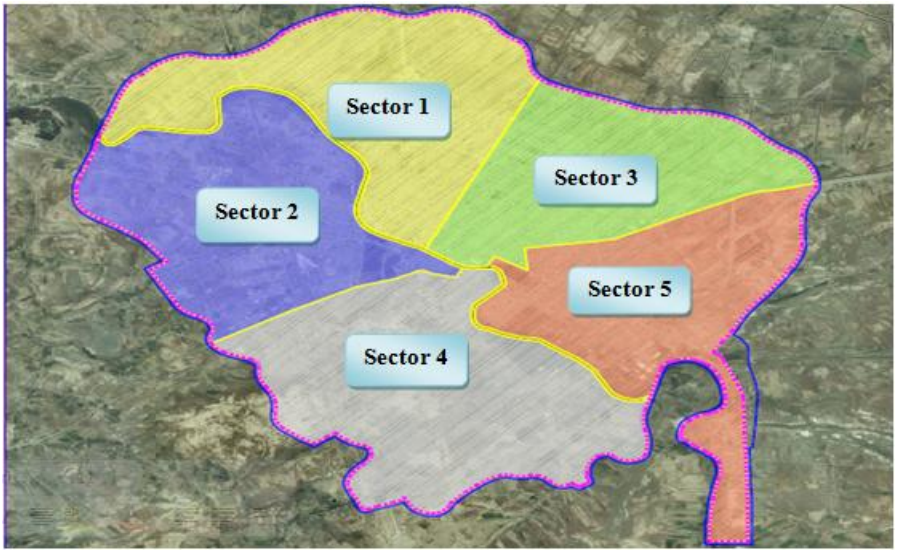


Figure (3) Study Area and Municipality Sector Divisions (Directorate of Al-Diwaniyah Municipality).

Figure (4) Internal Zone of Al-Diwaniyah City According to the Municipality Divisions (Directorate of Al-Diwaniyah Municipality).

4.3 Sample Size

The required size of the sample to be interviewed depends on the total population living in the study area. For accuracy, population censuses are taken from Directorate of AL-Diwaniyah Statistics. In the selected study area, there are (359659) inhabitants, and the total number of households is (52013). It is impractical to interview all the residents of the study area. So, the size of the sample is determined on the basis of the population of the study area and the recommended values are shown in Table (3) ***Kadiyali*** **[2009].**

Table (3) Sample Size for Home Interview Survey Kadiyali [2009]

Population of study area	**Sample Size**	
	Minimum	**Recommended**
Under 50,000	1 in 10	1 in 5
50 000 – 150 000	1 in 20	1 in 8
150 000 – 300 000	1 in 35	1 in 10
300 000 – 500 000	1 in 50	1 in 15
500 000 – 1, 000,000	1 in 70	1 in 20
Over 1 million	1 in 100	1 in 25

It can be noticed from Table (3) that, the recommended sample size for the population of the study area should be 1 in 15.Therefore, the required sample size is:-

Sample Size = (1/15)*52013=3467.5

Therefore, it is decided to distribute 3500 questionnaire forms.

5. Household Trip Generation Modeling

A trip generation model is traditionally derived with a standard statistical technique, called Multiple Linear Regression (MLR) ***Huisken* [2006].**

The regression modeling is the statistical process that 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 a best fit. The goal of multiple linear regressions is to develop the best model at a selected confidence level that satisfying the basic assumptions of regression analysis ***Al-Hasani* [2010].**

The conditions to achieve typical regression models as follows:

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

Multiple linear regression models of trip generation were developed by using the Statistical Package for Social Sciences (SPSS) software program version 16. The variables that have been considered in the analysis were symbolized as follows:-

1. **Dependent variables:** -
   - Y : Total household trips type per day.
   - Y_1: Household educational trips per day.
   - Y_2: Household work trips per day.
   - Y_3: Household other trips per day.
   - Y_4: Household religious trips per day.
   - Y_5 : Household social trips per day.
   - Y_6: Household shopping trips per day.
2. **Independent variables:-**
   - X_1 :Gender (Male or Female).
   - X_2: Family size.
   - X_3: Number of workers in the family.
   - X_4: Number of persons less than 6 years age in the family.
   - X_5: Number of persons 6-18 years age in the family.
   - X_6 : Number of persons 19-24 years age in the family.
   - X_7: Number of persons 25-60 years age in the family.

X_8 : Number of persons greater than 60 years age in the family.

X_9: Number of students in the family.

X_{10}: Household monthly income in (ID).

X_{11} : Area of dwelling unit in m^2.

X_{12}: Dwelling unit ownership (own, rented).

X_{13}: Dwelling unit type (house ,apartment).

X_{14}: Car ownership in (number).

The correlation matrix of the independent variables of the data set computed using SPSS software program version 16 and the result shown in Table (4).

