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CREATING TRIP GENERATION MODELS FOR UNPLANNED CITIES

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Abstract: Unplanned cities, like Zagazig, are suffering from traffic congestion, trip delaying, and accidents. This may be caused by harmful impact of the continuous constructing random projects and activities which maximize the number of trips generated in the city and change its distribution from time to time. Trip generation is the first and biggest challenge in transportation modeling process. This stage is used to predict all generated trips including those starting inside and outside the study area. Many terms are used to express trip generation based on its origin - destination, or production- attraction as a reference. This study aims to build regression models to determine all generated trips inside unplanned cities. To achieve this objective, a comprehensive experimental program was designed and implemented. It began with selecting Zagazig city (the capital of Alsharkia government, Egypt) as a case study. Different elements affecting trip generation, like households demographic, socioeconomic, and trips movement data were identified and used to design a detailed questionnaire for determining the daily number of trips generated in Zagazig city. Direct interviews were carried out with trip makers for resident and nonresident household samples. Three categories were targeted in data collection: employees, students, and other. A total sample of about 5116 households was targeted consisting of 4207 resident and 909 nonresident household. The collected data were used to create generation models for Zagazig city through carrying out relations between generated trips and each of population, number of household, employees, and students. Different models of trip generation were developed based on origins, destinations, production, and attraction. All developed models have high degree of significance and coefficient of correlation.

Keywords: Transportation planning, trip generation, regression models, and unplanned cities.

1. INTRODUCTION AND LITERATURE REVIEW

Cites constructed without transportation planning are suffering from many traffic and insurance problems. To overcome these problems; transportation studies must be conducted and their conclusions must be activated. Zagazig city is an example of unplanned cities from transportation point of view. The transportation planning studies starts by trip generation studies. It is most important stage in transportation planning studies. It is directed to determined trip rates for any transportation study area. Institute of transportation engineers (ITE) deduced trip rates for using in cities daily trips determination [1]. But these rates is not appropriate the nature of unplanned Egyptian cities. No previous studies were noticed to determine trip rates in unplanned cities of Egypt. This study aims to create regression models to determine all generated trip inside Zagazig city considering it as an example of unplanned cities. A comprehensive experimental program was designed and implemented to achieve the study starting with collecting the different finding of the previous studies carried out at this field.

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S. M. Sohel Mahmud and Md. Shamsul Hoque, (2010) [2] deduced that the absence of planes of unplanned cities led to constructing residential, commercial buildings and other socio-economic infrastructures supermarkets, high-rise buildings, apartments/complexes, and factories at various parts of the city without appropriate consideration of transportation planning principles. These led to patternless and uncoordinated transport network with city requirements. So, Zagazig city can be considered unplanned city.

Wirach Hirun, (2015) [3] states that there are two methods for estimating trip generation. The first is weighted average and the second is a regression analysis. In general, the trip generation rate derived from the weighted average is simpler to use and easier to understand. However, the regression linear equation is more accurate in estimating the trip generation rate. The ITE has developed trip generation rates using simple regression models. Also, **Kevin B. Modi and L. B. Zala (2011) [4]** conducted a review for different methods that used to trip generation. The study concentrated on two methods to calculate trip generation. The first was regression method. In this method, the trip generation models are generally developed using regression analysis approach and a zonal trips prediction equation is developed. The second was category analysis method. The category (cross classification) analysis. This technique is widely used to determine the number of trips generated. The approach is based on a control of total trips at the home end. The amount of home-end travel generated is a function of number of households, the characteristics of households, the income level, and car ownership.

The density of households can also consider. At the non-home end, a distribution index is developed based on land use characteristics, such as the number of employees by employment category, land use type, and school enrollment. **Justin S. Chang, Dongjae Jung (2014)** [5] conducted a comparative analysis between regression and category analyses that widely applied for trip generation molding. The study result indicated that the category-type model was superior in overall performance.

Trip rates can be also used to find trip generation of cities. **Lucas Jeffrey Fuson (2013)** [6] implemented a study to estimate the vehicle trip for F65 Street in Sacramento city, USA. The study results found that, daily trips calculated based on ITE rates were 125% of the observed trips as shown in table (1). This study concluded that ITE trip rates were greatly different from the trip rates deuced from it.

Table (1): observed and ITE estimated trips for F65 Site [6]

Trip Generation Method	Daily Trips	AM Peak Hour	PM Peak Hour
F65 Site Counts	4,976	479	853
ITE Multi-Use Method	125% of observed)	516 (108% of observed)	361 (42% of observed)

I.Ahmed and S. Abdulrahman et al 2014 [7] carried out a study to compare trip generation rates for two polyclinics in Malaysia and the identical activity rates of ITE. Table (2) shows that, the Observed daily trips represent 323% of the daily trips estimated using ITE rates and PM peak is 397% of the PM trips estimated using ITE rates

Table (2): observed and ITE estimated trips for F65 Site [7].

