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Predication of Production and Attraction Models Trips for CBD Sector within Hilla City

A Thesis

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By

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بِسْمِ اللّهِ الرَّحْمَنِ الرَّحِيم

﴿ قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا

عَلَّمْتَنَا

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Abstract

Prediction of the number and pattern of vehicle movements for different purposes of the trips is critical to urban planning to avoid traffic congestion and ensure shorter trip times on the grid. The objective of this research is to create projected models(production and attraction) of the travel demand forecasting process for CBD (Central Business District) sector in the city of Hilla, including socio-economic variables, location, and land use, in addition to the path network and database.

The research area is the CBD sector of Hilla's city, which comprises of 17 residential areas according to the division of Hilla Municipality Directorate; the region was separated into three sub-sectors to meet the study's goal. The home questionnaire and interview were utilized to obtain required data.

The database of the study area's road network, which covers the city's CBD Sector, was presented and produced using Arc GIS software version 10.3. The majority of road network data was gathered on the ground, with the remainder coming from the relevant government agencies.

There are two models that have been developed. The trips production model is the first model (a generic model regardless of the purpose of the trip). The second is the attraction trips model (workplaces and educational institutions), which was chosen as an attraction model for the sector in the city of Hilla. The stepwise regression II (multiple linear regression, MLR) techniques were used with (SPSS) version 26.

The results of the trips production model showed that: the family size, number of workers in the family, number of children, monthly household income, and number of students represent the most important independent variables that affect the total rate of production trips in the central business district sector in the Hilla. The production of trips has a coefficient of determination R^2 of 0.88, which is considered to be an excellent association, significance level is less than 0.05 for all

variables, the VIF value is less than 10, the T-value is greater than 2 for all the variables, the F-value is 198.297 for all the models.

The results of the attraction model showed that: The number of employees and number of students, independent variables that affect the total rate of attraction trips in the central business district sector in the Hilla. As the coefficient of determination R^2 for (Y) the attraction of trips 0.984 is regarded as an excellent relationship significance level is less than 0.05 for all variables, the VIF value is less than 10, the T-value is greater than 2 for all the variables, the F-value is 61.58 for all the models.

This research shows that the trips in the sector will increase as a result of the population growth and the increase in cars and income (trip growth rate is 7.6 percent). This requires development of roads and the creation of new roads and the development of service facilities related to the transportation system.

List of Acronyms

Acronyms	Description
CBD	Central Business District
GIS	Geographic Information Systems
O-D	Origin-Destination
r	Correlation Coefficients
MLR	Multiple Linear Regression
SEE	Standard Error of Estimate
SPSS	Statistical Package for the Social Sciences
TAZ	Traffic Analysis Zone
VIF	Variance Inflation Factors
R^2	The coefficient of determination
UTP	Urban Transportation Planning
BPR	Bureau of Public Roads

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Chapter One

Introduction

1.1 Introduction

In order to forecast future traveling demand, transport planning techniques were extensively utilized. The predicted traveling demand has been used to prepare for future transport infrastructure and services.

The basic objective of the trip generation study is to link the frequency of trips (the quantity of trips taken from one location to another) to and Across these sectors, from traffic zones to assessments of the type and amount of land usage, as well as other socioeconomic factors. The two sorts of trip generation studies that can be undertaken are as follows:

- Trip production.
- Trip attraction.

Travel demand was indeed defined as the cars or people numbers per time's unit that may be anticipated to utilize a particular section of a transportation system under various environmental, economic, social, and land-use circumstances. Forecasting the numbers, kind, and source of "trips" on a road transport network is known as travel demand estimating. The estimating of traveling demand may range from a meek extrapolation of detected trends to a sophisticated simulation procedure that includes data selection and arithmetical calculations [1].

The phrase "trip production " originally referred to the trips that residential zones produce, whether they are trips origins or trips destination[2].

Trips that finish at home have been referred to as home-based trips or trip production, whereas trips produced by activities at non-home ends have been referred to as trip attractions[3].

Home-based and non-home-based excursions are studied independently, despite the difficulty of integrating different types of trips into models. As a result, separate travel demand models for non-home and home-based trips must be improved, because the types of factors that may impact these trips are likely to be different, or even if the various factors are the same, because their effect on trip planning may differ, models for these two types should be kept separate[4].

Trip production modeling is the process of using suitable analysis methods to relate household trips to the factors that influence trip. Attraction modeling is the process of using suitable study methods to relate trips attracted to nonresidential ends to the factors that influence trip attraction[4].

Government agencies can use traffic demand modeling to figure out what the worst-case scenario is for the current traffic situation. Furthermore, the model forecasts future travel demand based on predictions of future land uses and highway and transit upgrades[5].

This study used a household-level analysis because studying movements for each household at this level can produce more reliable results. The process of transportation planning depends on the prediction of the travel demand that includes forecasting the different policies and programs effects on travel in the area.

The prediction method also gives exhaustive data of travel demand forecasting which may involve the number of cars in the future or the number of passengers on the road[6].

These reasons make detailed studies of the regions necessary in order to identify the reasons for these trips and then determine the origin and destination of these trips in order to build statistical models to predict the numbers of these trips, identify where the trips will go, and decide whether the origin-destination trips will be by private vehicle or public transportation.

Congestion, insufficient capacity, and a lack of user safety are examples of direct problems in urban transportation. Transportation issues are not limited to a single region, but they differ from one location to the next. Traffic difficulties are unavoidable as a result of social and economic development in human and geographical space, particularly in our regions[7].

The creation of a public transport network for an urban region as part of the process, which contributes to choices on transportation programs and policies was indeed referred to as transportation networks planning in the urban areas. This legislation mandated that every urbanized region with an inhabitant of 50,000 or more be dependent on long-term comprehensive Urban Transportation Planning Procedure (UTPP), and that is the process of urban road network improvement planning that follows the gathering and analysis of socioeconomic human travel characteristics in order to create travel demand models for the growth of the above-mentioned road network[8].

1.2 Problem Definition

The city of Hilla, especially Central Business District (CBD Sector), like several other cities in Iraqi, does not have widespread articles for a real investigation on the planning of transport or planning for organization traffic, taking into consideration the inhabitants increment annually, car ownership and employment, which made the performance of daily actions an encumbrance that is increasing day by day. The issue of reproducing data from a survey questionnaire is a common one for transportation engineers.

1.3 Research Objectives

The current study was designed to include the following objectives of the city of al- Hilla for CBD Sector:

1.3.1 Collecting the required data that initiate the need to make a trip.

1.3.2 Predication of Production and Attraction Models for CBD Sector within al- Hilla City utilizing the Multiple-Linear Regressions (MLR) method based on the collection economic, social, and traveling parameters, which lead to the requirement for the trip.

1.3.3 The goal of this procedure is to develop predictive statistical models that explain the behavior and connection of the phenomena being investigated. In reality, developing a model from field data was challenging attributed to the reality that several phenomena seem to be nonlinear and/or overlap or the model has been difficult to construct.

1.3.4 The last step in trip generation modeling is the balancing of production and attraction trips.

1.4 The Methodology of Research

An outline design is created to cover the demands for data collection in order to achieve the study's objectives. The data collecting methods are split into two categories: home interview surveys and questionnaires. A good questionnaire sheet should include nearly all of the factors that may influence transportation needs. The current study is designed to include the following stages to build the travel demand models:

- Collecting socioeconomic, travel, and educational data using home interviews and questionnaires form that initiates the essential to make a trip. to avoid traffic congestion and ensure shorter trip times on the grid

- Developed the trip generation models for CBD Sector within Hilla City using(MLR technique). Figure (1-1) shows work methodology.

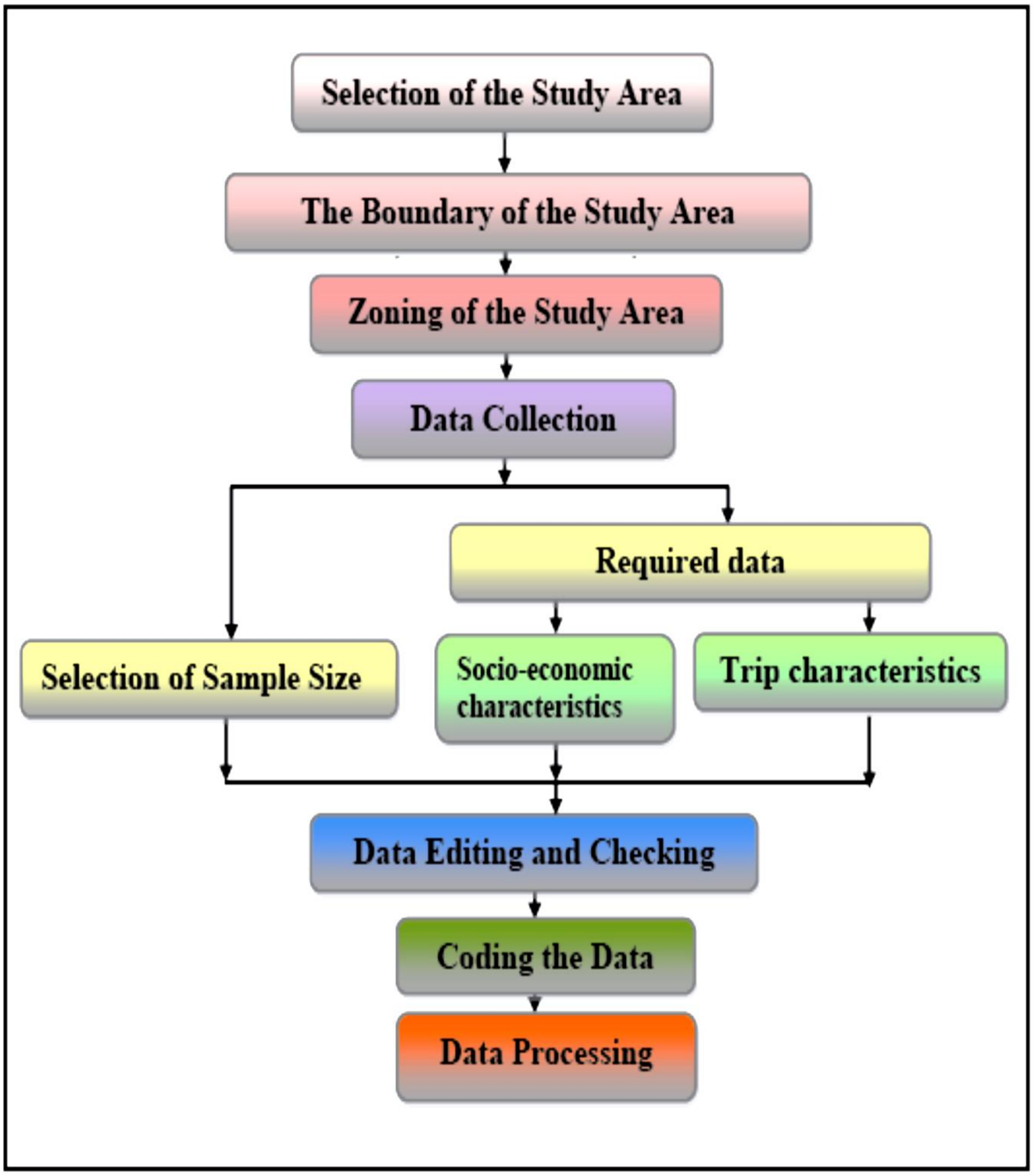


Figure (1-1) Work Methodology

1.5 Thesis Structure

This study contains five chapters as shown below:

1. Chapter one: shows the Introduction of forecasting transportation demand, Problem Definition, Research Objectives, and The Methodology of Research.
2. Chapter Two: defines Travelling Model (Production and Attraction), Parameters Impacting Traveling, Travel Purpose, Traveling Demands Modeling, Traffic Analysis Zone, Travel prediction Process, Growth Factor, Balancing Attraction and Production Travels, and Previous research on trip generation.
3. Chapter Three: shows the methodology, analytical frameworks, and the study area.
4. Chapter Four: deals with the detailed analysis of the collected data and category analysis. In addition to the development of mathematical models for the trip(Production and Attraction) using the Multiple-Linear Regressions (MLR) method and Growth Factor.
5. Chapter Five: Presents the conclusions and recommendations obtained.

Chapter Two

Review Of Literatures

2.1 Overview of Travel Generation

The total number of trips arriving or departing a region is estimated as a function of the socioeconomic, locational, and land-use features of the area in trip generation analysis[9].

2.2 Travelling Model Generation

The method for calculating the number of trips that will originate or terminate in each TAZ within a study region is known as trip generation. The trips are referred to be trip endings since they are determined without consideration for the destination. Each trip has two ends, which are specified in terms of trip purpose or if the trips are started by or drawn to a traffic zone. In the home zone, a trip end created and attracts people to the work zone, for example, would be called a home-to-work trip. The purpose of trip generation study is two fold[1]:

•To find the correlation between land use and trips (production or attraction).

•To estimate the number of trips using relation at a future date under a fresh set of land use conditions.

To demonstrate the process, regression analysis is a regularly used method that has been used to estimate both productions and attractions. Because it relies on zonal data collected, this method is usually employed. Persons, households, income, and vehicle units are examples of individual sample units that are preferable in trip generation techniques that use a disaggregated analysis[1].

Trip generation refers to both trip production(usually starting at home or at the beginning of a non-home based trip), and trip attraction(towards the point that an activity will be performed outside of the household), on zonal through the origin-destination(O-D), survey models to predict both types of trips can be correlated to social, and economic characteristics of each house-hold.

2.2.1 Travel Production

A trip from home to work and a trip from work to home each have a production end, which is home, in the trip production. In most cases, modeling links the dependent variable, such as trips produced by a region in aggregation in household-based models, to the corresponding Independent variables, which are characterized by the complete region or a household feature, respectively.

2.2.2 Travel Attraction

To and from each region, the trip attraction model calculates the number of non-home-based trips as well as the quantity of home-based trips. Attractions are calculated based on land usage characteristics within the traffic study zone (workplaces, educational institutions, etc.).Both travel as shown in Figures 2-1 & 2-2.

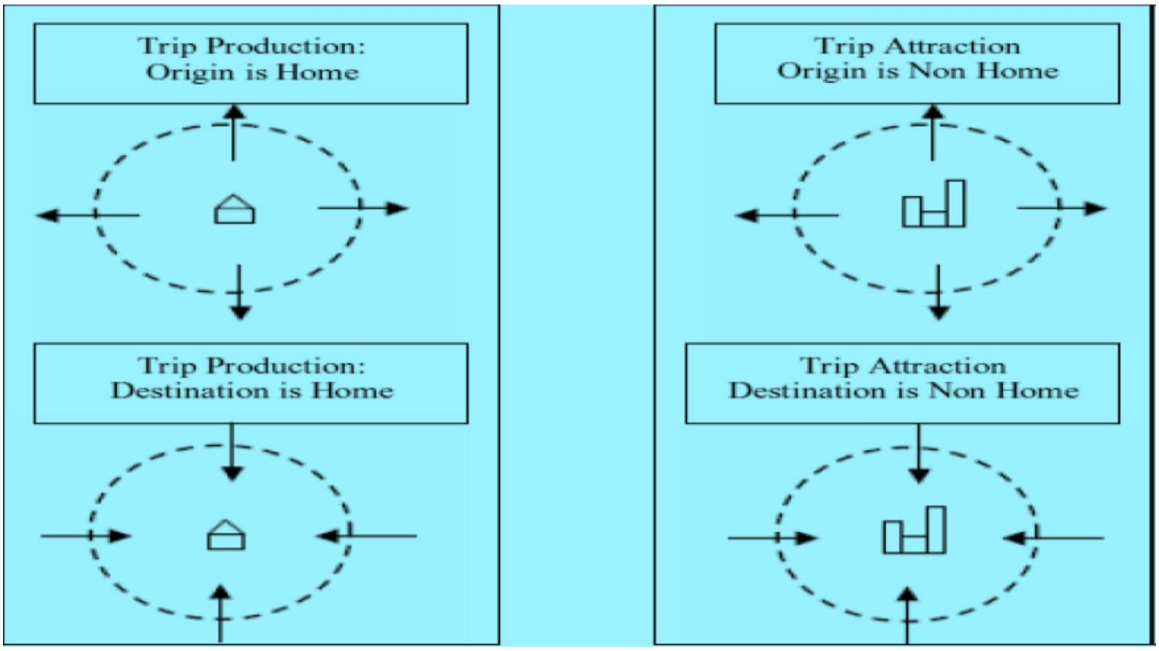


Figure 2.1: The Association between O/D and Productions and Attractions[10]

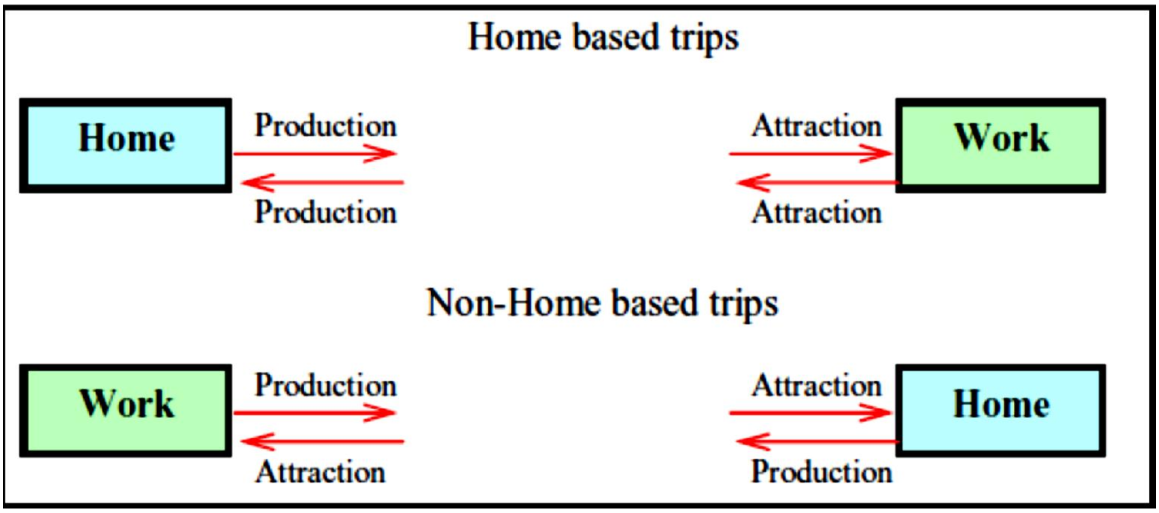


Figure 2.2: Kind of Travels [11]**.**

- The origin of a trip with neither end at home and the home end of any trip having one end at home is referred to as trip generation[12].
- Trip production: for home-based trips, trip production can be a trip origin, a trip destination, or a generation. For(non-home-based), trip production is also a trip origin, a trip destination, or a generation.
- Trip attraction: is the(non-home end) of (a home-based) trip or the (non-home-based) trip's destination[13].