Table (4) Correlation Matrix of the independent variables

Variables	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1	.045	-.013	.040	-.008	.023	.030	.041	-.015	.010	-.040	-.005	.[a]	.004
X2		1	.654	.383	.652	.392	.439	.335	.729	-.259	.123	-.021	.[a]	.439
X3			1	-.598	-.335	.187	.505	.045	-.365	.713	.120	-.117	.[a]	.467
X4				1	.022	-.148	.152	-.043	.010	-.191	.186	-.100	.[a]	.063
X5					1	-.102	.283	-.076-	.802	-.453	-.009	.073	.[a]	-.068
X6						1	-.153	.195	.483	.262	.074	-.083	.[a]	.093
X7							1	.043	.320	.670	-.133	.104	.[a]	.515
X8								1	-.037	.051	.138	-.038	.[a]	-.296
X9									1	-.332	-.012	.099	.[a]	-.322
X10										1	.173	-.102	.[a]	.780
X11											1	-.323	.[a]	.068
X12												1	.[a]	.479
X13													.[a]	.[a]
X14														1

a. Cannot be computed because at least one of the variables is constant

5.1 Multiple Linear Regression Models

Multiple linear regression models of trip generation were developed by using the SPSS software version 16.

The best and commonly used method to determine parameter of prediction model is stepwise method ***Al-Hasani*** **[2010]**. This method computing the simple regression model for each independent variable.

The independent variable that has the largest F-test is chosen as the first entering variables. If at least one variable exceeds the standard, the procedure continues. The procedure considers whether the model would be improved by adding a second independent variable and so on. It examines all variables to determine which has the F value test which suite the selected F-test to inter criteria ***Al-Zaidy*** **[2005]**. Either F value test or probability of F value test are used as

enter criteria. Probability of F equal to 0.05 was used in the analysis, this correspond to a value test of 3.48. The stepwise regression models are given in Table (5) to Table (10).
From Table (4) it can be notice that the gender (X_1) represents the most effective independent variable than others, it's factor is 0.46, and appear in four sectors. The car ownership(X_{14}) also represent effective independent variable in three sectors.

Table (5) Stepwise Regression Models for All Trips Type (Y).

No. of Sector	Models	R^2	Adj R^2	S.E.E
1	3.686+ 0.461(X_1) - 0.689 (X_5) + 0.155 (X_9) + 0.037 (X_3) - 0.287 (X_{11}) + 0.167 (X_{14})	0.917	0.865	0.95
2	3.389+ 0.528 (X_1) + 0.365 (X_3) + 0.476 (X_6) + 0.256 (X_4)	0.88	0.86	0.94
3	2.39 + 0.503 (X_1) + 0.194(X_{10}) + 0.1 (X_{14}) - 0.241 (X_{11})	0.879	0.875	0.94
4	----			
5	4.121+ 0.561(X_1) + 0.181 (X_{10}) + 0.107 (X_{14})- 0.059 (X_7) + 0.166 (X_{12})	0.807	0.806	0.94

Table (6) shows that the No. of student in the family (X9) represent effective independent variable, but it is not appear in the sector No.3 and No. 4 as the age group (6-18) has high correlation with (X9).

Table (6) Stepwise Regression Models for Educational Trips (Y_1).

No. of Sector	Models	R^2	Adj R^2	S.E.E
1	0.372+ 0.148 (X_9) - 0.076 (X_3)	0.92	0.91	0.91
2	0.444 + 0.119 (X_9) - 0.051 (X_1) - 0.071 (X_3) - 0.009 (X_6) - 0.006 (X_4)	0.82	0.81	0.90
3	0.847 + 0.055(X_1) - 0.151(X_{10}) - 0.002(X_{14}) + 0.022 (X_{11})	0.83	0.82	0.94
4	0.319 + 0.148(X_5)	0.81	0.81	0.90
5	0.44 + 0.119 (X_9) - 0.071 (X_3) - 0.052 (X_1) - 0.008 (X_6)	0.82	0.81	0.90

Table (7) shows that the variables, gender (X1), No. of worker in the family (X3), and No. of the student in the family (X9) have the high effective independent on the No. of work trips. It is also can we noticed that the No. of work trips is predicted by only the parameter (X_9) because this sector have high age group of student who go to work then to school.

Table (7) Stepwise Regression Result for Works Trips (Y_2).

No. of sector	Models	R^2	Adj R^2	S.E.E
1	0.571 - 0.164 (X9) + 0.188 (X1) + 0.130 (X3)	0.925	0.924	0.96
2	0.541 + 0.189 (X1) - 0.132 (X9) + 0.122 (X3)	0.865	0.864	0.91
3	0.026 - 0.114 (X9) - 0.012 (X6) + 0.193 (X1) + 0.130 (X3) +0.017 (X2) - 0.56 (X13)	0.839	0.834	0.86
4	0.895 - 0.152 (X9)	0.818	0.816	0.91
5	0.606 - 0.127 (X9) + 0.191 (X1) + 0.122 (X3) - 0.041 (X7)	0.824	0.823	0.91

The models in Table (8) did not show effect of specific variable that is generating effective in other trips which included healthy trips, recreational trips, and so on. These results may be due to the rare data related to such trips.

Table (8) Stepwise Regression Models for Other Trips (Y_3).