Trips; daily, PM		Polyclinic 1	Polyclinic 2
Observed No. of Trips	Daily	32	52
	PM	7	10
ITE No. of Trips	Daily	12.2	13.8
	PM	2.01	2.27

Kelly J. Clifton and Kristina M. Currans et al (2015) [8] conducted a comparison between the ITE trip rates and observed trip rates of thirteen studies carried around United States and Canada. The study concluded that ITE Trip rates do not provide accurate or consistent vehicle trip estimation.

Based on the above, the ITE trip rates need a deep investigation to determine the possibility of using its in Egypt. So in this study the trip generation models will be created. It is essential in estimating daily trips in unplanned cities. It is found that Trip generation is a function of some independent variables.

Hashem R. Al-Masaeid and Sanaa S. Fayyad (2018) [9] conducted a study to develop trip generation for Irbid city as residential area. It was found that, the number of generated residential trips was highly dependent on socio-economic variables, including household size, car ownership and household income level. **Bydouglas O A. Osula (1991)** [10] created a study to develop trip generation model. The study indicated that number of daily trips in each zone bears a simple relationship with zonal population. **Jerry G. Pigman and Robert C. Deen (1978)** [11] implemented a study to estimate trip generation. The study used the population and different types of employments as dependent variables. The study found that, the Population was the most significant variable which affected the outcome of the trip generation regression model.

William A. Martin and Nancy A. Mcguckin (1998) [12] stated in his study that, trip-generation models consist of two submodels including trip-production models and trip-attraction models.

This study aims to create trip-generation models as well as all sub models related to it for Zagazig city. The proposed sub-models are production, attraction, origin, and destination. To achieve study objective, A comprehensive experimental program was designed and implemented. Thoroughly presentation of the experimental program is shown in the following section.

2. EXPERMENTAL PROGRAM

Figure (1) shows a simplified flow chart to the study main steps. The study included three stages; a-academic activates, b- trips data collection, and c-analysis. The first stage started with a defining problem, study objectives, and the study area, followed by reviewing all studies related to trip generation. Then, data collection questionnaire was designed and tested using sample of targeted study area households. Consequently, the previously designed questionnaire was adjusted.

The second stage included data collection using the pre-adjusted questionnaire. Data collected were; a-family demographic and address data b- family members personal data c-trip movement data. In the third stage the data collected were analyzed. It started with classifying data to resident households data and non-resident households data. Then, the number of trips, population, number of household, number of worker, number of students, income, car ownership for resident households were determined for each TAZ.