2.2.3 Parameters Impacting Traveling Generation

The major parameters impacting individual travel production involve [3]:

- Incomes.
- Ownership of car.
- Households structure and size.
- kind of dwelling units.
- Lands usage.
- Distance of the zone from city center (CBD).
- Accessing to public transportation network.
- Opportunities for Employments.

Parameters impacting Traveling Attractions:

- Areas such as shopping, service, workplaces, manufacturing, and retail have a large floor area and a large number of job openings.
- Enrolments of college and school.
- Other activities centers include transport sports stadiums, terminals, major religious/ cultural/ recreational locations.

2.3 Travel Purpose

Trips are made for a number of reasons, therefore defining them by purpose is important. Work, shopping, school, personal business, social, and recreational trips are all examples of home-based excursions. Home-based trips will be considered as part of the return to home. Home-based trips can include any of the following[5]:

- From homes to works.
- From homes to educations.
- From homes to shops.

- From homes to social/recreational.
- From homes to other places.
- From works to homes.
- From educations to homes.
- From shops to homes.
- From social / recreational to homes.
- From other places to homes

2.4 Traveling Demands Modeling

2.4.1 General

The number of persons or vehicles that can be predicted to travel on a specific portion of a transportation system per unit time is known as travel demand, under specific land-use, social, and environmental circumstances. The vehicles volume on future or modified transportation system options is calculated using travel demand forecasts. Travel demand forecasting methods range from simple extrapolation of observable trends to an advanced modeling procedure including significant data collection and mathematical modeling[14].

The three parameters that impact the demands for urban traveling are as follows[14]:

- The land's usage intensity and location.
- The socioeconomically features of persons living in the selected zone.
- The quality, cost, and extent of accessible services of transport. These parameters are combined with traveling predicting procedures.

2.4.2 Traffic Analysis Zone (TAZ)

The research region must be divided into a series of Traffic Analysis Zones (TAZ) that constitute the basis for travel movements before the technical process of travel forecasting can begin [14].

Bruton1971, zones are often small enough to allow for accurate movement and the development of reliable trip generation rates. They are separated into residential, shopping, recreational, and industrial zones based on the major land use[15].

The selection of these zones is based on the following [14]:

• Socioeconomically properties must be homogeneous.

• Intrazonal trips must be reduced.

• Historical, political, and Physical boundaries must be applied in which probable.

• Areas must not be produced within other areas.

• The zone system should production and attraction approximately equal trips, households, population, or area.

• Areas must use census attracted boundaries in which probable.

• The total number of Areas must not be so large as to overwhelm computer resources.

2.4.3 Travel Prediction Process

The stages in the travel prediction process are as follows:

1-Land Use and Travel Characteristics: choices can complement transportation investments by locating suitable activities near transportation infrastructure and locating new activities where transportation infrastructure and services already exist or are planned. Land use decisions can also have an impact on the volume of travel, the geographic location of demand, and the relative attractiveness and utilization of various modes of transportation[16].

2-Trip Generation is the first phase in the typical four-phase transportation prediction technique, and it is commonly used to estimate travel demand. It predicts the number of trips that start or end in a special TAZ. (This study includes only this step).

3-Travel Distributions: The goal of a trip distribution model is to "distribute" or "connect up" the zonal trip ends, i.e., the production and attraction for each area, as predicted by the trip model, ability to forecast trip flow, Tij, from zone i to area attraction zone j. There are two approaches for distributing trips [12]:

•Growth parameter method.

•Synthetic methods.

4-Mode Choice: studies people's choices in terms of mode of transportation (auto, bus, train, etc). Mode utilization comes after trip distribution in the travel demand forecasting process. Mode utilization analyses, on the other hand, can be performed at various stages of the forecasting process[14].

5-Traffic Assignment: The last phase in the transportation prediction process is to identify the expressway and real street, which will be utilized, as well as the anticipated number of cars and buses on every highway section [12].

2.5 Parameter Growth Factor

As a linear function of explanatory variables, growth factor techniques are designed to forecast the number of visits (production and attraction) by a household or region[14].

In comparison to current trips, this model describes future travels by a factor of magnitude[11].

The models have the following plain formula:

$T_i = f_i * t_i$ …….(2-1)

Whereas;

T_i: Future trips number for selected year in the area,

t_i: Current trips Number in that area,

And f_i The growth parameter depends on the population of the area (P), mean incomes of households (I), and the mean ownership of vehicles (V). The simplest type of f_i has been characterized as follows:

$f_i = \frac{P_i^d \times I_i^d \times V_i^d}{P_i^c \times I_i^c \times V_i^c}$…….(2-2)

Whereas;
d: The design year.

c: The current year.

2.6 Balancing Attraction and Production Travels

The balancing of production and attraction trips is the final phase in trip generation modeling. At the household stage, the total number of trips created should equal the total number of trips attracted at the activity centers. The value of a trip production and the value of an attraction are not exactly equivalent. The variance can be explained by the number of households estimated, the socioeconomic characteristics of the households estimated, and the number of students and employers estimated.

To balance productions and attractions for each trip by equation (2-3) was utilized to determine the controlling total of travel productions[17].

.

$$CT_P = \sum P_z + \sum P_e - \sum A_e \text{.......(4-3)}$$

Whereas:

CT_p: the controlling total travel production,

P_i: travel productions for every area,

P_e: travel productions at every external area, and

A_e : travel attractions at every external area.

Control totals are computed for travel attrition, using Equation.

$$F_B = \frac{CT_p}{\sum A_z} \qquad (2\text{-}4)$$

Where:

F_B: Balancing parameter for A_z Travel attraction at each zone

2.7 Previous Research on Trip Generation

Several kinds of research were conducted to Predication of Production and Attraction Models, and Parameters Impacting Travel Generation were conducted:

In Kirkuk, Al-Jaff (2002) investigated the impact of socioeconomic determinants on trip generation. There were 12 internal zones and 6 external zones in the city. The data from the location survey was obtained using home interview questionnaires and distributed in the internal zones at random. An aggregate model was created using the linear regression technique. The researchers created models that correlated trip production with socioeconomic factors such as vehicle ownership, income, workers number in the family, households number, size of household, trip time and cost, distance from the CBD, and dwelling unit area. In addition, attraction models have been created considering variables such as land use area and employment numbers[18].

For the Dohuk city residential area, Al-Taei and Amal (2006) designed trips(production and attraction) models. The phenomena of trip generation were investigated for 20 residential zones out of 28 traffic zones in the Dohuk city urban region, which has a population of over 300,000 people. To do the trip analysis, the city-provided home-interview travel data was combined with special data acquired. To obtain the most statistically well-accepted projected trip models, dependent variables such as the number of housing units, employment, and so on were chosen as independent variables in the SPSS software. Because of their high (R^2) value, some models, such as home-based work trips, are constantly eliminated. In their research[19],

For Kirkuk, Safa-Eldeen (2006) created a trip generation model. There were 14 internal zones and 7 external zones in the research area. The questionnaires were issued in consultation with the city's secondary and industrial school administrations. The equation of trip generation was predicted using the multiple linear regression approach. The trip generation model was shown to be dependent on the family size, dwelling unit size, and the number of workers per family. Another model was developed to depict the relationship between trip attraction between zones and the number of jobs that are available in each zone[20].

Arabani and Amani (2007) looked at the parameters that influence urban travel generation in the Islamic Republic of Iran. The researchers noted that the most significant parameter among households properties that has the greatest impact on the dependent parameter was income level, with family size and vehicle ownership coming in second and third, respectively[21].

Al-Hasani (2010) investigated the association between daily trips and socioeconomic factors in Baghdad's Al-Karkh sector. There were ten zones in the research area. To forecast trip generation, multiple linear regression. The number of people who travel per household is connected to family size and composition variables such as the number of people over the age of 6, the number of men, and the number of male workers, according to the findings. It also has to do with the number of vehicles available and the type of residential unit. For the entire study region, a model was created with (R^2) of 0.678[22].

Al-Zubaidy (2011) developed a prediction trip production model for Al- Diwaniyah city that included social and economic factors and was based on statistical methodologies (Multiple Linear Regression). The city was divided into five sectors, each of which contained 70 zones. Using the stepwise regression technique, models were created to link home trips per day to social-economic characteristics (Multiple Linear Regression, MLR).In sector No.2, SPSS software was used to build a relationship between daily trips and socioeconomic characteristics. The trip generation model is based on the size of the family, gender, and the number of family workers and students, according to the research. For MLR, the coefficient of determination R^2 for (Y) (total number of trips) is 0.88, which is considered a very good relationship[23].

Dr. Ali Abdul Ameer (2019) has developed a predictive model for the production of trips and attraction of trips to the city of Hilla that included social and economic factors and relied on statistical methodologies (multiple linear regression). The city was divided into five sectors, each containing 70 districts. Using the stepwise regression technique, models were created to correlate daily home trips with socioeconomic characteristics (multiple linear regression, MLR). The production of trips model depends on gender (female or male), size of the family, number of workers, number of children <6 years old, number of students, money income, and number of vehicle ownership, according to the research. For MLR, the R^2 determination coefficient for (Y) (total number of trips) is 0.86, which is a very good relationship. The attraction of the trips model depends on the number of employees and the number of students, according to the research. For MLR, the R^2 determination coefficient for (Y) (total number of trips) is 0.971[24].

2.7 Summary

With regard to the prediction of trips produced and attracted in the previous study that the social and demographic factors have the most influence on the size of the family, the number of employees and students, the level of income, and the ownership of the vehicle on trips, as the multiple regression method is the most common method, especially with regard to discrete variables, in this research the CBD sector was studied as one the sectors of the city of Hilla to show the difference with the study of the largest areas and the impact of the previous factors on the trips.

Chapter Three

Methodology and Analytical Frameworks

3.1 Overall Methodology's Steps

The following approach will be used to conduct the study:

- Internet Research and Desk: This step includes reviewing the available studies, which involves publications for(Models for Production and Attraction Prediction).
- Identifying a Research Area: This includes considering the research area's boundaries and dividing Hilla City's CBD Sector into traffic zones based on predetermined criteria, using maps provided by the Hilla Municipality or other relevant organizations.
- Constructing a Household Questionnaire and Choosing a Sample Size: This includes specifying what information is required and creating a questionnaire to collect relevant socioeconomic parameters and trip information.
- Collection of the Essential Data: This relates to the gathering of field data from a random sample of households in various traffic zones. The overall number of travels conducted by household members, as well as the number of trips made by the household for each trip production, or attraction, or external trip, whether according to trip purpose, are all required data that can be obtained through (a home questionnaire and an interview).
- Available data analysis: This is done with the help of appropriate computer programs.

- Building Models: This includes using the linear regression analysis to identify appropriate models for the household's total number of trips and the number of people attracted to the area.
- Selection of Acceptable Models: The most suitable model for predicting the total number of trips produced and also the models that predict the attraction trips for sector CBD, is chosen using statistical and analytical approaches.
- Finding's Verification: This is achieved by comparing model outputs to actual numbers in order to verify the models and recalibrate the variables utilized in model construction.

The next sections and chapters describe the details of the methodology's stages.

3.2 Survey Techniques

The next step is to conduct the survey once the questionnaire is complete. There are several sorts of survey methods, each with its own set of benefits and drawbacks. The Features of the persons who will be interviewed, the sample size, the costs, and the rate of predicted response are all things to consider, and the size of the research region must all be known before selecting the appropriate survey method.

The following are the types of surveys that are commonly conducted[12].

- Surveys of home interviews.
- Surveys of commercial vehicles
- Taxi polls.
- Surveys were conducted on the side of the road.
- Questionnaires on postcards
- Surveys of registration numbers

- Use tags to organize your surveys.
- Surveys of public transportation.

The home interview survey can be conducted in a variety of ways:

- Full interview technique: This strategy entails interviewing as many members of the household as feasible and recording all of the information immediately.

- The use of a home questionnaire: The interviewer collects information about the household's characteristics before handing over forms with trip information to the residents. After a day or two, the interviewer collects the completed forms. The full interview technique is usually more costly than this one[2].

3.3 Techniques for Determining Specimen Size

Regrettably, there seems to be no simple or one objective solution to the issue of how to calculate the sample size. Choosing a specimen size is a trade-off issue [3] :

- Considering the study's goal and necessary level of accuracy, a far too extensive sampling might indicate a data-collecting and analyzing procedure that is excessively costly.
- A much too small specimen size might indicate findings with an abnormally high variability degree, lowering the exercise's overall usefulness. As a result, the most cost-effective (in terms of specimen size) specimen size for the particular research goal falls in between these two extreme values.

In urban transport planning studies, the data collection is took place in two ways either by home interview method or distribution of questionnaire forms method. In both methods, it will be needed to determine the sample size.

3.3.1 Bureau of Public Roads (BPR) Standards

The specimen size may be calculated depending on the research area's inhabitants, and the criteria set out by the United States Public Roads Bureau (BPR) were provided in Table (3-1).

Table (3-1): Standards for Determining Specimen Size from the Bureau of Public Roads (BPR) [25]

Population of Study Area	**Specimen size (Dwelling Units)**	
	Recommended	**Min**
Less than $50x10^3$	1/5 (20 percent)	1/10 (10 percent)
$50\ x10^3$– $150\ x10^3$	1/8 (12 percent)	1/20 (5 percent)
$150\ x10^3$– $300\ x10^3$	1/10 (10 percent)	1/35 (2.86 percent)
$300\ x10^3$– $500\ x10^3$	1/15 (6.67 percent)	1/50 (2 percent)
$500\ x10^3$– $1000\ x10^3$	1/20 (5 percent)	1/70 (1.43 percent)
Higher than 1000 $x10^3$	1/25 (4 percent)	1/100 (1 percent)

3.3.2 Specimen Size Statistically Equations

Statistical equations may be used to determine the specimen size. Often these statistical publications, particularly those concerned with descriptive probability and statistics, include these equations.

$$S_S = \frac{Z(1-0.5\alpha)\times P\times(1-P)}{C^2} \text{........3-1}$$

Whereas:

S_S : Specimen Size required.

$Z(1-0.5\alpha)$: Normal Standards are statistically equivalent to $(1-\alpha)$ level of confidence.

α : The fraction of the area under the normal curve that represents events that are not within the level of confidence (Thus, 1-α is the desired degree of confidence).

P: Decimal percent of the population that makes a choice.