No. of Sector	Models	R^2	Adj R^2	S.E.E
1	0.218 + 0.021(X6) - 0.054 (X11) + 0.022 (X3)	0.915	0.913	0.95
2	0.087 + 0.033 (X1) - 0.119 (X13) - 0.007 (X8) + 0.062 (X7) - 0.003 (X4)	0.807	0.803	0.89
3	0.147 (X13)+ 0.032 (X1)+ 8.64553E-05(X2) - 0.006 (X8)	0.814	0.812	0.90
4	----------			
5	0.104 + 0.032 (X1) + 0.023 (X10) - 0.003 (X4)	0.806	0.803	0.90

The models in Table (9) show that the gender (X1) represent effective independent variable in most of the sectors following by the No. of the student in the family (X9) and (people >60) (X_8)which correspond to religious trips.

Table (10) shows that in sectors No.1, No.3 and No. 4 the social trips did not correlate to any of the independent variables as sector No. 1, No.3 considered a recreational area so the household preferred relaxation, according to sector No. 4 it is consider a new area and far away from city centre. The car ownership (X14) and the no. of the students in the family (X9) appears her.

Table (9) Stepwise Regression Models for Religious Trips (Y_4).

No. of Sector	Models	R^2	Adj R^2	S.E. E
1	0.149 - 0.028 (X_1)	0.91	0.90	0.95
2	0.123 + 0.004 (X_{11}) - 0.028 (X_1) + 0.003 (X_2)- 9.26E-06 (X_9)	0.81	0.80	0.87
3	0.132 - 0.029 (X_1) + 0.003 (X_2) + 0.054 (X_8)	0.91	0.90	0.92
4	0.134 - 0.005 (X_5) - 0.014 (X_4)	0.81	0.80	0.90
5	0.102 - 0.0297 (X_1) + 0.023 (X_7) - 0.007 (X_{12}) - 0.009 (X_9) + 0.015 (X_6) + 0.102 (X_5)	0.812	0.806	0.90

Table (10) Stepwise Regression Result for Social Trips (Y_5).

No. of Sector	Models	R^2	Adj R^2	S.E.E
1	------	---	---	---
2	0.141 + 0.021 (X1) - 0.0003 (X9) + 0.005 (X7)	0.824	0.823	0.90
3	------	---	---	---
4	------	---	---	---
5	0.1 - 0.023 (X13) + 0.004 (X14) - 0.019 (X5) + 0.006 (X2) + 0.042 (X12)	0.808	0.803	0.90

Table (11) show that the car ownership (X14) and the gender (X1) appeared in the model as they are important parameters for the shopping trips.

In general, it can be concluded that the variables X_1,X_3,X_5,X_9, and X_{14} are important in all types compared to other variables. The income of the family(X_{10}) is correlated to some trips types in sectors (3 and 5), because the low income families especially sector 3 is represent 48%. A prediction model of specific sector cannot be applied to another sectors because the independent variables for prediction in each sector is different from others.

The main variables that affect the trip production rate in Kirkuk city are household size, monthly household income, car ownership and number of workers per household ***Safa-Eldeen*[2006],** but in Al-Kharkh district in Baghdad city the most effective independent variables on total trips were household size and structure variables and the most effective independent variables on person trips are gender and modes of travel ***Al-Hasani* [2010]**.

Table (11) Stepwise Regression Result for Shopping Trips Y_6

No. of Sector	Models	R^2	Adj R^2	S.E.E
1	0.146 + 0.091 (X_1) + 0.046 (X_{14})	0.826	0.824	0.90
2	0.131 + 0.044 (X_{14}) + 0.026 (X_{11}) + 0.099 (X_1)	0.829	0.826	0.91
3	0.972 - 3.99E-05 (X_4)+ 0.0002 (X_6) + 0.011 (X_{11}) + 0.0005 (X_{14}) + 0.002 (X_3) + 0.002(X_1) + 0.97 (X_{13})	0.83	0.82	0.91
4	--------			
5	0.124 + 0.033 (X_{10}) - 0.110 (X_3) + 0.01 (X_9) + 0.039 (X_{14})	0.812	0.808	0.90

6. Conclusion

1. The main factors that affect the household trip production rate are gender, workers per household, household age groups, car ownership and number of student in the household.
2. Home - based education trips represent a large proportion of the total trips, and these trips have related to the number of students per household and age group.
3. Large number of primary, intermediate and, secondary schools were located inside the residential lands and nearby the dwelling units. This lead to short walk education trips (less than 5 minutes).
4. Work trips represent a large proportion of total trips and these trips have related to the number of worker per household and the age group (25-60).
5. Number of the religious trips affected by the age group >60 is independent variable.
6. Trips generated affected by the number of gender (male) are more than female due to social considerations in the city.
7. The most effective independent variable on total trips (Y), is the number of persons of 6 years age and more. These persons are able to make more trips and usually they are either workers or students.
8. Increasing monthly household income leads to a slight increase in the average household trips.
9. There is a significant relationship between mode usage and monthly household income. Families that have high monthly income tend to use private vehicles whereas families with low monthly income tend to use public transportation.

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