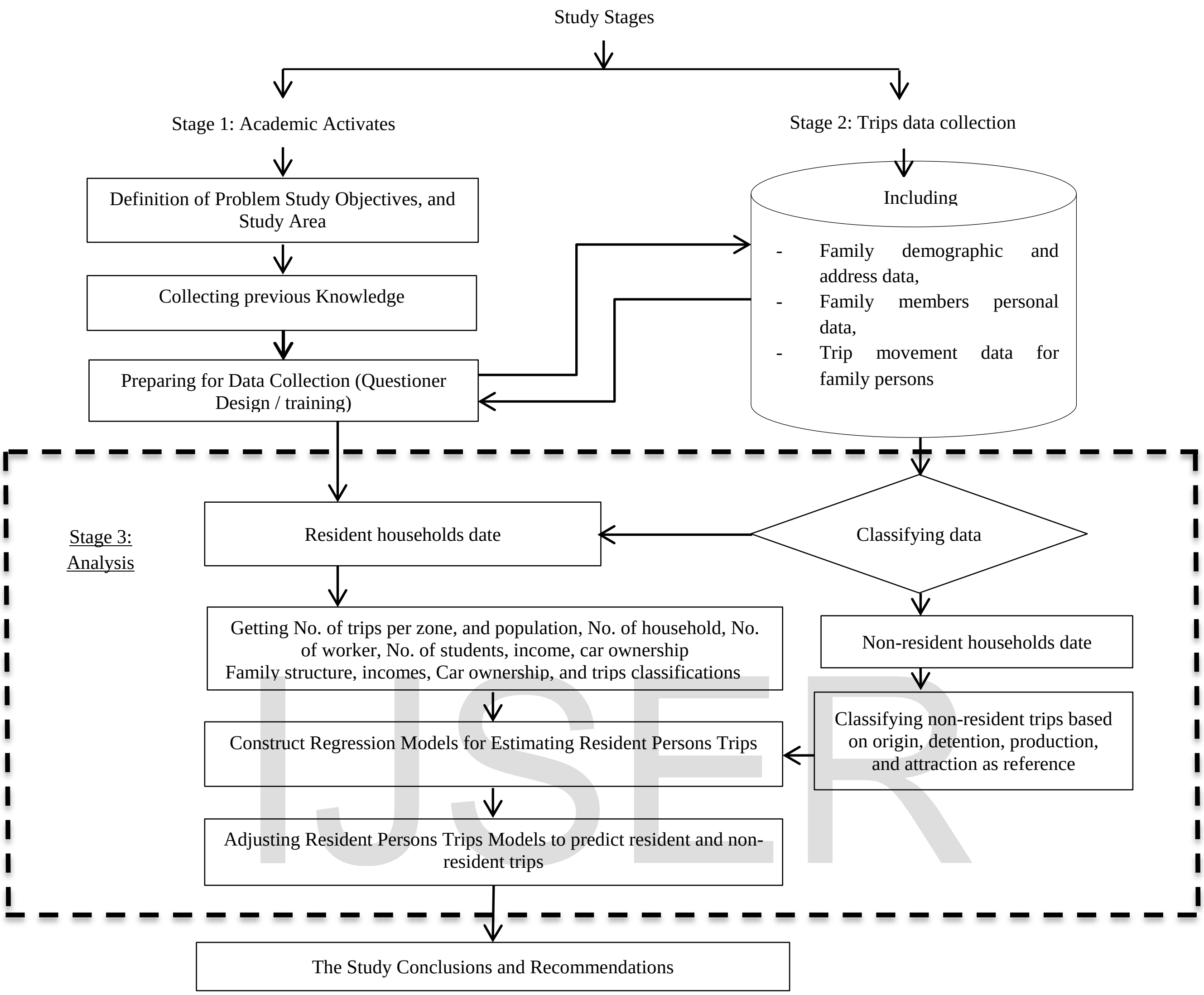

Figure (1): Study methodology flow char

The correlation matrix between total generated trips and all previously items was built. Based on the correlation matrix, the dependent items of high correlation with generated trips were defined. After that, regression models were constructed between generated trips as independent variable and all items of high correlation with it as dependent variables of resident household inside study area. The non-resident trips were classified according to its origin, destination, production, and attraction then it was combined. Each type like generated trips referred to origin was mixed with the identical type of resident to adjust regression model to predict resident and non-resident trips inside the study area. Finally, study conclusion and recommendation were collected.

3- STUDY AREA AND SAMPLE SIZE

The chosen study area was Zagzig city as a case study for unplanned cities in Egypt. Zagazig city locates at 86 km northeast of Cairo city. Zagzig city as a study area is surrounded by Hehya from north, Eltahra Elora from east, Kafer Abohakem From south, and Elznakalone from west direction as shown in Figure (2). Administratively description was considered the only guide to classify Zagazig city to sub-Zones as shown in table (4). Consequently, Zagazig city was divided into three main sectors. The first sector consisted of seven districts including Manshit Abazawhile (1-TAZ and code A-01), Kafer Moawad, Alnezam, Almontazah, Alharery, Alnahal, and Alhosinia. Similarly, the second sector included eight districts whereas, the third district included eight sub-zones. The total numbers of population in the study area are 569299 person with 143640 household in the base year (2018). The minimum sample size was 400 household according Yamane [13].A total sample of 5116 households was collected to complete this study. It was surveyed by direct interview with a random sample of trip makers to represent all zones in the case study.

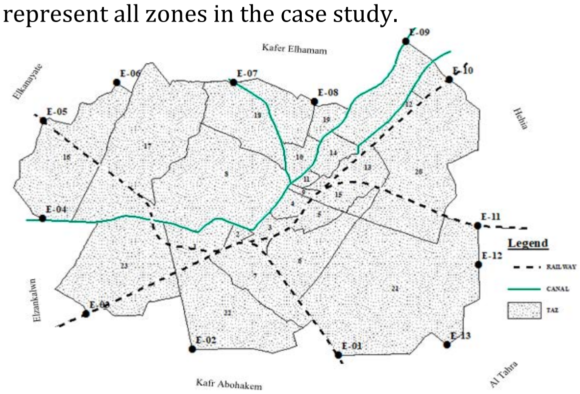

Figure (2): The boundaries between the case study TAZs

Table (3): The study area TAZs

Sector	TAZ	Code	District
The first sector	1	A-01	Manshit Abaza
	2	A-02	Kafer Moawad
	3	A-03	Alnezam
	4	A-04	Almontazah
	5	A-05	Alharery
	6	A-06	Alnahal
	7	A-07	Alhosinia
The second sector	8	B-01	Alashara
	9	B-02	Kafer Algamaa
	10	B-03	Alsyadeen
	11	B-04	Alhokama
	12	B-05	Kafer Yosef
	13	B-06	Kafer Abaelazez
	14	B-07	Kafer Zagzig Bahary
	15	B-08	Hassan Saleh
The third district	16	C-01	Alnakaria
	17	C-02	Shiba Alnakaria
	18	C-03	Banayose
	19	C-04	Kafer Alhoser
	20	C-05	Heria Razana
	21	C-06	Shobak Basta
	22	C-07	Kafer Mohamed Hessen
	23	C-08	Sherwida

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4- ANALYSIS OF VARIABLES AFFECTING ON TRIP GENERATION

The collected data were classified according to accommodation and the interviewer status. Five thousand one hundred and sixteen households were collected. Figure (3) presents a sample of collected data. One thousand one hundred and ninety seven households were refused due to doubtful of its recorded data. The surveyed samples included three thousand and ninety-four resident households and eight hundred and twenty-five non-resident households.