C: The confident interval, often known as the acceptable error margin, is a decimals representation of the standard error.

The sample size of a finite population is calculated using the formula below:

$$\text{Modified } S = \frac{S}{1+(S-1)/P} \ldots\ldots 3\text{-}2$$

Whereas:

S: Previously used sample size.

P: The survey region's population.

In this research, the Bureau of Public Roads Standards (BPR) method was used.

3.4 General Linear Regressions Technique

The regression method is one of several techniques for linking trips (production or attraction) to the affecting parameters.

The linear regression technique assumes that values of the dependent variable, Y (number of trips), can be collected for n views of the independent variable (Xi) and that a relationship of the form Y=α+βX is must be able to fit the data This equation is for the circumstance where there is just one independent variable.

Computer tools such as Excel and SPSS including coefficient of determination (R^2), parameter t-test, and F-test can be used to determine the best regression line.

3.4.1 The Linear Regression Analysis Method

The steps listed below can be used to construct regression equations [3]:

• Looking for nonlinearities in the dependent variable's connections with each of the independent factors. If nonlinearities are discovered, the relationship must be linearized by changing one or both of the dependent and independent variables.

• Creating an inter-correlations matrix that includes all independent factors.

• Examining for probable resources of multi-collinearity using a basic correlation matrix, compare two independent variables.

• If there is multi-collinearity between two independent variables (much closer to one), one of them must be discarded from the regression operation after checking the correlation matrix. Following the selection of associated independent factors, several regression equations are proposed, followed by the estimation of the variables of every one of the possible regressions formulas.

• Some regression equations are suggested after the identification of associated independent variables, and the parameters of each proposed regression equation are calculated.

•Necessary tests are conducted for each model produced to assess the model's goodness using logic and statistics testing. Statistical tests contain (R^2), the t-test for model factors, and the F-test for each model. There are also logical factors to consider, as the model must be statistically and logically sound.

• The outcome is summarized once all of the models or equations have been evaluated based on the test findings.

3.5 Analyzing Unit

The unit of analysis can be used to infer variables in general. When it comes to travel modeling, In most cases, the household and the person are considered. The household unit is favored for a variety of causes: most trips begin and conclude at home; income and ownership of car are typically shared by all Individuals of the household; and, in a social setting, the family forms the "cell society."

All of a person's basic needs are usually addressed in this environment. If the member is regarded as the base unit, the issue of allocating some of the previously indicated variables must be solved, or different quantities must be considered. As a result, in this study, the household serves as the analysis unit.

3.6 Software for Data Analyzing

Software Data analysis can be done with a variety of statistical software programs. One of the most extensively used statistical method software is SPSS-26. SPSS is a statistical software package that includes a variety of procedures and tests. It also includes 40 descriptive statistics, including frequency, mean, and relationships. Finally, it comes in handy for creating graphs. The linear regression analysis method will be employed in this study to estimate the trip generation models using SPSS software.

3.7 Model Requirement

The most prevalent sort of modeling approach that may be applied to trip creation models is multiple regression analysis. As a result, the trip generating models for this study will be developed using multiple regression equations. The linear function of the form is the most common type of trip generation model in Equation 3-3

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i + u \ldots\ldots 3\text{-}3$$

Where*as*:

The term of constant is $\boldsymbol{\alpha}$, the parameters of independent are $\mathbf{X_i}$, the regression's coefficients formula that represented as partial slope are $\boldsymbol{\beta_i}$, and a term of error is u, which was expected to be a random parameter. Regressions analyzing utilizing statistically analyzing software might be used to get the regression's coefficients formula. The formula above has been known as a multi-linear regressions formula.

3.8 Models Estimating

The trip generating models will be estimated after a review of the relevant literature. The models will be calculated using the MLR method by stepwise the dependent variable on each of the independent variables.

The trip generating models are rated into two types in this study. The first is a model of a production trip. The second is made up of The trip attraction model calculates the number of non-home-based visits as well as the number of home-based travels to and from each zone. Attractions are calculated based on the features of land uses within the traffic study zone (workplaces, educational institutions, etc.). Multiple linear regressions are employed in the trip attraction model, just as they are in the trip production model.

3.9 Statistically Testing

Here are some of the most commonly used statistical tests in model selection.

3.9.1 Correlation Matrix and Variance Inflation Factor:

Examining Multi-collinearity occurs when there are linear associations between two or more independent variables in a regression model. Exact or perfect multi-collinearity and inexact or imperfect Multi-collinearity are the two types of multi-collinearity.

When at least two independent variables are linearly related (exact or perfect) connections, this is known as exact or perfect multi-collinearity. When two or more independent variables are strongly related, this is known as incomplete multi-collinearity[26].

To find multi-collinearity more explicitly, analysts frequently employ the Variance Inflation Factor (VIF). The VIF illustrates how multi-collinearity causes an estimator's variance to be exaggerated[27].

The VIF develops as R^2, When a specific explanatory variable is linked to the other explanatory variables in the model, the coefficient of specificity approaches one. The higher the VIF score, the higher the level of multicollinearity of one explanatory variable with the other explanatory factors. If the VIF of a variable is larger than 10, it is termed strongly collinear[28].

3.9.2 R-Square: Goodness of Fitting

The coefficient of determination (R^2), is a measurement for the regression model's quality of fit. The proportion of total variance of the dependent variable that must be made clear by the model's explanatory parameters is calculated. R-squared is a number that ranges from 0 to 1. R-squared number value near 0 refers that the model is poorly-fitting, whereas a value near 1 refers to that the model is well-fitting.

There is, however, no agreement on what degree of R^2 is "excellent". The application determines this.

The square of R is determined from the equation 3-4 [29]:

$$R^2 = \frac{\text{Regression Sum of Squares (RSS)}}{\text{Total Sum of Squares (TSS)}} \quad \text{........3-4}$$

The ANOVA test is used to illustrate the total variation analysis in the dependent variable. This variation is divided into two categories: Error-related variance and regression-related variance are two types of variance.

3.9.3 F-Testing: Testing Generally Model Significance

The F-statistic is used to determine whether or not the regression coefficients are all zero. To put it another way, the F-Test is utilized to determine the regression model's overall significance.

The null hypothesis for determining the model's overall significance is that all of the explanatory variables' regression parameters are equal to zero. Another possibility indicates that at least one of these parameters is not 0. The F-value is usually accepted at a 95% level of significance[30].

3.9.4 T-Test: Testing Individual Coefficients

Testing Individual Coefficients are tested for significance using the T-Test. If the estimated t-statistic is more than two in an absolute account, According to the rule of thumb, at the 95 percent level of significance, the approximation is statistical significance from zero.

3.10 The rationale used in choosing the model

Below is a list of rational conclusions factors to consider when choosing the right regression model:

- The expected sign of the regression coefficients must be correct, and their proportions must be reasonable. An independent variable, for example, is expected to have a positive effect on the dependent variable, but regression analysis indicates a negative effect.
- Both value and sign of the constant (intercept) term must be acceptable.

3.11 The Area of Study

The research region has been separated into a number of zones to make data collecting easier throughout transportation planning processes. These zones were chosen based on a number of factors, including homogeneity, social, and economic qualities. Zoning is generally used for the following reasons[12]:

- Improve understanding of the area's structures in terms of land use and activities.
- Making data collection and display simpler.
- Reducing the time required to calculate and store data processing.

After determining the border, zoning entails dividing the research area into smaller land-use regions known as (TAZ) or simple zones. Internal regions are defined as regions within the study area. A compromise between a set of criteria mentioned in this section and another set of criteria will be used to establish the number and division of internal zones.

The zoning system's goal is to[3]:

- Make it easy to spatially quantify land use and economic factors that influence traffic patterns.
- Assist in locating the origins and destinations of trips on a map.

The study area was defined using the maps of the division of the Municipality Directorate of AL-hilla city, CBD Sector of Hilla City is Sector Number 2, Where the city consists of five sectors as demonstrated in Figure (3-1), Figure (3-2)and Figure(3-3).

The Central Business District (CBD Sector) consists of 17 residential areas and contains educational, commercial, and public facilities as shown in the Figure(3-4) for the Hilla Municipality Directorate.

The sector was divided into three subsectors for the purpose of facilitating the study, as shown in the Figure(3-5). The Table(3-2) contains the names of residential areas for each sub-sector and the population percentage for 2018 from the Directorate of Statistics of Babylon.

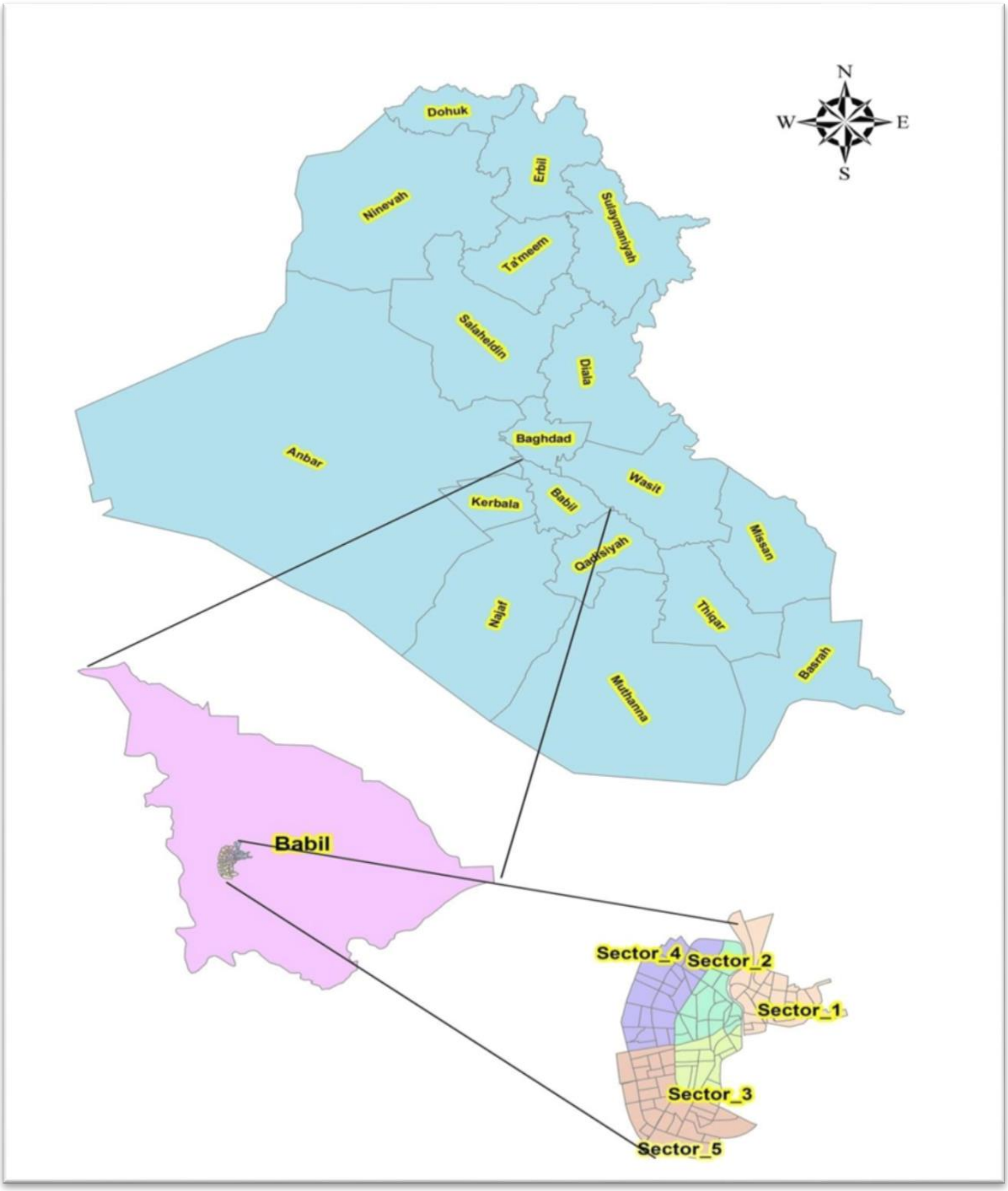


Figure 3-1 The Location of Study Area According to Municipality Directorate (Hilla City)

