URBAN TRIP DISTRIBUTION MODELLING USING GRAVITY MODEL APPROACH: A CASE STUDY OF VADODARA CITY

Thesis Submitted in
Partial Fulfilment for the
Award of the Degree of

Master of Urban and Regional Planning

by

PUSHPAK KUMAR V. PATEL
Second Semester, MURP – II (2020-21)

Primary Guide: Dr. Pankaj Prajapati
Secondary Guide: Mr. Pradeep Rajput

Master of Urban and Regional Planning (MURP) Program

Department Of Architecture

Faculty Of Technology and Engineering

The Maharaja Sayajirao University of Baroda

D.N Hall, Pratap Gunj, Vadodara, Gujarat, India

JULY 2021

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CERTIFICATE

URBAN TRIP DISTRIBUTION MODELLING USING GRAVITY MODEL APPROACH: A CASE STUDY OF VADODARA CITY

The Contents presented in this Thesis represent my original work and it has not been submitted for the award of any Degree or Diploma anywhere else.

PUSHPAK KUMAR V. PATEL

This Thesis is submitted in partial fulfilment of the requirements for the Degree of Master of Urban and Regional Planning
at the Department of Architecture
Faculty of Technology and Engineering
The Maharaja Sayajirao University, Vadodara, Gujarat, India.
The present work has been carried out under our supervision and guidance and it meets the standard for awarding the above stated degree.

Pradeep

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ABSTRACT

Trip distribution finds prime place, after trip generation in sequential modelling of urban travel demand to cover the spatial dimensions in a geographical area, to reflect on trip length and transport cost on one hand and to link the people to the activity centres on the other. The prediction of likely trip distribution involves the prediction of flows in a network, regardless of possible transportation mode or travel route. Trip distribution is usually carried through an allocation model that splits trips from each origin into distinct destination zones depending on land use distribution of urban activities. Modelling Trip distribution can be carried out using conventional methods like growth factor or synthetic gravity model with main focus on separation factor between the zones in terms of distance, travel time or travel cost. But problems in the real world quite often turn out to be quite complex owing to prevailing uncertainty in the concerned attributes.

Travel demand estimation is one of the most important and difficult tasks in transportation planning process. Trip making process involves human decision making, where in uncertainty prevails. Trip distribution from residence as origin and activity centre as destination is affected significantly by the land use, income level and vehicle ownership. The present research is attempts to brief the application of Gravity trip distribution modelling for predicting trip distribution.
Vadodara city is taken for study area (Vadodara municipal corporation). Vadodara city has nearly 16.7 lakh population over 159.95 sq.km area. For this analysis 898 households were surveyed by home interview survey.

Also, an attempt is made to understand the effect of vehicle ownership on trip distribution. In this context in this study, travel mode ownership is studied as with maximum trip purpose is made. Vehicle ownership is divided into seven categories like households having two-wheeler, four-wheeler, auto, bus, vanpool, bicycle and walking. The travel purpose can be divided into main four categories like, work, education, shopping and others.

Different models are developed for each travel purpose using vehicle ownership categories. Realizing the influence of vehicle ownership on trip distribution, four different models has been developed for different vehicle ownerships as households have different types of travel modes, the ɑ value is calibrated for the different types of travel purpose. Each travel purpose has many travel modes, so I calibrated the different ɑ values for the different travel modes with the travel purpose using trial and error method. In most of the trip distribution model 'α' is considered as a single value for the whole geographical area and in most of the studies it varies from 1 to 3 at macro level.

All the four gravity models developed above are based on the sample data which is obtained from the survey data. Using the expansion ratio, the trip interchanges obtained from the survey data are projected for whole population. By using this model, the trip distribution prediction can be done for whole city.