The classifications of acceptable samples with respect to its source included 61% of samples collected from students, 30% from employees, and 9% from other persons. Three thousand and ninety-four resident households were classified according to family size, income, and vehicle ownership.

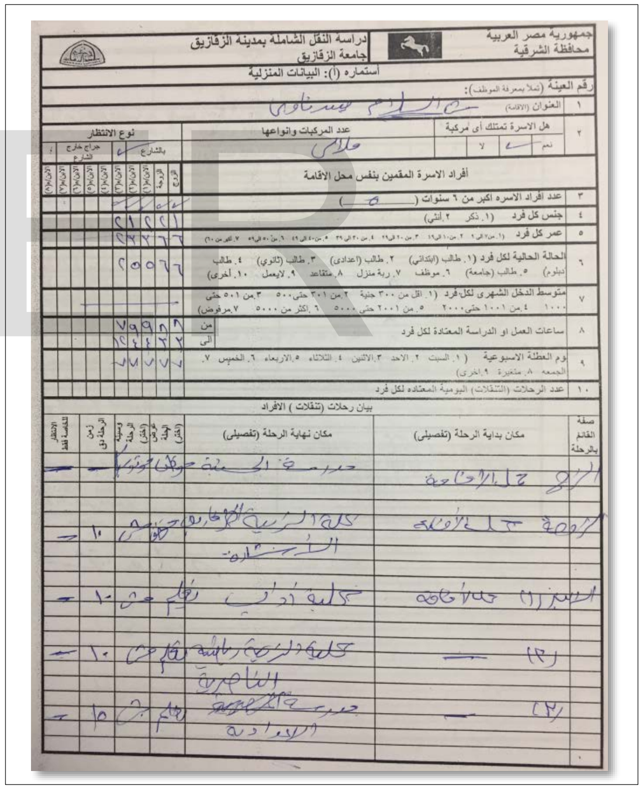
جمهورية مصر العربية
محافظة الشرقية
دراسة النقل الشاملة بمدينة الزقازيق
جامعة الزقازيق
استمارة (أ): البيانات المنزلية

Figure (3): Sample of collected data

Referred to the household structure; Figure (4) shows the classification according to family structure. It illustrates that 82.90% of surveys sample has person between four and six. The average number of person per family is 4.59.

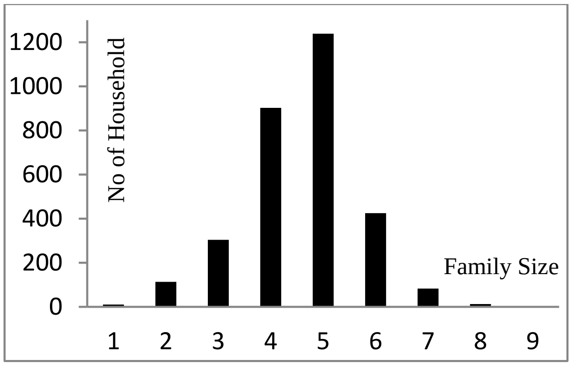

Figure (4): Family structure in study area

With respect to income; It is worth mention about 54% from collecting samples refused to disclose their income. Table (4) presents the classification of 46% (1420 household) from collected questionnaire according to its income to five groups. As an example 508 household had income less than two thousand and five hundred LE. It illustrates also, that 81.90% of investigated samples has income less than five LE per month for all family.

Final, Table (5) illustrates vehicle ownership in the study area. It shows that 67.07% of samples do not have any vehicle while 29.22% of families have only one vehicle.

Table (4): Income levels in study area

Income Levels	No of Household	Percent
< 2500 LE	508	35.77
2500-5000 LE	655	46.13
5001-7500 LE	179	12.61
7501-10000 LE	58	4.08
> 10000 LE	20	1.41

Table (5): Vehicle ownership in study area

Vehicle Ownership	No of Household	Percent
Zero Vehicle	2075	67.07
One Vehicle	904	29.22
Two Vehicles or more	115	3.72

5- ANALYSIS OF GENERATED TRIPS

The generated trips are classified to many aspects. Firstly, according to accommodation, the trips divided to resident persons trips with 90.70% and nonresident persons trips 9.30%. With respect to trip maker statuses; it found that 57% of generated trips make by students, 27% by employee, 5% by workers, and 11% by other persons. Also, the trip classified according to the relation with home to, 32% home base work (HBW), 54% home base education (HBE), 12% of trips home base other (HBO) and 2% non-home base (NHB). The lack and randomness of services in the study area led to decrease of home base other and non-home base (NHB) trips this sets a special trips pattern for unplanned cities.