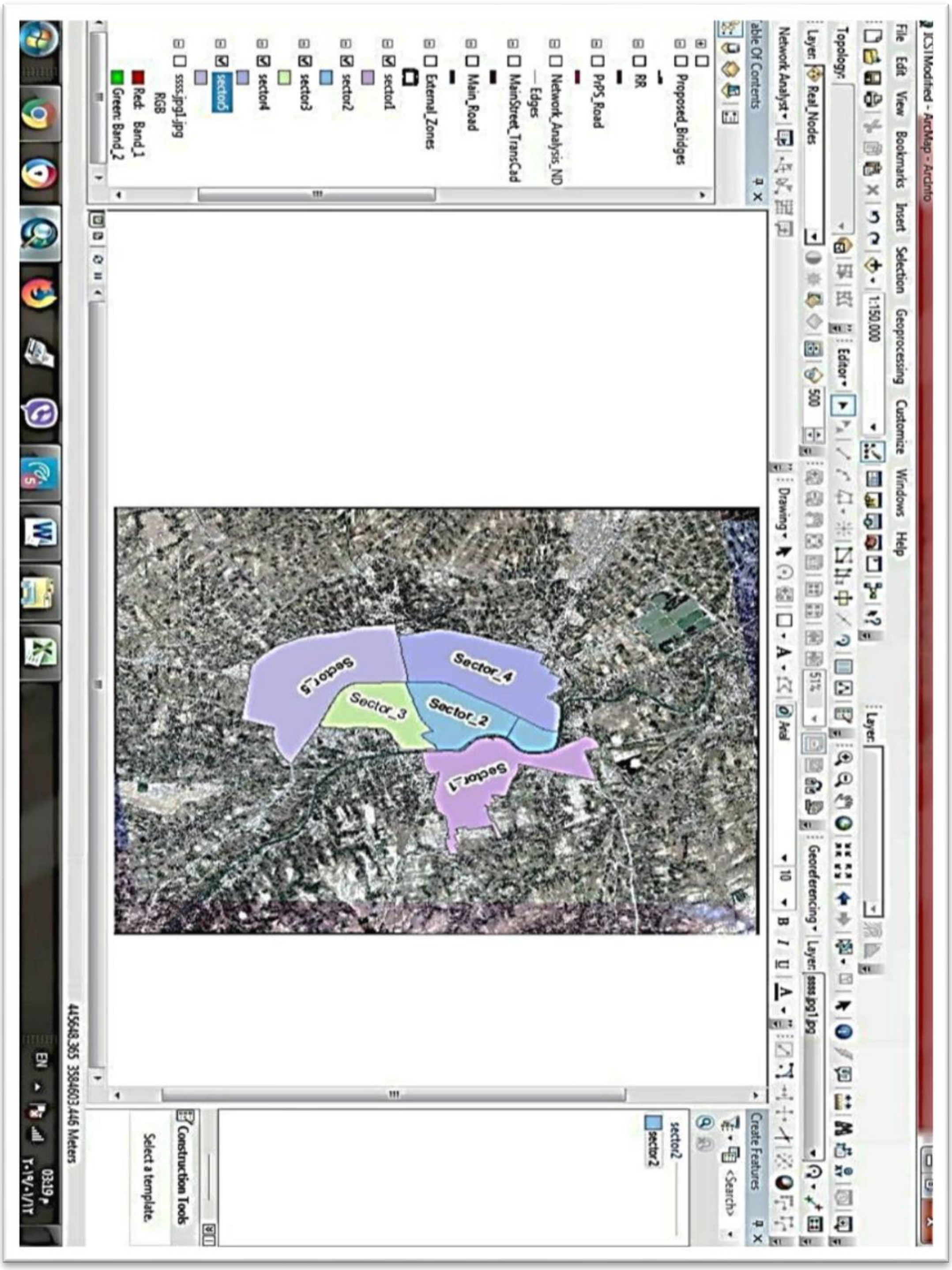


Figure 3.2 Thematic Image Map for Hilla City

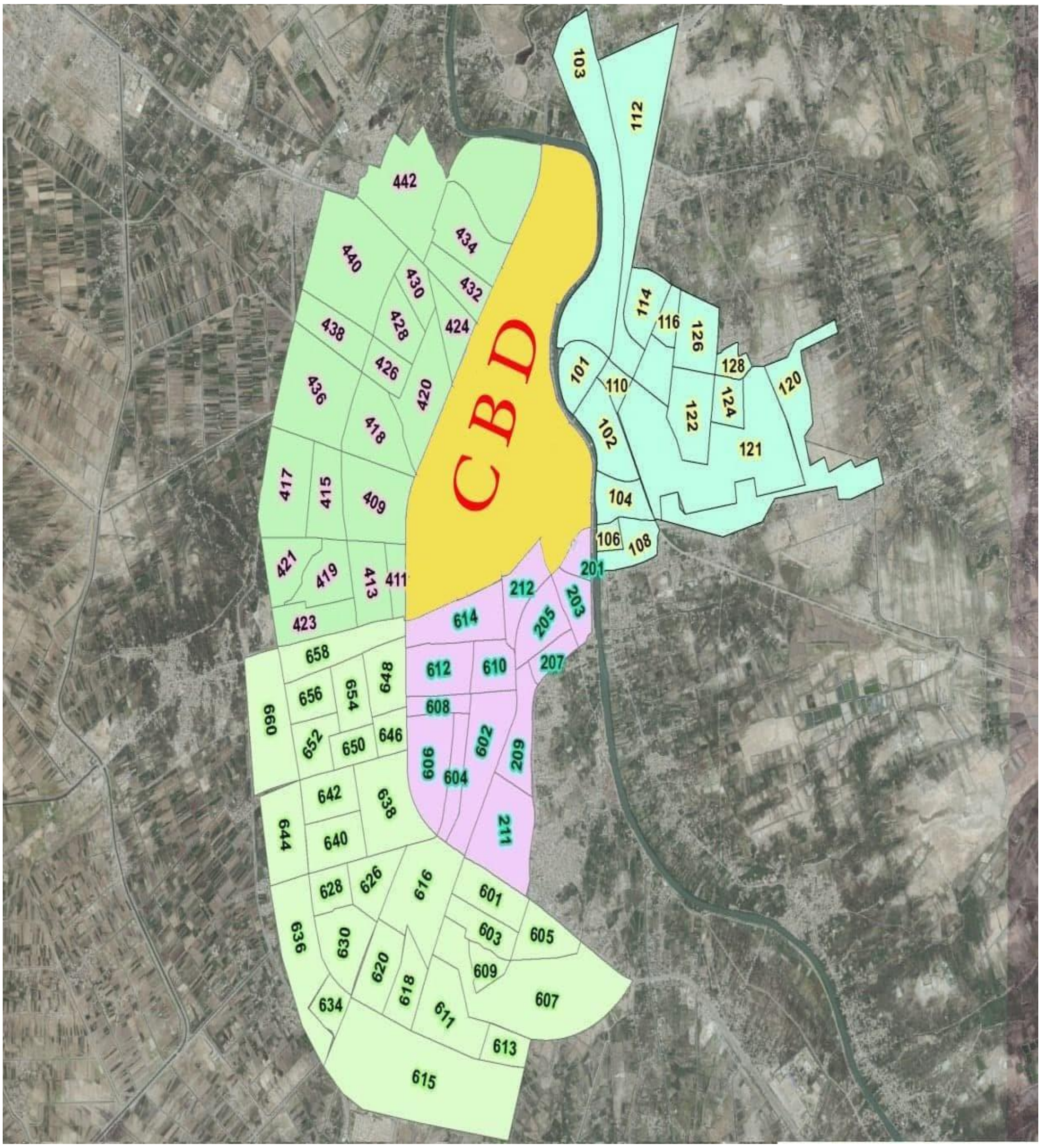


Figure 3-3 Thematic Image Map for CBD sector

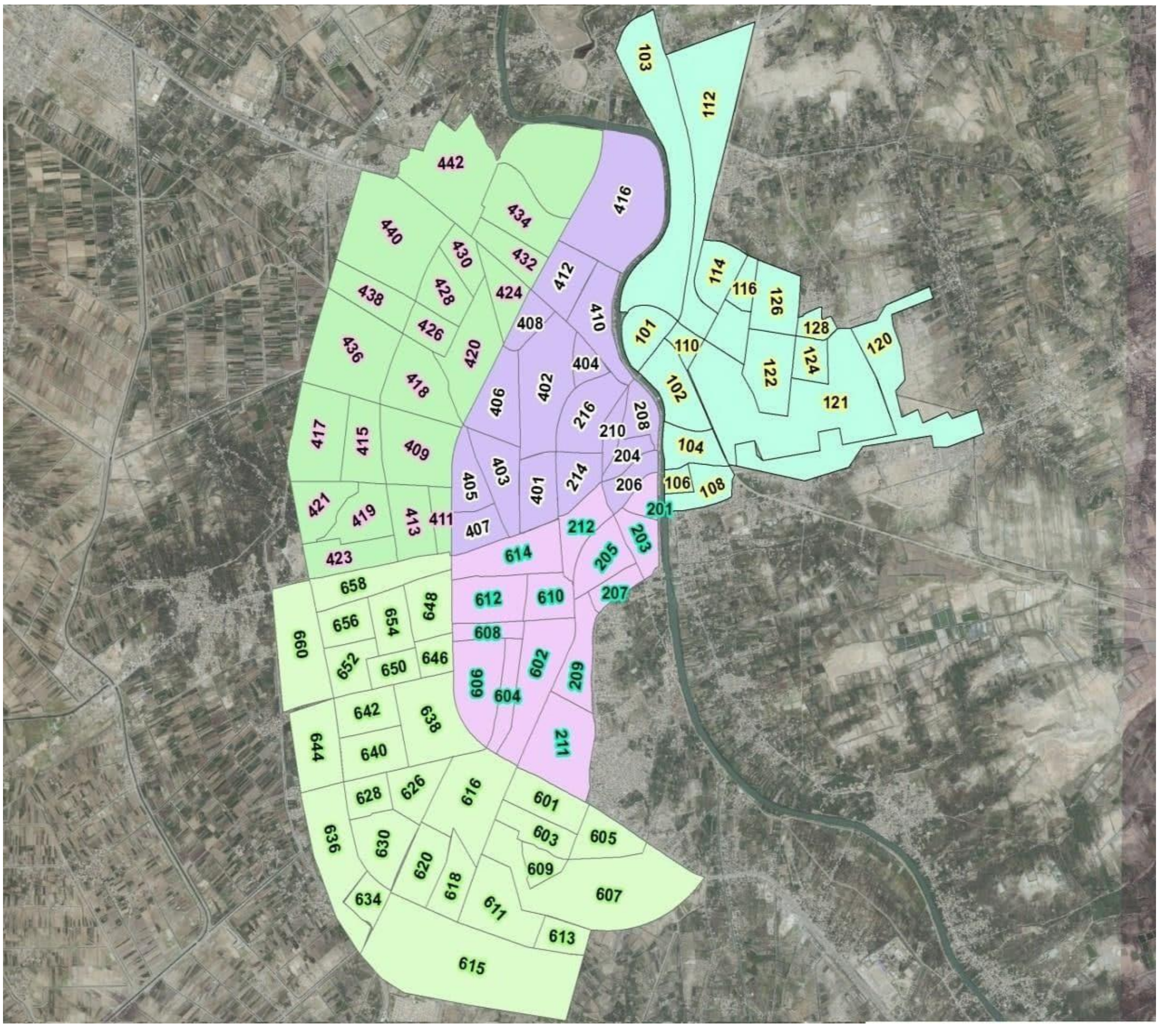


Figure 3-4 Zones Notation of Hilla City (by the researcher with the cooperation of the Municipality Director of Hilla city)

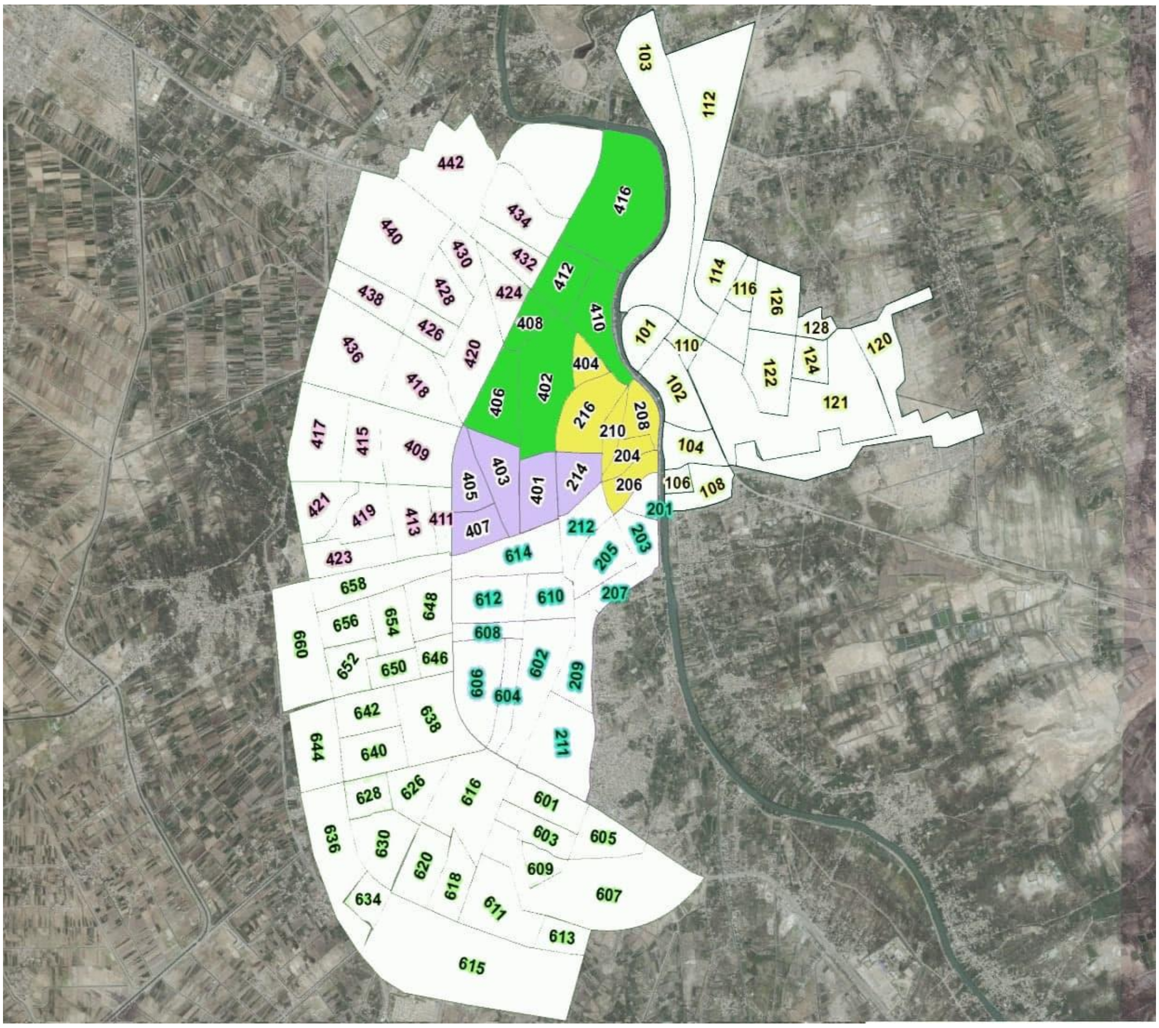


figure 3-5 Showing the Subsectors of the CBD Sector

Table 3-2: Sub-sectors, Names of Residential Areas, Percentage of the Population from the Babil Statistics Directorate for the Year 2018, and Land Uses (District)

Subsector No.	Zone Id	Zone Name	District No.	Population 2018	center of attraction
Subsector1	1	Q. Mustafaa Ragaib	214	1400	Al Amam Al Saadiq School, Directorate of Education2
	2	Q. Jameaya_Eslaah	401	4100	Al Iaetimad School, credit bank
	3	Q. Al-Hussein	403	3748	Al Hudaybiyah School, Social Welfare Directorate
	4	Q. Al-Sendbad	405	3351	Hammurabi Medical Complex, Al Aqsa School
	5	Q. Al-Mukhabaraat	407	5651	Ishtar Medical Complex, Al-Nusour National School
Subsector2	6	Q. Khraama	402	2622	Al-Waeli High School , the Endowment Department
	7		406	2980	Rayat Al Aislam School, almadina medical
	8	Q. New Governorate	408	4740	Babylon Tax Department
	9	Q. Al-Taiyaraa	412	1822	Al Jazra School ,Mam Jalal School
	10	Q. Al-Sahaa	410	5322	Directorate of Civil Defense and School almazaya
	11	Jazraa_Marrana	416	5662	Babylon Electricity Directorate and Al-Qalam alahilia School
Subsector3	12	Q. Mahdyea	204	4510	alhilal alahmir complex, Ashur Medical Complex
	13		206	3905	Al Zahraa School
	14		210	1167	Hammurabi School, Directorate of Statistics
	15	Q. Khtheeya	216	3300	Al Hilla Preparatory School for Boys , Directorate of Education
	16	Q. Kraad	208	4972	Al Markazia School
	17	Q. Al-athamun	404	5605	Baghdad National Bank, BDC . Mall

Chapter Four

Collection and Analysis of Data

4.1 General

Data collection processes for building trip production and trip attraction models to valuation the number of trips (production and attraction) in the geographically tiny area. In general, the area was divided into subsectors containing a group of residential areas to start surveys and determine the distribution of samples to TAZs in order to collect data. This is critical in order to make the data collection process more smooth.

This is the most important stage of any transportation planning process. Any study must begin with data collection, which may include field surveys in addition to obtaining supporting data or inventories, such as land use statistics. The origin and destination (O&D) house interview surveying is the field survey used in this research.

4.2 Data Collection

The following are the five main steps in data collection :

4.2.1 Decision on the Required Data

Different forms of data from various sources are required to meet the study's aims. These are:

•Formal data: These data were collected from various government departments, namely includes:

1-Population number and growth factor obtained from Babylon Statistics Directorate.

2-Vehicle growth factor, Babylon Traffic Directorate, and

3- Hilla city maps provided by the Municipality Directorate.

• Design questionnaire forms can be used to obtain socioeconomic data such as income, family size, and car ownership.

4.2.2Preparing Questionnaire Form

Creating a Questionnaire Household data is one of the most essential characteristics for estimating a city's travel pattern, as it contains all of the information needed to construct the model. However, due to the additional time and resources required, this is not practical. Furthermore, handling these enormous data sets at the modeling step will be tough. As a result, household samples are chosen at random and a survey is conducted to collect data. A well-designed questionnaire will generate a better response from respondents and considerably improve data quality.

Information should be arranged in a way that makes acquiring and analyzing it simple. The questionnaire form for this study was created with simplicity in mind so that the questionnaire filler could understand it. Appendix A contains the questionnaire form.

The traditional household survey includes five sections; information for a dwelling unit, household characteristics, Characteristics of car ownership, individual characteristics, and trip details[16]:

1. Characteristics of a household include:

• The number of persons per family.

• The number of males.

• The number of females.

•The number of workers per household.

•Number of persons less than school age(< 6 years).

•The number of students per household.

•Average monthly income (ID).

2. Characteristics of a dwelling unit include:

• Dwelling Unit ownership (Rent or owned).

• Dwelling unit area.

3. Characteristics of car ownership include:

• The number of available cars.

• The type of vehicle, public or private.

4. Characteristics of the person include:

• Gender.

• Age.

• The number of daily trips/person.

5. Characteristics of trip data includes:

• The purpose of the trip.

• The origin and destinations of the trips.

4.3 Sample Size

The size of the sample that must be interviewed is determined by the entire population of the study region. The Hilla Statistics Directorate was used to ensure the correctness of the 2018 census. A sample size of 500 households was established.

4.4Work Plan of the Surveys

The home data was collected using a single survey method, namely questionnaires. As a result, a meticulous plan was devised to carry out the most practical method of distributing the questionnaire forms. The form was repeatedly tweaked until it arrived at its ultimate state. Surveys were conducted during working hours (Monday- Wednesday), as the start was on Wednesday 11/8/2021 to Monday 12/10/2021.

4.5Checking and Editing of Data

After the forms are collected, each form must be reviewed for completeness and suitability, including the address of residence, the first part of the form, and whether all information has been filled out. Incomplete forms are neglected.

4.6 Data Coding

It will be necessary to code the acquired data because it will be processed by a computer. For this aim, a coding system should take into account each and every piece of data collected. The coding system is illustrated in Table (4-1).