DEDICATION

DEDICATED WITH DEEPEST GRATITUDE AND WARMTH AFFECTION

TO MY FAMILY FOR THEIR UNCONDITIONAL LOVE AND SUPPORT

&

MY GURU

DR. PANKAJ PRAJAPATI

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

VMC	Vadodara Municipal Corporation
VUDA	Vadodara Urban Development Authority
HH	Household
O/D	Origin/Destination
Ai/Pi	Attraction/Production
NE	National Expressway
SG-UTDM	Synthetic Gravity Urban Trip Distribution Model
AVII	Accessibility Vehicle Ownership Influence Index

1.INTRODUCTION

1.1 GENERAL

The main purpose of urban transport planning and management is to match the supply of transport with the demand for travel, which is a "need". A thorough understanding of the existing travel pattern is required to identify and analyse existing traffic and land use problems. Traffic patterns and volumes are also required to develop travel prediction / forecasting models. Predicting future travel needs is an essential part of the long-term transportation planning process to determine strategies to meet future needs. The estimation of travel needs must be carried out with the highest precision. Therefore, traffic planners bear an extremely high level of responsibility for the demands of urban travel. Most transportation decisions are made under conditions of inaccuracy, uncertainty, and partial correctness. Some goals and constraints are often difficult to measure with precise values. Traditional analysis techniques are not effective on problems where the dependencies between variables are too complex or poorly defined. In addition, physical calculation models cannot effectively take into account the ambiguities and uncertainties of traffic decision-makers.

Many techniques have been proposed over the past few decades for each step of the travel requirement analysis. among these, travel distribution was probably the most important field of demand analysis in the urban geographic area. Researchers and transportation professionals have recently been interested in investigating the ability to apply soft computing (computationally intelligent) techniques to real-world transportation problems. Research into more effective and predictive methods for spatial interaction and modelling travel distribution has also led to some landmark studies in this area.

Most of the previously developed travel distribution models are based on analytical relationships that determine the travel exchange between source and destination pairs. In addition, they do not take into account the vagueness of the human mind and the uncertainties associated with travel. It aims to examine the impact of vehicle ownership on driving distribution modelling using a

Traditional synthetic gravity model and address the prevailing uncertainty that is lacking in the traditional gravity model picked up in Vadodara city, Gujarat.

1.2 NEED OF THE STUDY

The conventional transport planning process consists of four phases: trip generation, trip distribution, modal split and route selection. A travel distribution model generates a new travel matrix for origin and destination that shows new future trips by population, employment, and other demographic changes in people's choice of destination. They are used to predict future travel departure and destination patterns and to create a travel matrix that can be mapped into an association model and a mode selection model. Travel distribution models have been developed to predict future travel patterns in the event of major network changes.

1.3 AIM & OBJECTIVES OF THE STUDY

The basic research assignment is to develop urban travel distribution models using the gravity modelling approach in a case of the Vadodara municipal corporation. With this aim the following objectives are set for the study.

- To study the trip characteristics for the selected study area.
- To Develop and calibrate the trip distribution models for intra zonal trips by using synthetic gravity model.
- To develop and calibrate synthetic gravity trip distribution model (SG-UTDM) by considering the trip purpose using different travel mode ownership in trip distribution pattern.

1.4 SCOPE AND LIMITATION OF THE STUDY

The scope of this study is limited to the development of the travel distribution model. Other phases of the modelling of the travel requirement such as travel generation, modal split and route selection are not in the current scope of the study. The study area is limited to the Vadodara municipal corporation boundary. The city of Vadodara and its intrazonal trips are taken into account for the trip distribution, inter-zonal trips are not taken into account.

1.5 METHODOLOY

The following methods were selected for this study.

1.5.1 DEFINING PROBLEM AND OBJECTIVES OF THE STUDY

The main aim of the study is to develop trip distribution models of categories as per various vehicle ownerships. In this study travel mode and Travel purpose is a prominent category. This category is further divided into seven different sub-categories viz. TWO-WHEELER, FOUR-WHEELER, AUTO, BUS, WALKING, VANPOOL and BICYCLE As vehicle ownership is the major influencing factor in trip distribution.

1.5.2 LITERATURE REVIEW

After the problem is identified, the researcher needs to learn more about the topic under study. To do this, the researcher must review the literature on the research problem. This step provides a basic understanding of the problem area in order to understand the various factors that affect the distribution of the trip, conventional models used, advantages and disadvantages of the models.

1.5.3 SELECTION OF STUDY AREA

For the urban travel distribution modelling a typical rapidly developing city, Vadodara, the growing industrial city of Gujarat, is considered. Vadodara municipal corporation city limit is adopted as the study area. The total 12 wards are considered for the study area. Household survey can be taken in all 12 wards according their population and density.