Referred to transportation modes; Figure (5) present different trips modes used in Zagazig city. The most tips is walking trips that represent 40.37% from generated trips. The most traditional trip mode is a public microbus with 35.32%, followed by privet cars and Taxi with 80.08% and 6.31% respectively. The absence of public transportation systems indicates a significant problem in the management of transport in the study area. The high percent of Public microbus and walk trips reflect low average income of study area.

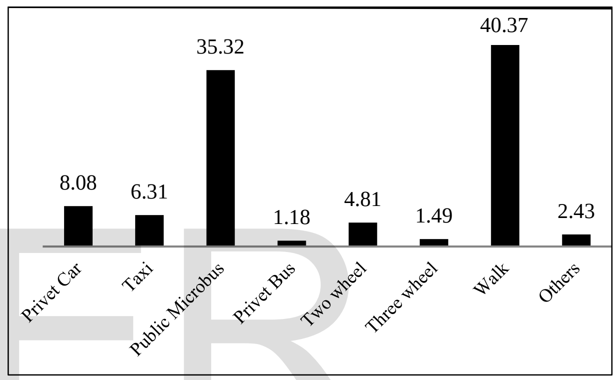

Figure (5): Trips modes percentages

It is very essential to investigate the peak periods per day as a time, period, and number. This will be useful to determine the required number of trips to complete the transportation model. Figure (6) shows the distribution trips through a weekday hours. The figure illustrate that, There are three peaks including morning peak at 8:00 am, afternoon peak at 12:00 pm and evening peak at 14:00 pm. The figure presents peaks intervals with respect to trip making timing that may differ with traffic movement peaks intervals.

With respect to trip duration; Figure (7) illustrates the relation between number of trips and trips times per minutes. The figure shows that most trips have small time periods as common in small urban cities.
Finally, the trips were classified according to trip ends locations as internal – internal, internal – external, and external – internal trips. It was noticed that 94% of resident trips is internal trips that starts and ends inside the study area while 6% of trips have one direction (origin or destination) outside the study area as shown in figure (8).

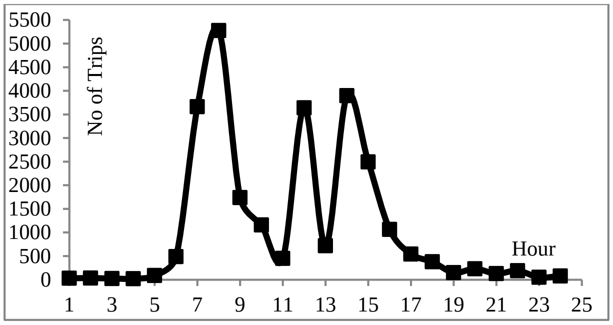

Figure (6): Time of day trips

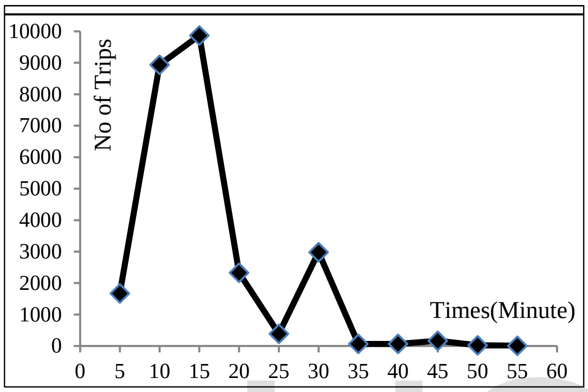

Figure (7): Trips length frequencies

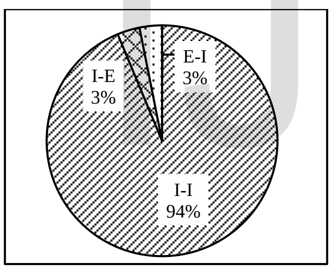

Figure (8): Trips ends types

6- TRIP GENERATION MODELS

In this section the trip generation models are created to predict the generated trips, trips-origin, trips-destination, trips-production, and trips-attractions of study area.

Firstly, the correlation between trip generation and affecting independent variables are tested. Table (6) presents the values of variables affecting on trip generation (T_R) of each TAZ. These variables are number of households (HH), population (POP), total worker (TW), total students (TS), and average household income (I). The correlation matrix results are shown in Table (7). It can be deduced from table that low correlation is noticed between trip generation and average household income. It can be deduced also that highest correlation coefficient (0.99) is noticed between the population as dependent variable and trip generation by resident persons as independent variable followed by the number of households and number of total students (0.98). Finally, the total number of worker has a correlation coefficient with trip generation slightly lower than that of other variable. It is equals to 0.97. The analysis related to searching the correlation between trip generation and all variables effect on it is taken into consideration when constructing the trip generation models as shown in the following sub-sections.