Table (4-1) Coding System of the Case Study

Item	Variable	Description	Code	Range
1	Family size	Writing number	----	1-15
2	Number of males	Writing number	----	0-10
3	Number of females	Writing number	----	0-10
4	Number of workers	Writing number	----	0-10
5	Number of children (< 6 years)	Writing number	----	0-10

Table (4-1) Coding System of the Case Study

Item	Variable	Description	Code	Range
6	Number of students	Writing number	----	0-10
7	Income (*1000 ID)	Low (<500)	1	1-3
		Medium (500-1000)	2	
		High (>1000)	3	
8	Dwelling unit ownership	privet	1	1-2
		rent	2	
9	Area of Dwelling unit (m^2)	< 150	1	1-3
		(150-300)	2	
		>300	3	
10	No. of Car ownership	Writing number	---	0-5

4.7 Preliminary Results Analysis

Before the model was predicted, the data from the field survey was subjected to a preliminary analysis. The Prediction model could use the examined data to help with decision-making later on. The data gathered for each zone is summarized in Figures (4-1), (4-2), (4-3), (4-4), (4-5), (4-6), (4-7) and (4-8) .

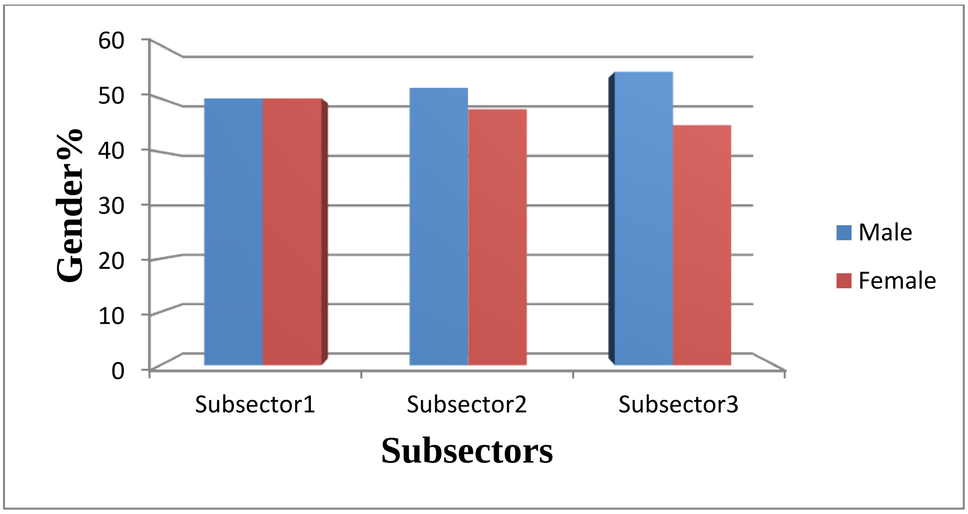


Figure (4-1) Gender Distribution Percent in all Subsectors

It can be concluded from Figure (4-1) that in almost all subsectors, the proportion of females is equivalent to the number of males.

Dividing the population of the second sector (Central Business District) of the city of Hilla into four categories: workers, students, non-workers, and children. Figure (4-2) shows that the proportion of workers and students is the highest, especially in a sector that generates more trips, and this leads to increased rates of (Work and Education) trips as shown in Figure (4-3) and then Shopping, Social, Others and Religious trips.

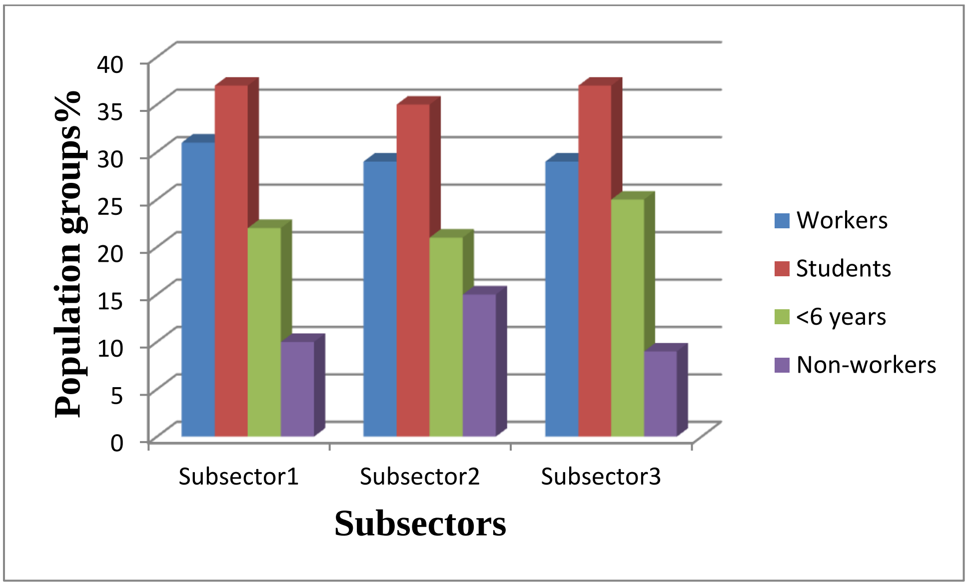


Figure (4-2) Population groups Distribution Percent in all Subsectors

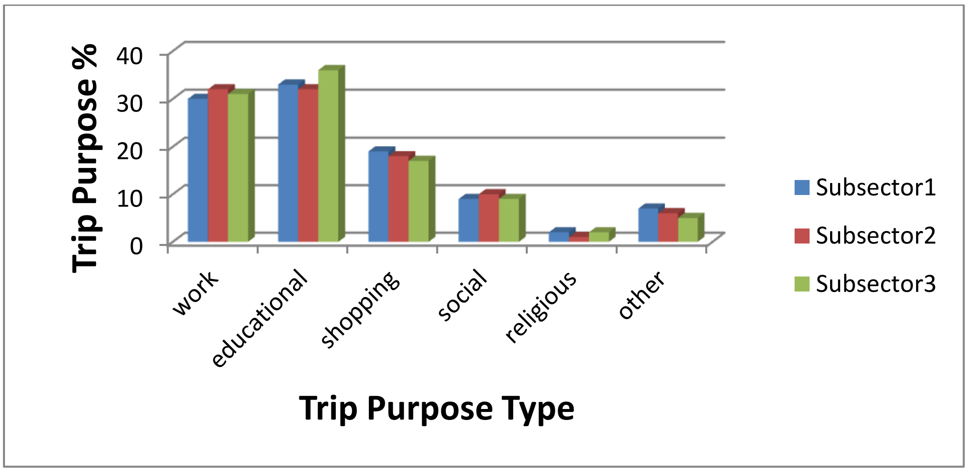


Figure (4-3) Types of Trip Purpose in all Subsectors

Figure(4-4) shows the type of Travel used on the trip (private or public) as a percentage for each subsector(Increasing private transport means increasing pollution and congestion, increasing journey time and more economical cost) and figure(4-5) shows the Percentage of car ownership for each subsector.

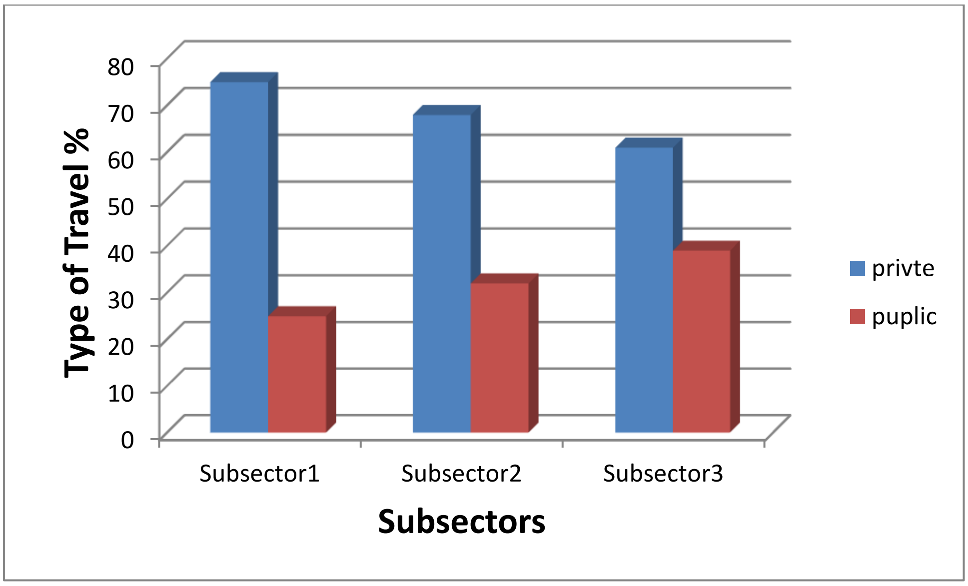
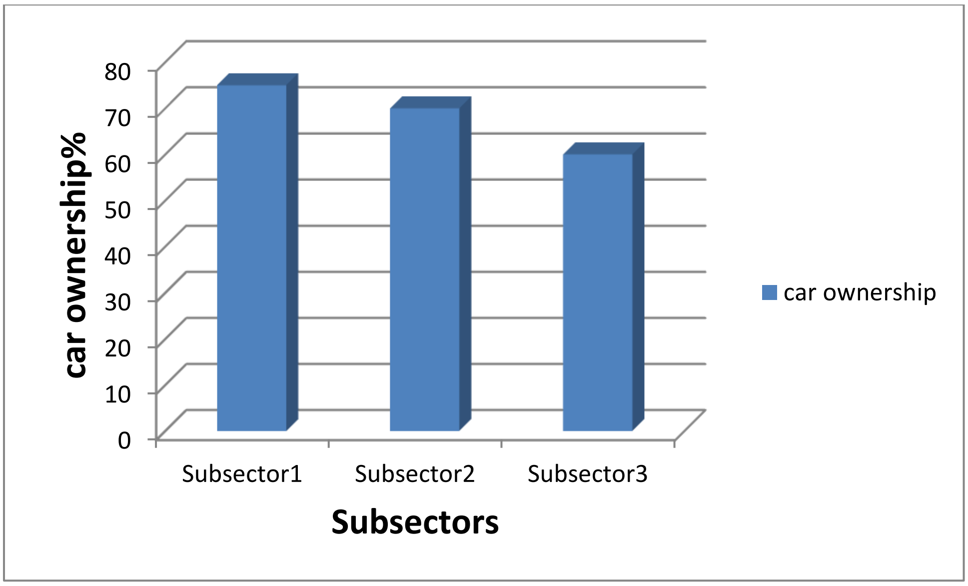


Figure (4-4) Types of Travel in all Subsectors



figure(4-5) Car Ownership in all Subsectors

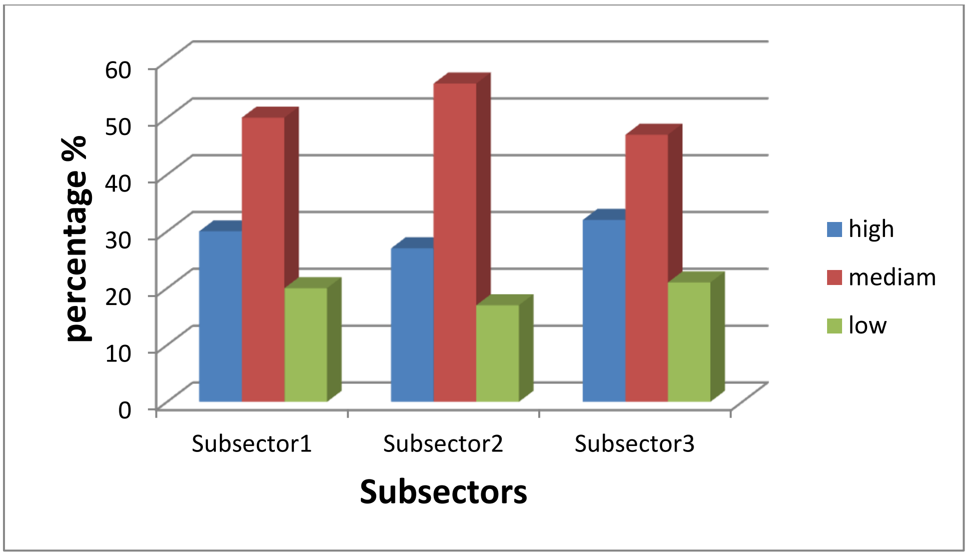


Figure (4-6) Distribution of Income in all Subsectors

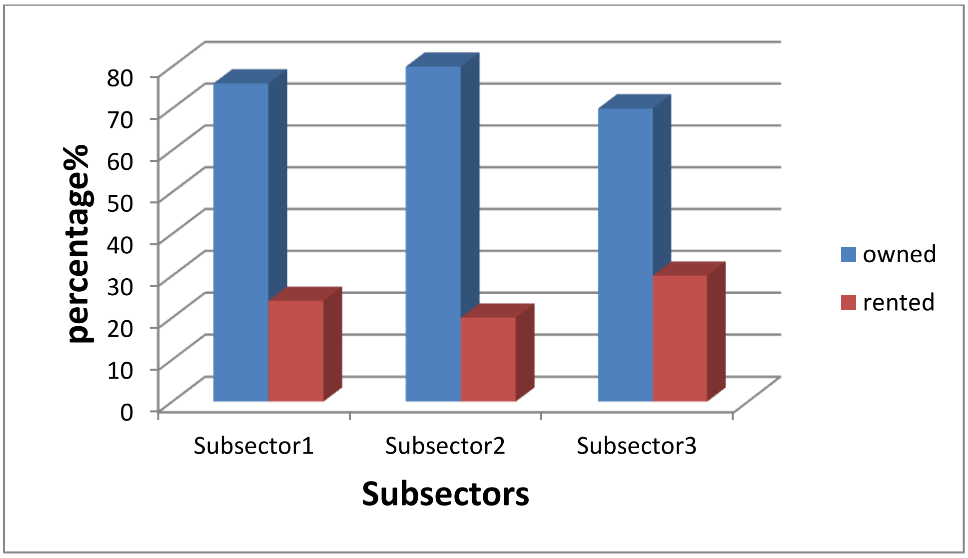


Figure (4-7) Dwelling Unit Ownership in all Subsectors

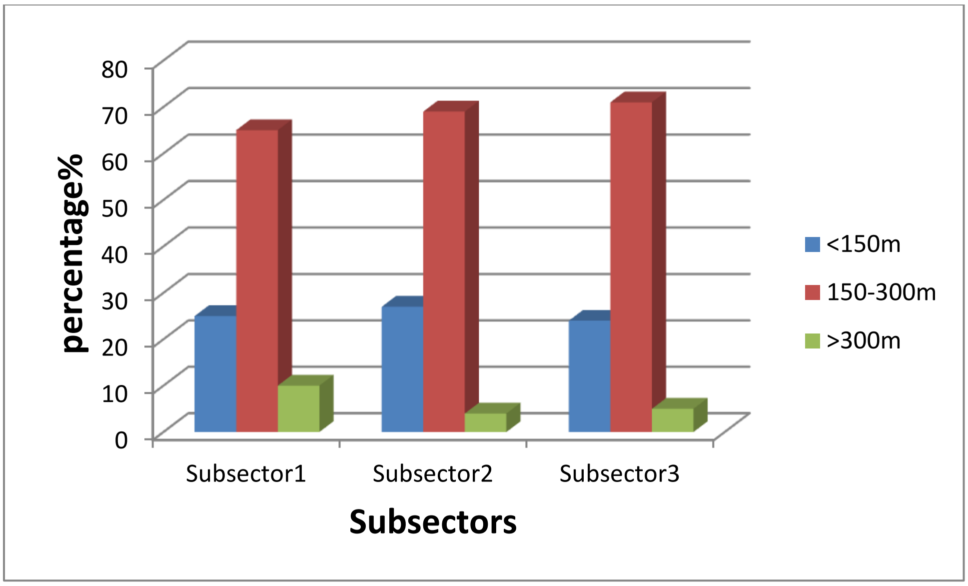


Figure (4-8) Dwelling Unit Area in Subsectors

Figure (4-6) also shows the level of income in each subsector, the figure(4-7) shows the dwelling unit ownership in each subsector, and figure(4-8) shows Dwelling Unit Area in each subsector.

This chapter examines the obtained data in order to develop a trip generation model that assumes a relationship between the number of trips production and attraction (dependent variable) and the given subsector's social-economic factors (independent variable)

The purpose of the trip (production and attraction) procedure is to forecast the number of person trips that will start or conclude at each TAZ in the study region[31].

A trip generating model (MLR) can be driven using a common statistical technique known as Multiple Linear Regression[14].

The statistical process of identifying the association between two or more variables in order to construct a model to forecast one variable from the other(s) in order to display data in the most appropriate possible is known as regression modeling. The purpose of multiple linear regression is for a given confidence level, select the best model that fits the basic presumptions regression analysis[32].

There are various conditions that must be met in order to achieve optimal regression models[33]:

- No substantial inter-correlation among the predicted variables,
- No effective observations or outliers in the data, and
- Normal error distribution, Zero mean for the error distribution.