1.5.4 IDENTIFYING THE PARAMETERS, DATA COLLECTION AND DATA PROCESSING

The distribution of the trip is a function of the total production in the i zone, the total attraction in the j zone, and the general cost of the trip. Vehicle ownership is identified as the factor that has the greatest impact on the distribution of the trip. before conducting a field survey, an inventory should be made to gather basic data on the study area. A model that addresses uncertainty is likely to be a better way of solving the unsafe environment that prevails in the planning process.

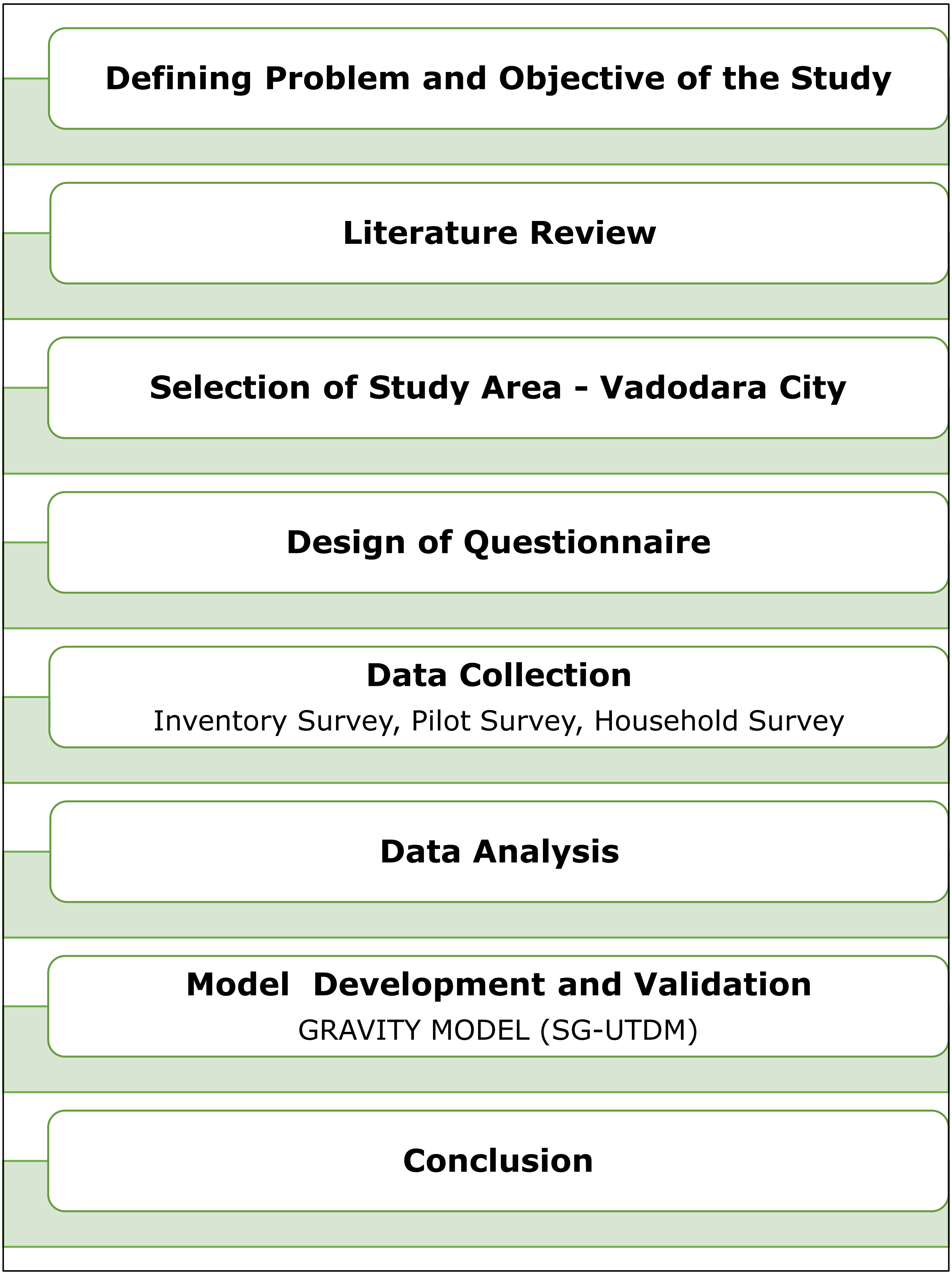


FIGURE 1:1 CONCEPTUAL FRAMEWORK

1.6 DISSERTATION FRAMEWORK

The thesis is presented in six chapters. The first four chapters give an overview of the identification of the problem, the need for the study, the studies carried out in the past, the definition of the study area and the discussion of field studies, etc. The fifth chapter contains the development of the model, the validation. The sixth chapter describes the summary and the conclusion of the present work. The structure of each chapter is as follows:

The first chapter provides a general introduction to the subject, the necessity of the study, the objectives and the scope and the methodology of the study. The conventional urban planning approach is explained together with the studies carried out previously. The third chapter discusses the selection of the study area, the delimitation of the zones, details of the study area in terms of demographics, land use patterns, road network, etc. field studies, proposed surveys, and questionnaire design are discussed in chapter 4.

The analysis of the collected data and the development of the model are explained in detail in chapters four and five. The analysis of the travel data is explained in chapter 4. Chapter 4 discusses the factors that affect travel distribution. The traditional travel distribution model is discussed in chapter 5.

The final chapter summarizes the work along with the limitations and scope for future work. References, appendices etc. are given at the end of the report.

1.7 SUMMARY

This chapter summarizes the background of the selection of the research topic, the research topic and its meaning, etc. The delimitation of the study area, the research goal and the scope are presented here. The different steps of research are represented by the research flow diagram. In the background, the necessary theoretical fundamentals and the review of the research work are dealt with in the next chapter.

2. LITERATURE REVIEW

2.1 URBAN TRAVEL DEMAND FORECASTING

In the past, transportation planning has followed the rational planning model of defining goals, identifying problems, generating alternatives, evaluating alternatives and developing plans. The four-stage model (FSM) is the primary tool for forecasting demand and performance of a transportation system, typically defined at a regional or sub-regional scale (Saxena, 1989). The transportation planning process consists of four stages which are:

2.1.1 TRIP GENERATION

Trip generation is the first step in the traditional four-step transportation forecasting process (Followed by trip distribution, mode selection, and route assignment) That Is Often Used to Predict Travel Demand Needs. (Kadiyali, 2003) In general, travel generation analysis focuses on residential homes, and residential travel generation is viewed as a function of the social and economic characteristics of households. At the traffic analysis zone level, residential areas use "produce" or generate travel. Traffic analysis zones are also travel destinations, travel tractors. The attractor analysis focuses on land uses outside of residential areas. (Saxena, 1989)

2.1.2 TRIP DISTRIBUTION

The distribution of the trip (or the choice of the destination or the analysis of the zonal exchange) Is the second component (after the creation of the trip but before the choice of the mode and the assignment of the route) in the traditional four-stage transportation forecasting model. (Kadiyali, 2003) This step matches the start and end locations of the trip creators to develop a "Trip Table", a matrix that shows the number of trips that go from each start point to each destination. (Allen, 1984) Historically, this component has been the least developed component of the transportation planning model. (Saxena, 1989)