Table (6): Observed values of different dependent variables affecting on TR

TAZ	T_R	HH	POP	TW	TS	I
1	1168	141	630	197	328	4576
2	72	9	41	16	22	4688
3	401	52	213	82	100	4583
4	557	68	300	104	147	3986
5	402	48	207	67	106	4524
6	2433	314	1426	394	740	3791
7	1023	111	550	171	296	3945
8	3286	423	1849	602	961	4526
9	181	25	105	32	55	4250
10	1087	126	632	219	351	4015
11	351	48	222	90	118	3792
12	346	41	175	71	93	3836
13	1022	123	588	165	321	3734
14	1698	175	858	246	504	3431
15	2435	258	1163	439	628	3946
16	490	67	267	73	137	3603
17	558	78	323	94	166	3313
18	1468	159	731	321	388	4495
19	641	70	353	97	182	3371
20	1745	192	956	279	527	3633
21	3158	348	1580	616	777	3419
22	1050	103	522	215	290	3917
23	931	115	520	156	258	3309

Table (7): Correlation (R^2) matrix between TR and each of HH, POP, TW, TS, and I

Variable	T_R	HH	POP	TW	TS	I
T_R	1.00	0.98	0.99	0.97	0.98	0.01
HH	0.98	1.00	0.99	0.95	0.98	0.01
POP	0.99	0.99	1.00	0.95	0.99	0.01
TW	0.97	0.95	0.95	1.00	0.94	0.01
TS	0.98	0.98	0.99	0.94	1.00	0.01
I	0.01	0.01	0.01	0.00	0.01	1.00

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6.1- Creation General Trip Generation Model

Trip generation is constructed by making regression analysis between trip generation of each TAZ and all variables of high correlation with it through trials. These variable are HH, POP, TW, and TS. Table (8) presents the different trials of creation the trip generation model. The first trail is constructing a model between trip generation and all variables. The relation is:

T_R = 0.518*POP + 2.313*TW + 1.428*TS - 0.759 * HH – 8.344 {1}

The coefficient correlation of this model is 0.995 and the standard error is 70.838. The objective of, the second trial is decreasing the number of dependent variables without touching the coefficient of correlation. The deduced model is:

T_R = 0.241 * POP + 2.328 * TW + 1.629 * TS - 7.723, R^2=0.995, Std err=69.149 {2}

This model is easier and more accurate than the previous model. The number of the dependent variable is lower (3). Its standard error is also less (69.149).
The third trial is searching about anther decreasing of dependent variables in the trip generation model with keeping the same coefficient of correlation. The deduced new model is:

T_R = 2.442 * TW + 2.017 * TS – 8.860 {3}

This model has two dependent variables only and has the highest correlation coefficient, and the minimum standard error (67.82). So it is considered the best model.
Still the number of dependent variables is high (two variables). This leads to the difficulty of using these models.
The last trial is searching for the most applicable and simplest model have accepted correlation coefficient. The simplest model is:

T_R = 1.870 * POP – 2.957 {4}

This model is function of population only. It has correlation of coefficient of 0.987 and standard error equal 107.684. This model is the most applicable model due to it depends only on population numbers and can be obtained directly from the census.

Table (8): Created trips generation models

Model	R^2	Std Err
T_R = 2.442 * TW + 2.017 * TS – 8.860	0.995	67.826
T_R = 0.241 * POP + 2.328 * TW + 1.629 * TS - 7.723	0.995	69.149
T_R = 0.518 * POP + 2.313 * TW + 1.428 * TS - 0.759 * HH – 8.344	0.995	70.838
T_R = 1.870 * POP – 2.957	0.987	107.684

6.2- Creation Trip Generation Sub-models

The proposed sub-models are trip-origin (O_R), trip-destination (D_R), trip-production (P_R), and trip-attraction (A_R) models that are produced by resident persons. The following subtitles discuss the methods of constructing all proposed trip-generation sub-models. To construct the targeted models, the O_R, D_R, P_R, and A_R are combined for each zone as shown in Table (9). Regression analysis are carried out for each of O_R, D_R, P_R, or A_R as an independent variable and all factor affecting on it. The factor affecting on it includes HH, POP, TW, TS, I. Many sub-trip generation models are constructed for each independent variable. One sub-trip generation model is selected for each variable based on the value of coefficient of correlation

Table (9): Observed trip origins, destinations, productions, and attractions for each TAZ.

TAZ	O_R	D_R	P_R	A_R
1	1725	1729	1153	2298
2	222	225	81	368
3	619	615	471	763
4	2378	2395	619	4147
5	255	254	377	132
6	2168	2162	2468	1856
7	1593	1605	1084	2121
8	5231	5345	3342	7230
9	164	119	187	98
10	974	971	1076	871
11	296	286	330	251
12	807	821	344	1286
13	822	816	1031	605
14	1065	1048	1696	417
15	1357	1340	2268	434
16	283	269	489	63
17	562	564	554	571
18	869	864	1467	265
19	466	466	608	325
20	1293	1290	1740	845
21	1883	1880	3131	631
22	674	653	1048	279
23	797	786	939	647

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6.2.1- Creation Trip-origin Models