The MLR is a widely used model for the trip generation that has the following conditions:

• Independent variables should not be dependent on one another.

• The dependent and independent variables have a linear relationship.

• The residuals (the difference in values between the real observed value and the MLR value) should follow a normal distribution and be unrelated to the independent factors.

4.7.1The Defined of the Variables

The following symbols represent the variables that are taken into account in the model development:

• Dependent variables:

-Y: Household all trips type per day

• Independent variables:-

-X_1: Family size

-X_2: Number of males

-X_3: Number of females

-X_4: Number of workers

-X_5: Number of children (< 6 years)

-X_6: Number of students

-X_7: Income (*1000 ID)

-X_8: Dwelling unit ownership

-X_9: Area of Dwelling unit (m^2)

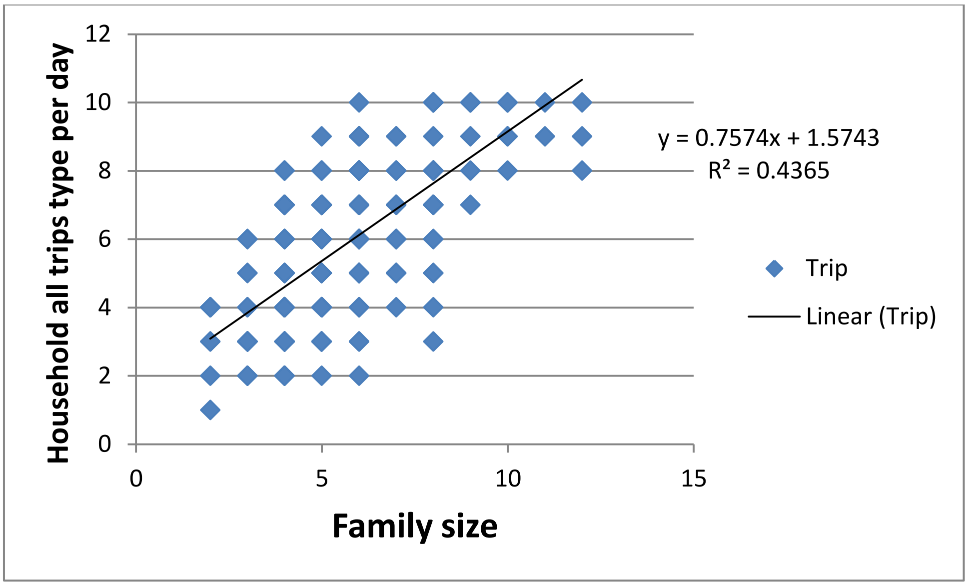
-X_{10}: No. of Car ownership

4.7.2 Scatter Plots of Data

At the start of the modeling process, A scatter plot is a graph of information that describes the general pattern of the data in a visual form. To determine the components relevant for trip generation models, a scatter plot is created using Microsoft Excel software.

It may be possible to modify the variables x and/or y so that the resulting relationship resembles a linear relationship. The changed variables can then be used to create linear regression models, and the transformed data can be used to conduct appropriate analysis.

These Figures (4-9), (4-10), (4-11), (4-12), and (4-13) show the effect of these variables on the number of trips by the strength of the linear relationship represented by R^2, where the effect increases whenever the values of R^2 are closer to 0.5, as shown in the Figures below.



Figure(4-9) Household all Trips Type Per Day and Family Size

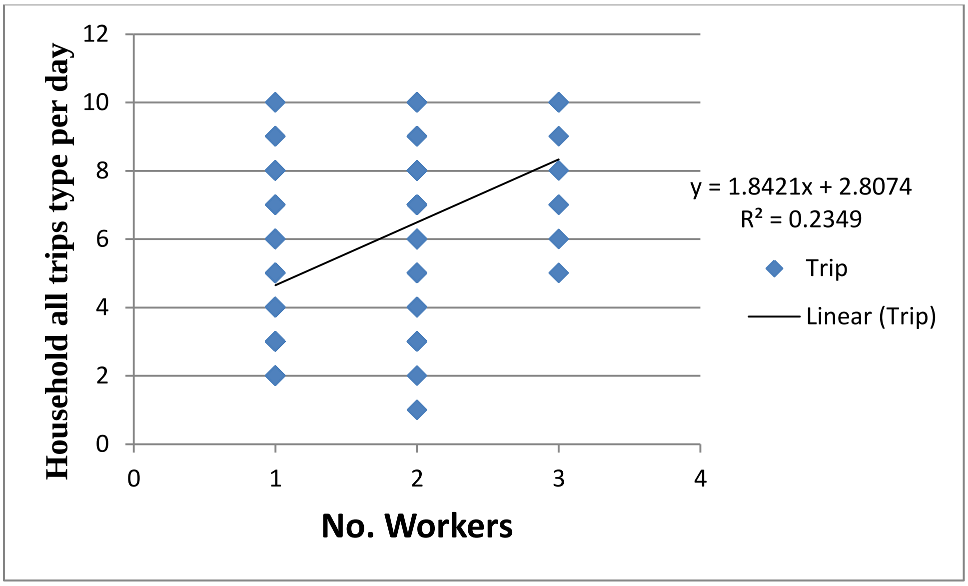
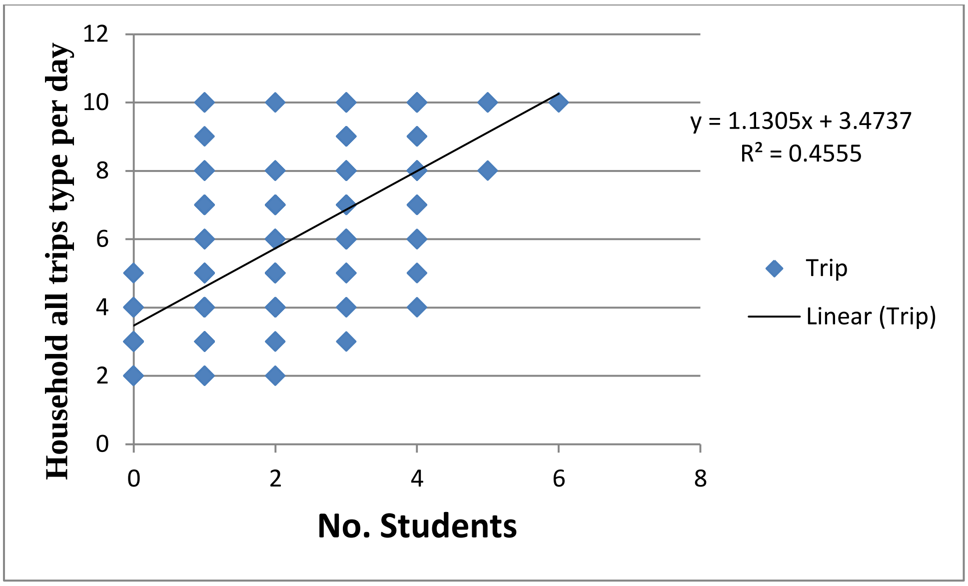


Figure (4-10) Household all Trips Type Per Day and Number of Workers



Figure(4-11) Household all Trips Type Per Day and Number of Students

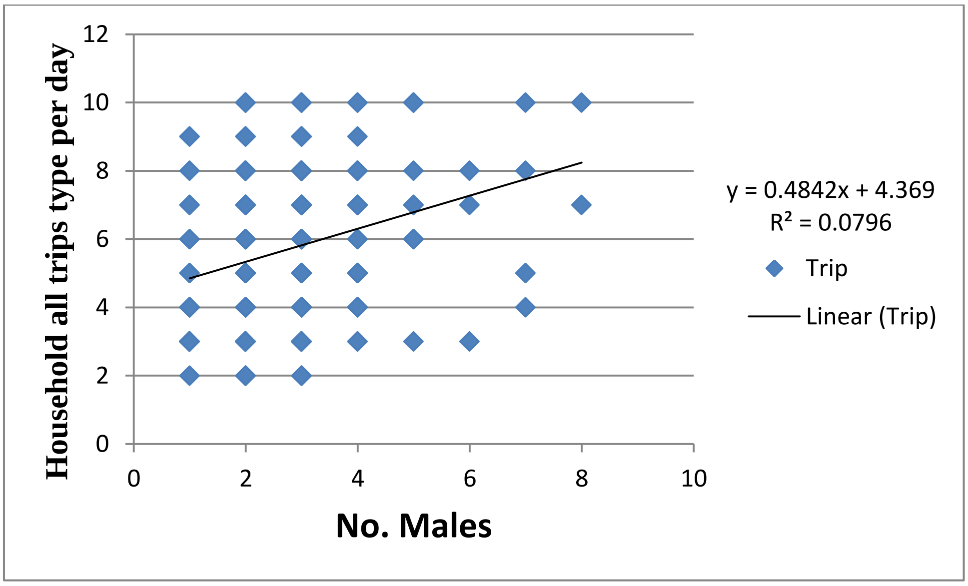
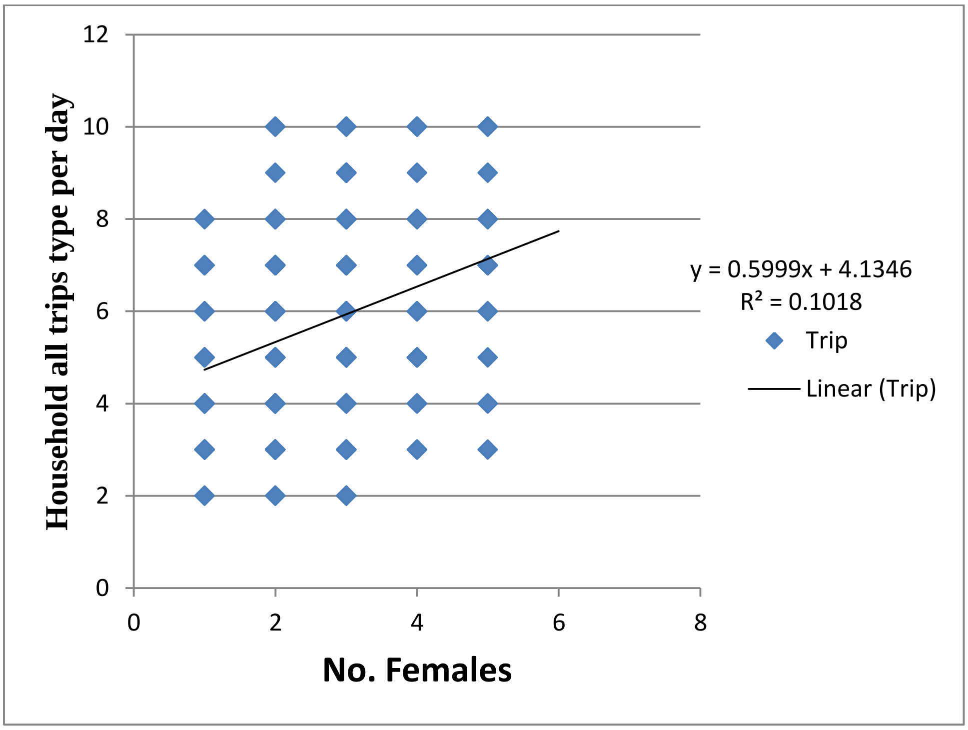


Figure (4-12) Household all Trips Type Per Day and Number of Males



Figure(4-13) Household All Trips Type Per Day and Number of Females

4.8Prediction of Production Model for CBD Sector

The collected data were used for the prediction of the production trips Model for the CBD Sector within Hilla City using the method of multiple linear regression. Among the ten independent variables, the most appropriate variables were considered in the analysis. For each independent variable, the stepwise method is the most popular and favored method for generating simple prediction regression models[34].

The best Prediction of the general trip production model(Parameters for Stepwise Regression Models for Production) are summering in the Table (4-2). Table (4-3) summarizes the regression results for the estimated general trip production model.

Table (4-2) Parameters for Production Regression Models

Subsectors	Models	R^2	Adjusted R^2	S.E.E
1	0.469+0.461X1+0.628X4-0.603X5+0.363X6+0.613X7+0.452X10	0.89	0.84	0.88
2	0.652+0.311X1+0.654X4-0.549X5+0.490X6+0.692X7+0.578X10	0.87	0.86	0.88
3	0.029+0.406X1+0.857X4-0.563X5+0.272X6+0.754X7+0.67X10	0.89	0.82	0.89
Total(Y)	0.625+0.429X1+0.618X4-0.614X5+0.305X6+0.637X7+0.583X10	0.88	0.83	0.87

Table(4-3) Regression Results for the Trip Production Model

Intercept & variables	coefficient	Standard error of Estimation	t-vale	significance	VIF
intercept	0.625	0.251	2.494	0.013	0
X_1	0.429	0.076	5.612	0.001	4.614
X_4	0.618	0.123	5.046	0.000	1.993
X_5	-0.614	0.083	-7.382	0.000	1.551
X_6	0.305	0.094	3.227	0.000	1.494
X_7	0.637	0.103	6.163	0.000	2.530
X_{10}	0.583	0.105	5.559	0.000	5.460
excluded variables	coefficient	Standard error	t-vale	significance	VIF
X2	0.054	---	1.263	0.207	2. 73
X3	0.039	---	0.976	0.330	2.35
X8	0.O43	---	1.538	0.125	1.14
X9	0.038	---	1.328	0.185	1.23
R^2			0.88		
R			0.938		
F-value			198.297		
Sample size			450		

4.8.1 Regression Coefficients for Total Production Model

The coefficient of X_1 (the family size for household) is 0.429, It's important to note that the coefficient is positive. This indicates that if the size of the family rises, the number of household trips will increase as well.

Similarly, the parameter of X_4 (number of person workers) is 0.618. As expected, this coefficient is positive. This means that the number of people who work is proportional to the number of daily household trips.

X_5 (number of children (less than 6 years)) has a coefficient of -0.614. The number of children in the household (under the age of six) and the number of daily household trips appear to be negatively associated. In other words, as the number of children (under the age of 6) rises, the number of daily household trips decreases.

The coefficient of X_6 (number of students) is 0.305. As expected, this parameter is positive. This means that the number of people in the family who receive an education is proportional to the number of daily household trips.

The coefficient for X_7 (family income in thousand Iraqi dinars) is 0.637. The parameter indicates that as family income rises, the number of trips will rise as well. This indicates that the monthly household income and daily household trips have a favorable association.

The coefficient for X_{10} (no. of car ownership in the household) is 0.583. The coefficient indicates that as the number of car owners rises, so will the number of daily home trips. This indicates a positive correlation between the number of cars owned and the number of trips.

Finally, as for the excluded variables X_2, X_3, X_8, and X_9, which represent the number of men, the number of women, dwelling unit ownership, and area of dwelling unit (m^2), respectively, the value of the transactions was few and they neglected their work. Impact on the trip by program and according to Table (4-3).

4.8.2 Correlation Matrix and Variance Inflation Factors (VIF): Testing for Multi-collinearity

The correlation between independent variables must be examined to satisfy the multiple linear regression assumptions[3].

To check for Multi-collinearity, typically, the correlation matrix is formed. Table (4-4) shows that the correlation matrix to be utilized in the model development method. The Values on the major diagonal (from upper left to lower right) show the one-to-one correlation of one variable with itself, which is always 1. On a pair-by-pair basis, the values off the main diagonal reflect the correlations between the independent variables (Xs).

Table(4-4) Correlation Matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1	1.000	0.782	0.742	0.456	0.280	0.744	0.335	0.069	0.286	0.258
X_2	0.782	1.000	0.182	0.408	0.198	0.543	0.244	0.033	0.310	0.110
X_3	0.742	0.182	1.000	0.286	0.234	0.594	0.249	0.061	0.131	0.280
X_4	0.456	0.408	0.286	1.000	-0.273	0.455	0.470	0.228	0.315	0.443
X_5	0.280	0.198	0.234	-0.273	1.000	-0.222	-0.150	-0.112	-0.077	-0.202
X_6	0.744	0.543	0.594	0.455	-0.222	1.000	0.441	0.149	0.317	0.404
X_7	0.335	0.244	0.249	0.470	-0.150	0.441	1.000	0.301	0.367	0.490
X_8	0.069	0.033	0.061	0.228	-0.112	0.149	0.301	1.000	0.122	0.286
X_9	0.286	0.310	0.131	0.315	-0.077	0.317	0.367	0.122	1.000	0.299
X_{10}	0.258	0.110	0.280	0.443	-0.202	0.404	0.490	0.286	0.299	1.000

The correlation matrix's first row shows the relationship between X_1 and the other explanatory factors. The correlation between X_1 and X_2, for example, is 0.782, while the correlation between X_1 and X_3 is 0.742, and so on. The correlation matrix shows that the majority of these pair-wise correlations are low, indicating that there is no substantial multi-collinearity issue.