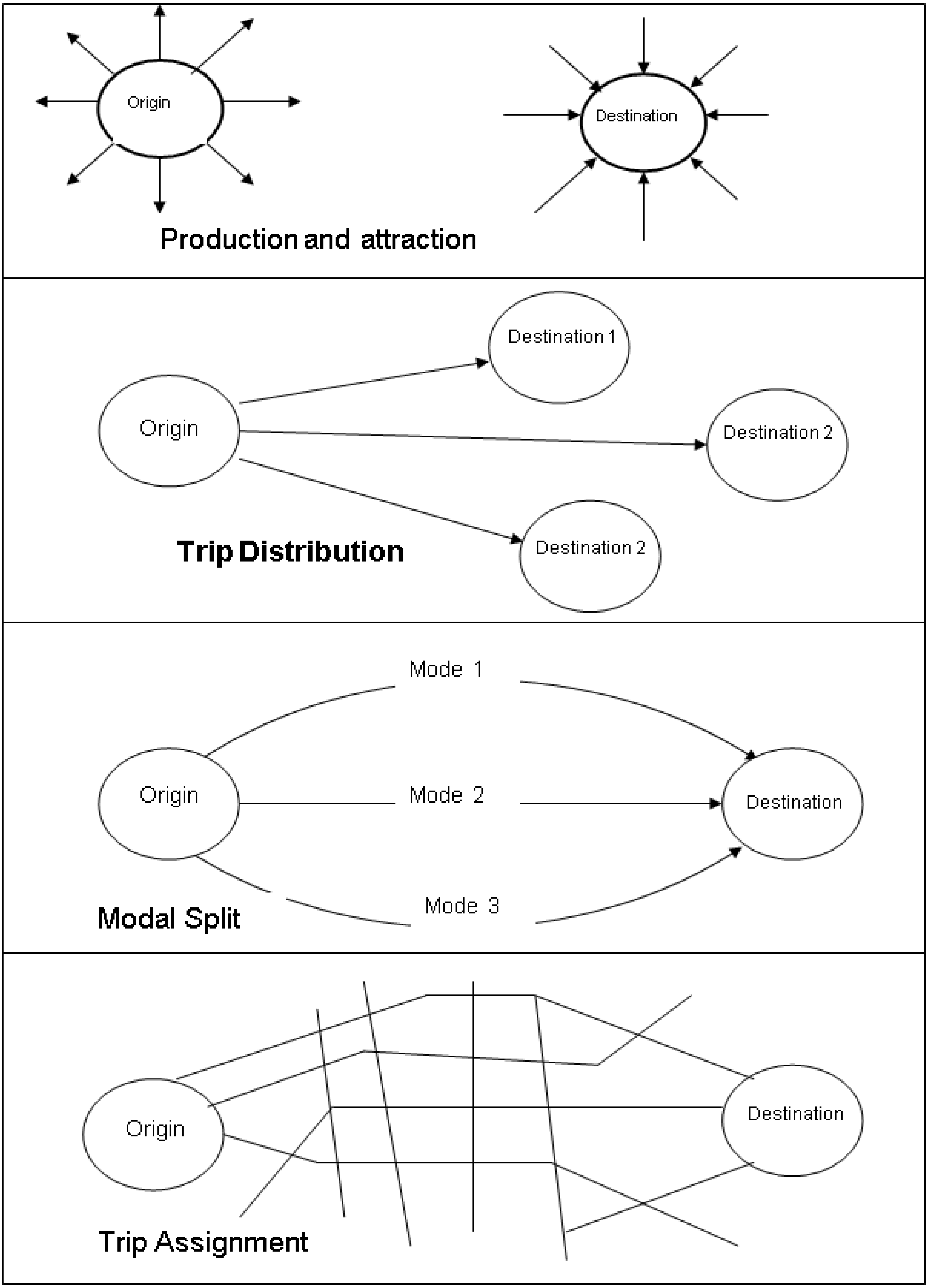


FIGURE 2:1 FOUR STAGE MODELLING OF TRANSPORT PLANNING

2.1.3 MODE CHOICE

The choice of mode is the third step in the traditional four-stage transportation prediction model after the trip is generated and distributed, but before routing. (Kadiyali, 2003) The zonal exchange of travel distribution analysis produces a source set, a destination table, indicating where modal selection analysis enables the modeler to determine which mode of transport is used and which delivery route results. (Saxena, 1989)

2.1.4 TRIP ASSIGNMENT

Trip assignment refers to the selection of routes (alternatives, referred to as routes) between origins and destinations in transportation networks. This is the fourth step in the conventional transport forecast model after trip generation, trip distribution and mode selection. Offers departure tables for origin and destination. The mode selection analysis shows which travellers are using which mode. (Kadiyali, 2003) To determine the needs, costs, and benefits of a facility, we need to know the number of travellers on each route and the network connection. (a route is simply a chain of connections between an origin and a destination.) We need to make a traffic assignment (or a trip). Suppose there is a network of roads and transport systems and a proposed addition. We want to know the current pattern first. The traffic delay and what would happen if the addition were made. (Saxena, 1989)

In the present study, of the four phases, only the distribution of trips was taken into account. Say; the following are the traditional methods that have been developed to model the distribution of travel.