Trip origins model is used to calculate the number of trips that starts from each TAZ. These trips may be generating from this TAZ or not. Table (10) shows the deduced trip-origins regression models, their correlation coefficients, and standard errors. Based on the coefficient of correlation value, the selected model is shown in equation {5}.

$$O_R = 153.881 + 43.025 * HH - 7.724 * POP - 4.137 * TW + 2.567 * TS \quad \{5\}$$

Table (10): Created trips generation models

Model	R2	Std Error
O_R = 153.881 + 43.025 * HH -7.724 * POP - 4.137 * TW + 2.567 * TS	0.701	659.741
O_R = 150.322 +27.273 *HH -5.378*TW-4.778 *TS	0.690	654.490
O_R =77.376+7.991*HH	0.629	680.311

6.2.2- Creation Trip-destination Models

Table (11) presents three models to calculate trip-destinations. It shows that the model that of the highest correlation coefficient is:

$$D_R = 140.081 + 44.692*HH - 8.101* POP - 4.236* TW + 2.700* TS \quad \{6\}$$

Table (11): Created trip destination regress-ion models

Model	R^2	Std Error
D_R = 140.081 + 44.692*HH - 8.101* POP - 4.236* TW + 2.700* TS	0.697	678.720
D_R = 136.348 + 28.169*HH -5.538*TW-5.004*TS	0.685	673.811
D_R = 60.194 + 8.118 * HH	0.623	701.172

6.2.3- Creation trip-production models

Five regression models are listed in Table (12) to determine trip-production. It is noticed that, all models have a high correlation coefficient and low standard error. For simplest, trip-production model depending on population is selected. The selected trip-productions model is:

$$P_R = 3.380 + 1.859 * POP, R^2=0.991 \quad \{7\}$$

Table (12): Created trip productions regress-ion models

Model	R^2	Std Error
P_R = 0.978 -1.262*HH+ 1.341* POP +1.718* TW + 0.424* TS	0.996	63.359
P_R = 1.766 -1.826*HH+ 1.704* POP +1.663* TW	0.996	62.020
P_R = 2.010 + 0.881* POP +1.742* TW+0.757* TS	0.996	62.285
P_R = 5.455 + 1.315* POP +1.621* TW	0.996	62.31
P_R = 3.380 + 1.859 * POP	0.991	87.309

6.2.4- Creation trip- attraction models

Regression analysis is carried out between trip-attraction and HH, POP, TW, and TS. Five regression models are deduced as shown in Table (13). All deduced models are of low coefficient of correlation (< 0.447). So, none of these models can be recommended.

Table (13): Created trip-attraction regression models

Model	R^2	Std Error
P_R = 293.662 +88.879*HH-17.171* POP -10.066* TW + 4.876* TS	0.447	1337.458
P_R = 302.730+82.384*HH-12.988* POP -10.70* TW	0.445	1303.994
P_R = 220.988 +15.266* POP -11.809* TW-18.610* TS	0.323	1440.084
P_R = 136.29 + 4.592* POP -8.825* TW	0.281	1446.730
P_R = 147.591 + 1.626 * POP	0.239	1452.418

To determine trip- attraction for any TAZ of study area, trials to join the values of trip-origin and values of trip- attraction shown in Table (9) are carried out. Also, regression analysis carried out between trip-destination and trip-attraction. Table (14) presents the best models describing the relations between trip-attraction and each of trip-origin and trip-destination respectively. The model that has the highest coefficient of correlation is:

$$A_R = 2.023*\left(\frac{O_R+D_R}{2}\right) - 1.900* POP - 4.062 \quad \{8\}$$

So, trip-attraction can be calculated from the model shown in equation {8} with high degree of accurate.

Table (14): Created trip attraction regression models

Model	R^2	Std Error
$A_R = 2.023*\left(\frac{O_R+D_R}{2}\right)$ -1.900* POP - 4.062	0.997	87.039
$A_R = 2.059*\left(\frac{O_R+D_R}{2}\right)$ -8.846* HH – 30.575	0.996	110.171

7- BALANCING TRIPS DETERMINED USING DIFFERENT CREATED MODELS

Tables (6 and 7) illustrate the real observed total trips, trip-origin, trip-destination, trip-production, trip-attraction. The summation of real T_R, O_R, D_R, P_R, or AR are equal. But, the sum of T_R, O_R, D_R, P_R, or A_R determined from the deduced models of each of them are not equal. So, balance between TR calculated from models and each of O_R, D_R, P_R, and A_R is to be conducted. The following relations {9 to 13} are used to obtain the balance between the outputs of general trip generation model and outputs of each of trip-origin, trip-destination, trip-production, and trip-attraction models.