The variance inflation factors (VIFs) for every one of the explanatory variables utilized in the general trip generation model are shown in Table (4-3). The VIF of each explanatory variable is less than ten. As a result, the generated generic trip generating model has no multicollinearity issues.

4.8.3 Individual T-Testing of Coefficients

The t-test magnitude for the parameter of the independent variable, X_1 (household size), is 5.612. At the 99.9% level of significance, this result is statistically substantially different from zero. As a result, the hypothesis that household size has no effect on daily household trips (Y) is rejected, whereas the alternative hypothesis that family size and the number of trips are positively connected is passable.

Finally, all regression parameters have a t-test greater than 2. Each of the independent variables (X_1, X_4, X_5, X_6,X_7 and X_{10}) is significant at the 95 percent level of significance. This suggests that each of the independent factors influences the dependent variable in some way (number of trips per household). The T-test magnitude for the parameters for every one of the explanatory variables utilized in the general trip generation model are shown in Table (4-3)

4.8.4 R-Squared (R^2): Goodness of Fit

The Multiple Correlation Coefficients (r) show how closely the dependent variable (Y) and the independent variables are related (X_1-X_n). The closer this coefficient is to 1, the better the linear relationship between the variables. The linear relationship becomes worse when (r) approaches (0). r is significant because its square (R^2) is about the decimal percent of the variation in the dependent variable (Y) that is demonstrated by the independent variables (X_1 to X_n) [15].

The calculated model has an R^2 magnitude of 0.88. This means that the independent variables (X_1, X_4, X_5, X_6,X_7 and X_{10}) in the created model explained 88 percent of the difference in a household's total number of daily trips, demonstrating that the model is effective in explaining data variability shown in Table (4-3).

4.8.5 F-test: Testing Overall Significance of Model

The F-test examines the hypothesis that all of the multiple regression model's slope coefficients are zero at the same time, implying that the dependent variable is unaffected by any of the independent variables. The F-statistics for the general trip production model is 198.297, as shown in the ANOVA Table(4-5). Because This is a highly significant value, rejecting the hypothesis that all of the independent variables in the trip production model (X_1, X_4, X_5, X_6,X_7 and X_{10}) do not affect the dependent variable (number of daily trips per household) at the 100% level of significance while accepting the alternative hypothesis that all of these variables have a combined effect on the dependent variable.

Table(4-5) ANOVA

	Degrees of Freedom	Sum of squares	Mean square	F-value	significance
Regression	6	1189	198	198.297	0
Residual	444	304	1.01		
total	450	1483			

4.8.6 Multiple Linear Regression Model Checks

Some important checks must be carried out, and they are summarized in the following Figures (4-14),(4-15), and (4-16) as follow:

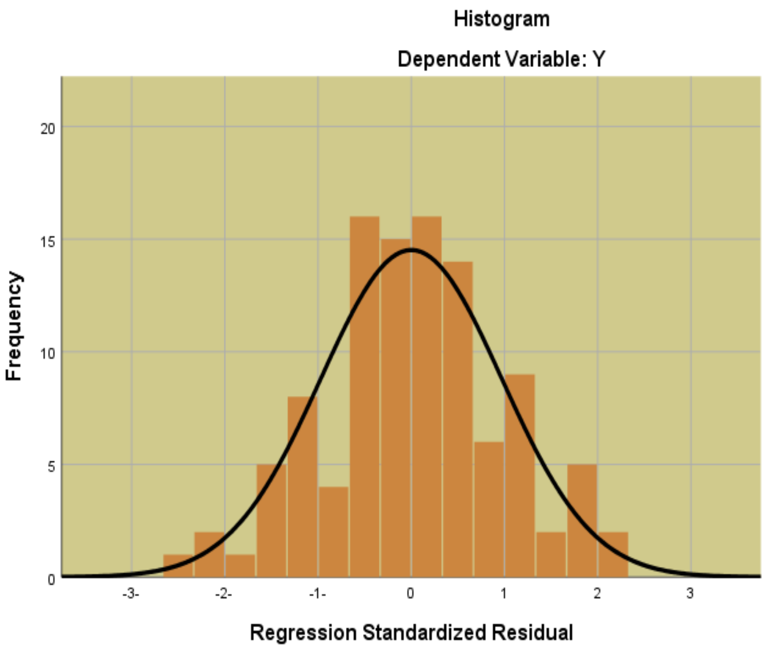


Figure 4.14 Histogram of Standardized Residual and Frequency Total Trip for the CBD Sector

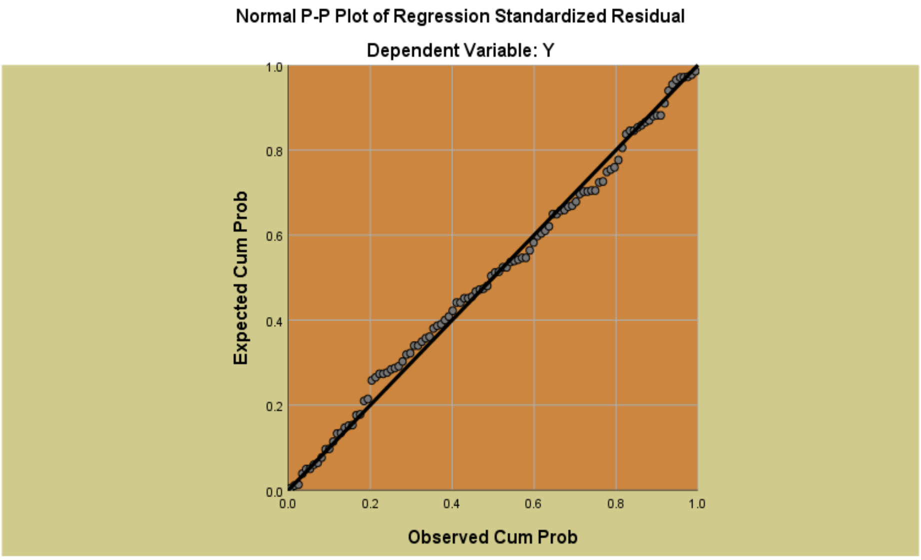


Figure 4.15 Observed Trip Rate versus Regression Trip Rate of Total Trip

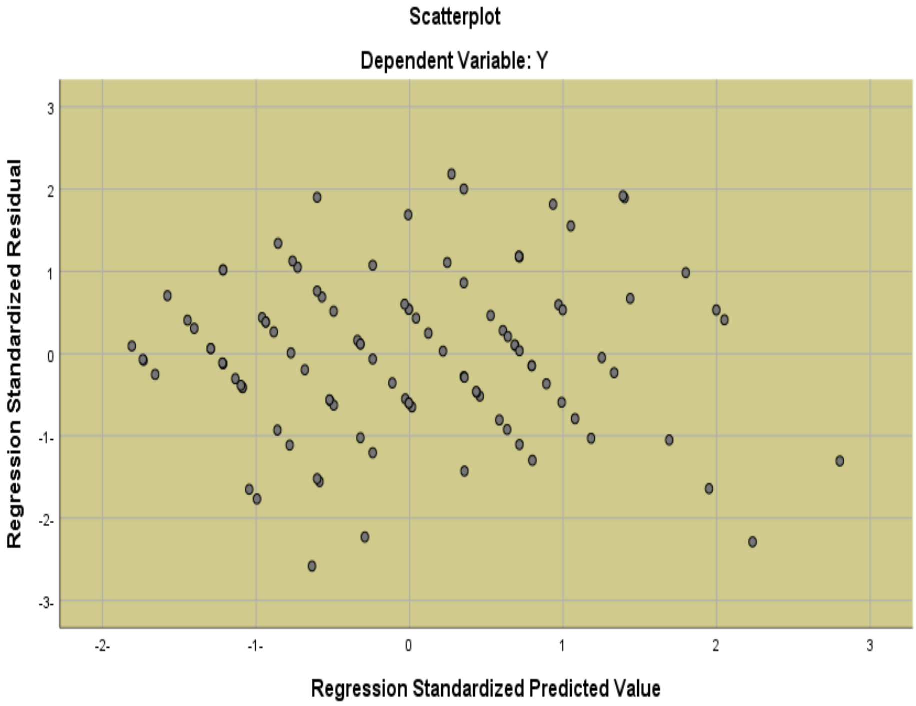


Figure 4.16 Regression Standardized Residual Analysis of Total Trips

4.9Prediction of Attraction Model for CBD Sector

The trip attraction model calculates the number of non-home trips as well as home trips to and from each region. Attractions are calculated based on the features of land uses within the traffic analysis area (workplaces, educational institutions, etc).

The goal of this research is to determine the model of attracting trips for land uses, including educational institutions and workplaces (state institutions and health centers) in CBD Sector within Hilla City as shown in the Table(3-2).

4.9.1Data analysis

The goal of data analysis is to create an equation model that includes both dependent and independent variables. Attracting traffic to educational institutions and workplaces is the dependent variable in this model. The number of students and employees was used as an independent variable in this study.

4.9.2 Attraction Model for CBD Sector

As the study trip and the business trip have the greatest impact in the sector, which contains the most important school buildings and work centers, which is located in the central business district of the Hilla sector.

For each independent variable, the stepwise method is the most popular and favored method for generating simple prediction regression models [6].

by the following symbols:

Y: All Attraction trips per day.

X_1: The number of students.

X_2: The number of Employees.

The trip attraction model is summering in Table (4-6), Table (4-7) are summer: Regression Results for Trip Attraction Model in CBD Sector, shown in the tables below.

Table(4-6) Stepwise Regression Models Parameters for Attraction

Subsectors No.	Models	R^2	Adjusted R
1	199.551+1.391X1+5.669X2	0.991	0.988
2	201.793+1.114X1+6.425X2	0.99	0.98
3	197.804+1.776X1+4.790X2	0.976	0.97
Total(Y)	199.243+1.482X1+5.505X2	0.984	0.982

Table(4-7) Regression Results for attraction trips

Intercept & variables	coefficient	Standard error	t-vale	significance	VIF
intercept	199.243	1.854	9.06	0.003	0
X_1	1.482	0.474	7.6	0.0	3.0
X_2	5.505	0.178	8.3	0.0	4.1
R^2			0.984		
R			0.992		
F-value			61.58		

The coefficient of X_1 (number of students) and X_2 (number of employees) are 1.482 and 5.505 respectively. Coefficients have a positive sign, which should be noticed. This indicates that if the number of employees and students grows, so will the average number of attraction trips.

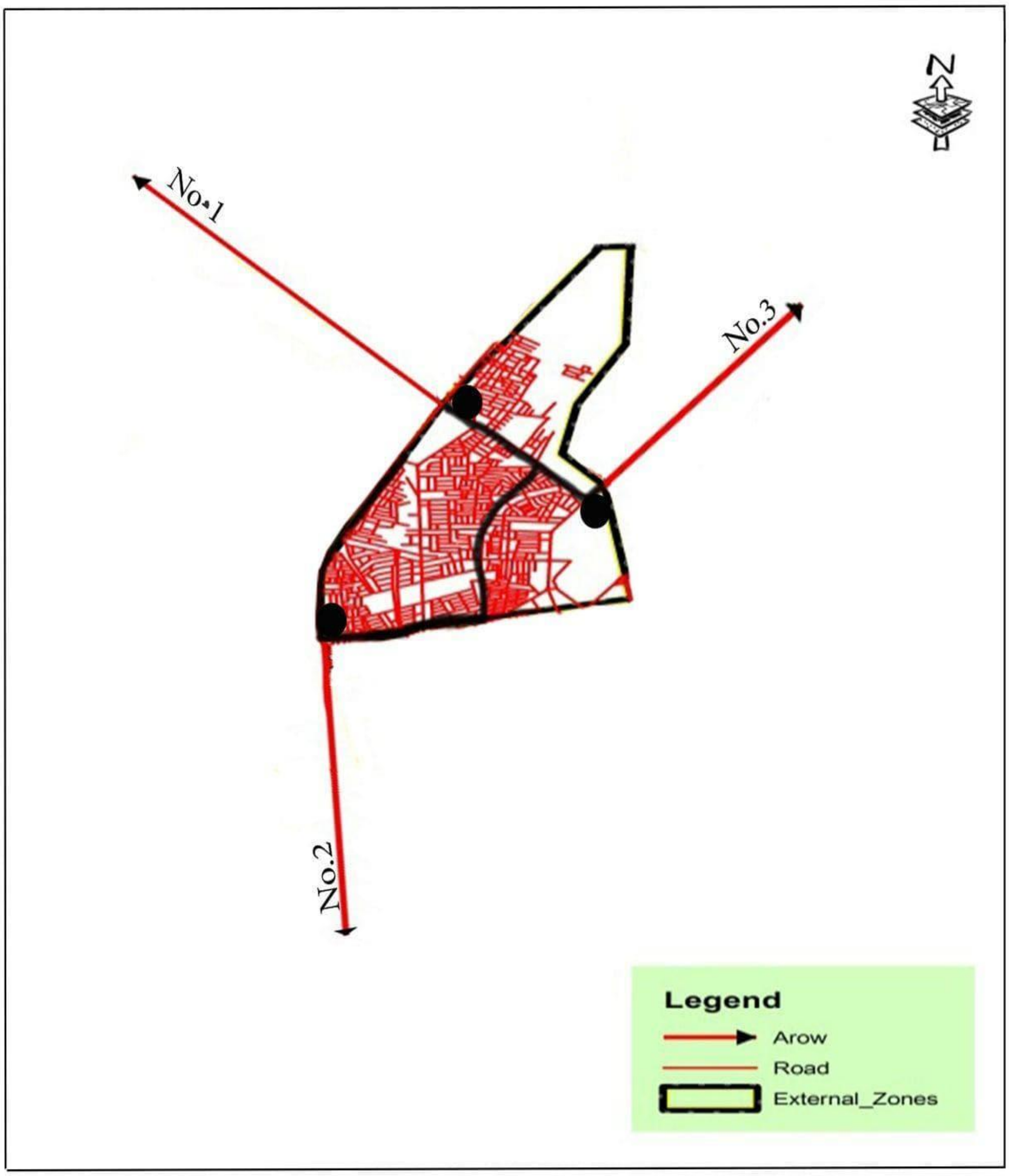
The calculated model has R^2 magnitude of 0.984. This means that the independent variables (X_1, X_2) in the created model explained 98.4 percent of the difference in Attractions trips in the sector, demonstrating that the model is effective in explaining data variability as shown in the Table(4-7).

4.10Estimation of External Trips

The 'external cordon,' an imaginary line that represents the study area's boundary, is used to define it. Internal zones are traffic analysis zones located within the research area's perimeter, whereas external zones are those located beyond the study area's limit.

External trips are those that have at least one end outside of the research region. When the start and destination of a trip are both outside the exterior cordon, it is referred to as an external-external trip. When one end of the excursion is outside the research region, it is referred to as external-internal or internal-external[17].

Each site is located at the crossroads of the main road and the outer ring of the study area, known as the outer station. To simulate overseas flights, outstations are used as outposts. The three remote sections of the CBD sector are shown in Figure(4-17).



Figure(4-17) External Zones and Their Locations

A traffic data survey was conducted in each outdoor location for two days, Monday and Tuesday, during the study period. This is done to account for fluctuations in traffic volume across the observation period.

The average daily traffic and the proportion of classified exterior trips are shown in Table (4-8).

Table(4-8) External Zones Percentage of Trips Classification

External No.	Average Daily Traffic (ADT)	(E-E) Travel (%)	(I-E)Travel (%)	(E-I) Travel (%)
No.1	7500	50	26	24
No.2	8100	48	26	22
No.3	10360	51	21	29

As part of the trip generation process, an estimate of the external-internal trip's productions and attractions is necessary. Production trips in an external zone are those with a home base outside the area, whereas trips with a home base within the area are those with a home base within the area. Appendix B contains the questionnaire form.

The auto occupancy factor should be used in order to convert external vehicle trips to person trips. The number of individuals per vehicle is referred to as the auto occupancy factor, and for all trip reasons, an average occupancy factor of 1.67 was employed[17].

4.11 Balancing Production and Attraction Trips

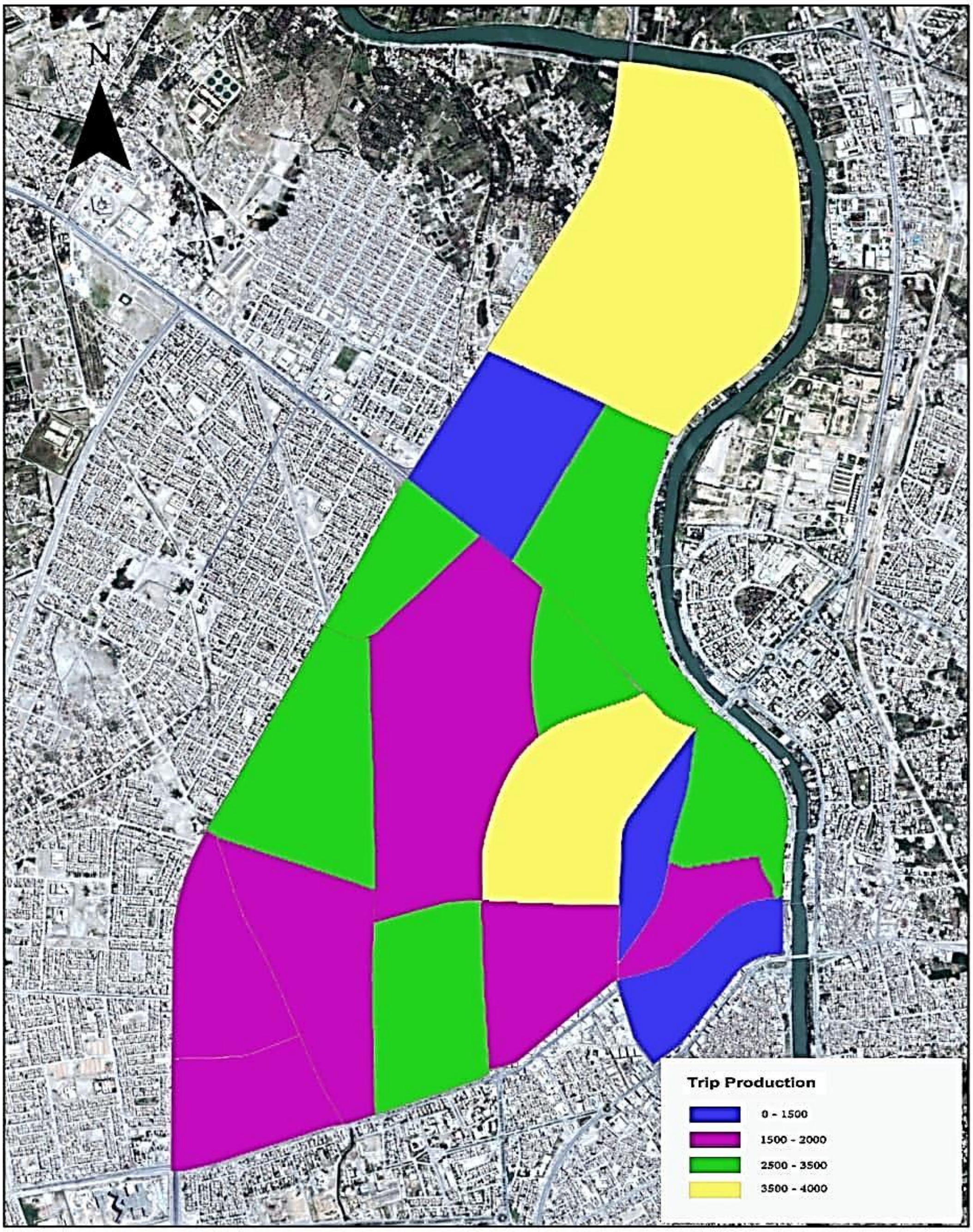
The balance between production and attraction trips is the final stage of trip generation modeling.

The control total of trip productions is calculated using Equation (2-3)[19].

The equation is used to calculate control totals for trip attraction using Equation (2-4).

Factor $= \frac{CT_p}{\sum A_z} = 1.08$ for all attraction trip

The final output of the trip generating modeling procedures is balancing total production trips and attractions. Figures (4-18) show the results of TAZ total trip generating modeling production for the base year 2021.



Figure(4-18) The Result of the Traffic Analysis Zone's Trip Generation in 2021.

The areas in yellow represent the districts with the largest number of trips generated in the sector due to population density, family income, and other influencing factors, while the blue color represents the districts that generate the least number of trips generated in the sector.

4.12 Growth Factor and Travel Forecasting

The models are made up of the following equation 2-1.The simplest formula of $f_i$is indicated as follows equation 2-2 .

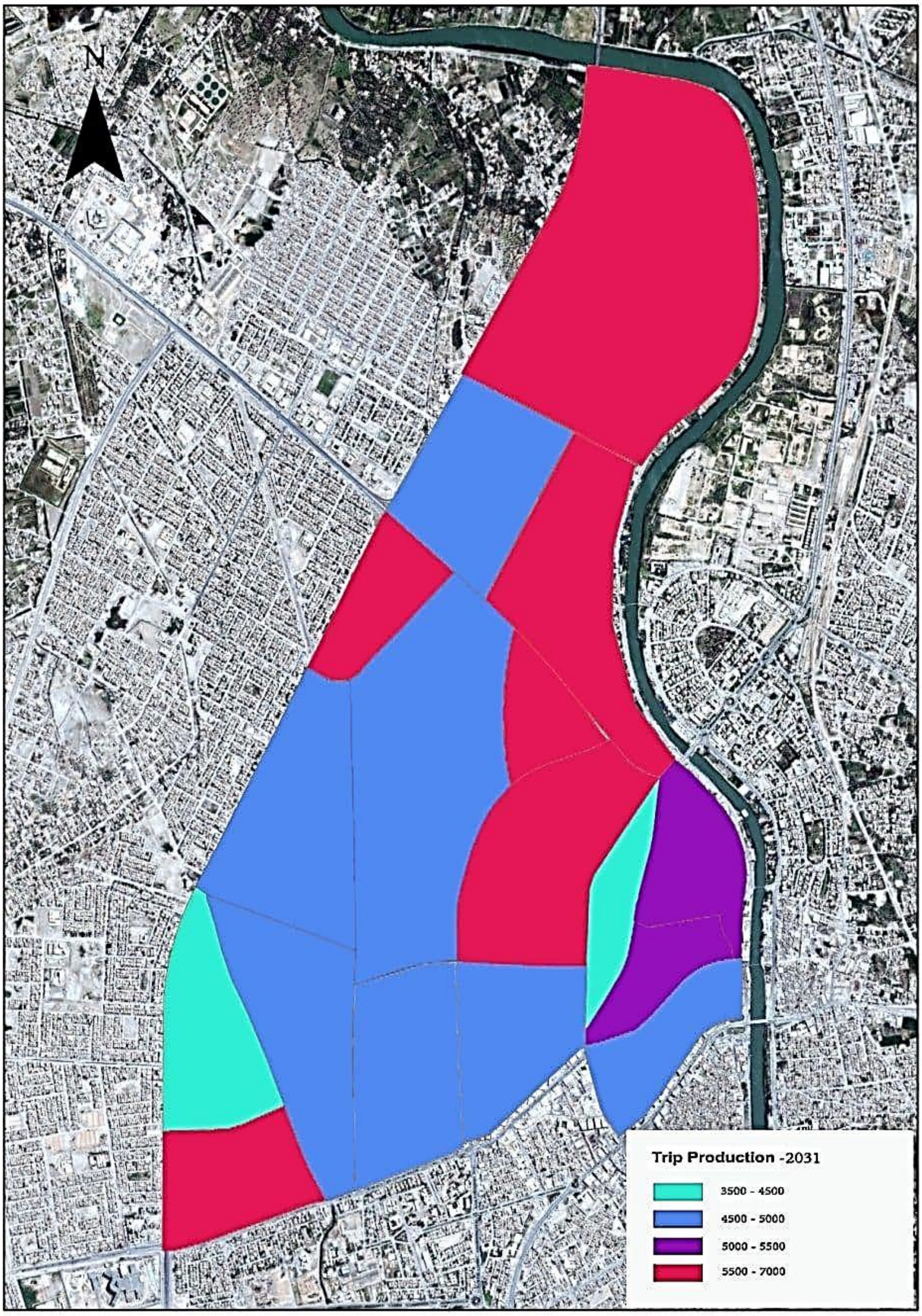
Where;

d: the design year (2031), and

C: the current year (2021).

According to Hilla city's Urban Planning Directorate, population projection for the following years (2021-2031) may be estimated using an annual growth rate of 2.7 percent.

According to the government payroll, the average yearly increase rate of individual income is 2.2 percent. According to the Hilla city Directorate of Traffic, the average annual growth rate of vehicles in Hilla city from 2021 to 2031 is 2.5 percent. The average yearly trip growth rate is 7.6 percent, according to equations 4-3 and 4-4. Figure (4-19) shows the results of trip generating models for the design year [2031].



Figure(4-19) The Result of the Traffic Analysis Zone's Trip Generation in 2031.

Chapter Five

Conclusions and Recommendations

5.1 Conclusions

The findings of this study lead to the following conclusions:

1. The explanatory strength of the production trip model is R^2 0.88, meaning that explanatory variables incorporated in the model explain 88 percent of the variance in daily trips per household, while the attraction model is R^2 0.984.

2. The monthly income, the number of people working, and the percentage of the family owning a private car are the most important variables that influence the number of daily trips produced for each family. All of the above variables have a positive impact on the number of trips, the number of children in the household has a negative impact. This result is in line with previous studies by previous researchers.

3. The number of students and the number of employees are the variables that affect the number of trips attracted to the CBD sector, as most trips are to study and work.

4. The average annual trip growth rate is 7.6 percent, which is affected by population growth, increased income, and an increase of Car ownership. The growth of high trips increases congestion, increases trip times and delays, and increases environmental pollution, which requires increasing the capacity of existing roads and encouraging public transport, as it is less polluting ,more economically efficient and reduces congestion.

5.2 Recommendations

The findings of this study lead to the following recommendations:

1. It is recommended to complete the three steps of the residual transport forecasting (technique Trip Distribution, Mode Split, and Traffic Assignment) for better future traffic flow models to transportation development planning in the CBD Hills sector.

2. Researchers are invited to collect new data in the future and incorporate it into the models developed in this study to confirm that the models remain relevant in the future by comparing predicted trips from the developed models to actual trips.

3. The growth rate of the trips is high in the sector, which requires a special study in this matter.

5.3 Recommendations for field

The results showed an increase in trips in this sector over the coming years, which requires an increase in the capacity of the existing roads, with the need to build new roads with the development of road facilities.

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Appendix-A

Appendix-A

استمارة استبيان لأغراض تخطيط النقل

رقم النموذج:

الحي السكني:

الجزء الأول: معلومات عن الأسرة

عدد أفراد الأسرة ☐ عدد الذكور ☐ عدد الاناث ☐

عدد العاملين من الأسرة ☐

عدد الأطفال أقل من 6 سنوات ☐

عدد الطلاب في الأسرة (مدارس أو جامعات) ☐

دخل الأسرة (دينار عراقي):

اكثر من 1000000 ☐

من 500000 -1000000 ☐

اقل من 500000 ☐

ملكية المنزل : تمليك ☐ إيجار ☐

مساحة المنزل متر مربع : اقل من 150متر ☐ من 150-300 متر ☐

من300 او اكثر ☐

عدد السيارات المتاحة ☐

الجزء الثاني: معلومات عن الرحلات التي يقوم بها أفراد الأسرة

عدد	ذكر/ انثى	العمر	الغرض من الرحلة (عمل ، تعليم ، اجتماعي ، تسوق ،ديني	نوع الرحلة (خارجي ، داخلي)	مكان بداية الرحلة	وجهة الرحلة	نوع مركبة السفر (خاصة ، عامة)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Appendix-B

Appendix-B

المسح على حدود القطاع

رقم استمارة المركبة الداخلة للقطاع

المقصد المركبة

الغرض من الرحلة

رقم استمارة المركبة الخارجة من القطاع

موقع انطلاق المركبة

الغرض من الرحلة

الخلاصة

يعـد التنبـؤ بعـدد ونمـط حركـات المركبـات لأغـراض الـرحلات المختلفـة أمـرًا بـالغ الأهميـة للتخطـيط الحضـري لتجنـب الازدحـام المـروري وضـمان أوقـات رحلـة أقصـر علـى الشـبكة. الهـدف مـن هـذا البحـث هـو اسـتنباط نمـاذج التنبـؤ (الانطـلاق والجـذب) لعمليـة التنبـؤ بالطلـب علـى النقـل لقطـاع الأعمـال المركزيـة (منطقـة الأعمـال المركزيـة) فـي مدينـة الحلـة ، بمـا فـي ذلـك المتغيـرات الاجتماعيـة والاقتصـادية والموقـع واسـتخدام الأراضـي ، بالإضافة إلى شبكة الطرق وقاعدة البيانات.

منطقـة البحـث هـي قطـاع الأعمـال المركزيـة فـي مدينـة الحلـة ، والـذي يتكـون مـن 17 منطقـة سـكنية وفقًـا لتقسـيم مديريـة بلديـة الحلـة ؛ تـم تقسـيم المنطقـة إلـى ثلاثـة قطاعـات فرعيـة لتحقيـق هـدف الدراسـة ، وتـم اسـتخدام الاسـتبيان المنزلـي والمقابلـة للحصول على البيانات.

تـم تقـديم وإنشـاء قاعـدة بيانـات شـبكة الطـرق فـي منطقـة الدراسـة ، والتـي تغطـي قطـاع منطقـة الأعمـال المركزيـة بالمدينـة ، باسـتخدام ArcGIS الإصـدار 10.3. تـم جمـع غالبيـة بيانـات شـبكة الطـرق علـى أرض الواقـع ، وجـاء البـاقي مـن الجهـات الحكوميـة ذات الصلة.

هنـاك نوعـان مـن النمـاذج التـي تـم تطويرهـا. نمـوذج إنتـاج الرحلـة هـو النمـوذج الأول (أي نمـوذج عـام بغـض النظـر عـن الغـرض مـن الرحلـة). والثـاني هـو نمـوذج رحلـة الجـذب (امـاكن العمـل والمؤسسـات التربوية)والـذي تـم اختيـاره كنمـوذج جـذب للقطـاع فـي مدينـة الحلـة. اسـتخدام الحزمـة الإحصـائية للعلـوم الاجتماعيـة (SPSS) الإصـدار 26 وتقنية الانحدار التدريجي II (الانحدار الخطي المتعدد ، MLR).

أظهـرت نتـائج نمـوذج إنتـاج الـرحلات أن: حجـم الأسـرة ، وعـدد العـاملين فـي الأسـرة ، وعـدد الأطفـال ، ودخـل الأسـرة الشـهري ، وعـدد الطـلاب تمثـل أهـم المتغيـرات المسـتقلة التـي تـؤثر علـى المعـدل الإجمـالي للـرحلات الإنتاجيـة فـي الوسـط. قطـاع الحـي التجـاري فـي الحلـة. إنتـاج الـرحلات لـه معامـل تحديـد R^2 يبلـغ 0.88 ، والـذي يعتبـر ارتباطًـا ممتـازًا ،

ومستوى الأهمية أقل من 0.05 لجميع المتغيرات ، وقيمة VIF أقل من 10 ، وقيمة T أكبر من 2 للجميع المتغيرات ، قيمة F هي 198.297 لجميع النماذج.

أظهرت نتائج نموذج الجذب أن: عدد العاملين وعدد الطلاب متغيرات مستقلة تؤثر على المعدل الإجمالي لرحلات الجذب في قطاع منطقة الأعمال المركزية بالحلة. نظرًا لأن معامل التحديد R2 لـ (Y) ، فإن جذب الرحلات 0.984 يعتبر مستوى أهمية علاقة ممتازًا أقل من 0.05 لجميع المتغيرات ، وقيمة VIF أقل من 10 ، وقيمة T أكبر من 2 لجميع المتغيرات. المتغيرات ، قيمة F هي 61.58 لجميع النماذج.

يوضح هذا البحث أن الرحلات في هذا القطاع ستزداد نتيجة النمو السكاني والزيادة في السيارات والدخل (معدل نمو الرحلات هو 7.6 بالمائة). وهذا يتطلب تطوير الطرق وإنشاء طرق جديدة وتطوير المرافق الخدمية المتعلقة بنظام النقل.

جمهورية العراق

وزارة التعليم العالي والبحث العلمي

جامعة بابل / كلية الهندسة

قسم الهندسة المدنية

التنبؤ لنماذج الانطلاق والجذب للرحلات لقطاع منطقة الاعمال المركزية ضمن مدينة الحلة

رسالة

مقدم لكلية الهندسة / جامعة بابل مستوفياً جزئياً متطلبات درجة الدبلوم العالي / الهندسة المدنية / طرق ومواصلات

بواسطة

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ربيع الاول 1443هـ

اكتوبر 2021