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$$\sum_i^n T_R = \sum_i^n O_{Rb} = \sum_i^n D_{Rb} = \sum_i^n P_{Rb} = \sum_i^n A_{Rb} \quad \{9\}$$

$$O_{Rb} = O_R \frac{\sum_i^n T_R}{\sum_i^n O_R} \quad \{10\}$$

$$D_{Rb} = D_R \frac{\sum_i^n T_R}{\sum_i^n D_R} \quad \{11\}$$

$$P_{Rb} = P_R \frac{\sum_i^n T_R}{\sum_i^n P_R} \quad \{12\}$$

$$A_{Rb} = A_R \frac{\sum_i^n T_R}{\sum_i^n A_R} \quad \{13\}$$

Where; T_R is the total generated trips, O_R is the trips-origin, D_R is the trips-destination, O_{Rb} is the balanced trip-origin, D_{Rb} is the balanced trip-destination, P_R is the trips-production, A_R is the trips-attraction, P_{Rb} is the balanced trips production, and A_{Rb} is the balanced trips attractions by resident persons for each zone.

8- ESTIMATING NONRESIDENT PERSON TRIPS FOR CALCULATING TOTAL TRIPS FOR STUDY AREA

Total trips of zagazig city as a study area are the summation of resident and nonresident persons trips. It is required to make a model to determine total trips using resident trips only. So, Trip-origin, trip-destination, trip-production, trip-attraction for nonresident person are combined from the collected data questionnaires. The collected nonresident trips are then added to the identical of resident to determine the total trips of each TAZ. Regression analysis is carried out between total trip-origin (O_T), total trip-destination (D_T), total trip-production (P_T), and total trip-attraction (A_T) and their identical (T_R, O_R, D_R, P_R, or A_R) values for resident of each TAZ. Stronger relation is found between O_R, D_R, P_R, and A_R of resident and O_T, D_T, P_T, and AT as total trips of each TAZ as shown in Figure (9). The following equation is deduced:

$$Y = 1.1108*X, \quad R^2=0.991 \quad \{14\}$$

Where; Y is O_T, D_T, P_T, or A_T and X is T_{Rb}, O_{Rb}, D_{Rb}, P_{Rb}, or A_{Rb}.
It can be deduced that, the nonresident person trips represents about 11.08% of resident person trips within study area.

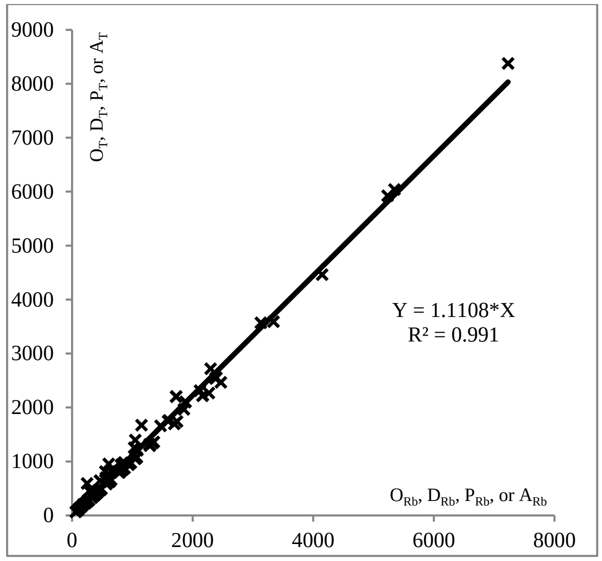

Figure (9): Origin and destination adjusting

9- CONCLUSIONS AND RECOMMENDATIONS

Analyzing the study results leads to the following conclusions and recommendations for zagazig city as study area.

- About 40.37% of generated trips are accomplished by walking due to the nature of the city.
- The most traditional trip mode is public microbus; 35.32% from generated trips are conducted by it.
- Based on trip makers, there are three peaks; the first is morning peak at 8:00 am (19.9%), the second is afternoon peak at 12:00 pm (13.70%) and the third is evening peak at 14:00 pm (14.7%).
- Trip rates are 8.57 person trips per household and 1.86 person trip per person.
- Transportation model {4} is created to determine trip generation of resident persons.
  T_R = 1.870 * POP – 2.957, where R^2= 0.987 {4}
- Transportation sub-model {5} is created to determine trips-origin of resident persons.
  O_R =153.88+ 43.025*HH-7.724*POP-4.137*TW + 2.567* TS, where R^2= 0.701 {5}
- Transportation sub-model {6} is created to determine trips-destination of resident persons. D_R=140.081+44.692*HH-8.10*POP- 4.236*TW +2.7*TS, where R^2= 0.697 {6}
- Transportation sub-model {7} is created to determine trips-production of resident persons.
  P_R = 3.380 + 1.859 * POP, where R^2= 0.991 {7}
- Very weak correlation is found between trips-attraction and numbers of population, households, worker, and students.
- Trip-attraction can determine as function of trips-origin and trip-destination as shown in model {8}

Total generated trips by resident and nonresident persons are predicting using equation {14}.

- The generated trips by nonresident persons represent 11.00% approximately of resident persons trips.
- Making balance for the outputs calculated using of different created models of T_R, O_R, D_R, P_R, and A_R are recommended.

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