2.2 TRIP DISTRIBUTION TECHNIQUES

In the trip distribution, two known sets of travellers are joined together without specifying the actual route and sometimes without reference to the travel mode to form a travel matrix between known origins and destinations. There Are Two Types of trip distribution methods,

1) Growth Factor Methods
2) Synthetic Methods

2.2.1 TRIP DISTRIBUTION USING GROWTH FACTOR

The growth factor methods assume that the travel pattern will remain essentially unchanged in the future, but that travel volume will increase in line with the growth of the creation and attraction zones. These methods are simpler than synthetic methods. (Tom. V. Mathew, 2007)

(A) UNIFORM GROWTH FACTOR METHOD

This method is also known as the constant factor method. It is assumed that all zones will increase equally and that the existing traffic pattern will remain the same for the future, taking into account the growth. The relationship between current and future travel can be expressed as follows:

$$\mathbf{Tij} = \mathbf{tij} \times E$$

Where,

Tij is the future number of trips between zone (i) and zone (j)

tij is the present number of between zone (i) and zone (j)

E is the constant factor derived by dividing the future number of trip ends expected in the survey area by the existing number of trip ends.

This method has the disadvantage that it tends to overestimate travel between densely built-up areas with likely little development potential and to underestimate future travel between underdeveloped areas that are likely to be extremely developed in the future. plan for areas that are currently undeveloped and which may cause significant numbers of travel in the future. (Kadiyali, 2003)

(B) AVERAGE FACTOR METHOD

The average growth factor used is the one related to the final origin and destination of the trip and determined for each area as in the mathematically expressed constant factor method

$$\mathbf{Ei = Pi\ /pi} \text{ and } \mathbf{Ej = Aj\ /aj}$$

Where,

Tij = Future flow between i and j zones

tij = Present flow,

Pi = Future production of zone i, pi = Present production of zone i,

Aj = Future attraction of zone j, aj = Present attraction of zone j.

The average factor method has many of the disadvantages of the constant factor method and, in addition, when a large number of iterations are required, the accuracy of the resulting travel matrix can be questioned (Saxena, 1989) (Kadiyali, 2003) (Tom V. Mathew, 2007).

(C) THE FRATAR METHOD

This method was introduced by t. Fratar to overcome some of the disadvantages of the constant factor and medium factor methods. according to this method, the total trips for each zone are distributed to the interzonal movements in a first approximation according to the relative attractiveness of each movement, so that the estimated future trips for each zone are distributed among the movements that affect this zone in relation to the existing trips between her and the other zone and in proportion to the expected growth of each of the other zones.

This may be expressed as

$$\mathbf{T_{ij} = t_{ij}\, x \frac{P_i}{p_i}\, x \frac{A_j}{a_j}\, x \frac{\sum_{.}^{k} t_{ik}}{\sum_{.}^{k} \left[\frac{A_k}{a_k}\right] x t_{ik}}}$$

Where,

Tij = Future trips from zone i to zone j

tij = Present trips from zone i to zone j

Pi = Future trips produced at zone i pi = Present trips attracted at zone i

Ai = Future trips attracted to zone j aj = Present trips attracted to zone j

k = Total numbers of zones

The method is tedious except for simple problems, but can traditionally be computer-approached, has the same drawbacks as other growth factor models, and does not predict travel to areas that were largely underdeveloped during the base year. without considering the effects of changes in accessibility for different parts of the study area. (Saxena, 1989) (Kadiyali, 2003) (Tom V. Mathew, 2007)

(D) THE FURNESS METHOD

The method developed by k. Furness is also iterative in nature. this requires estimates of the future traffic that begins and ends in each zone so that source growth factors and destination growth factors are given for each zone. Alternating with the future traffic originating from each zone and the estimated future traffic ending in each zone until both conditions are approximately met. (Saxena, 1989) (Kadiyali, 2003) (Tom V. Mathew, 2007)

2.2.2 TRIP DISTRIBUTION USING SYNTHETIC MODELS

Synthetic travel distribution models seek to discover the underlying causes of movement between places and establish relationships between travel and measures of attraction, generation, and resistance to travel. Synthetic models have the important advantage that they can be used not only to predict future travel distribution, but also to synthesize base annual flows. This avoids the need to examine every single cell in the trigger matrix and reduces the cost of data collection.

(A) GRAVITY MODEL

One of the most famous synthetic models is the gravity model. Based on newton's concept of gravity, the model proposed by Voorhees assumes that the exchange of travel between zones in an area depends on the relative attraction between the zones and the spatial separation. Between them as measured by an appropriate distance function. This spatial separation function adapts the relative attraction of each area to the ability, desire or need of the traveller to overcome the spatial separation. While the travel exchange is directly proportional to the relative attraction between the zones, it is inversely

Proportional to the degree of spatial separation. A simple equation that represents the above relationship is as follows:

Where,

$$\mathrm{T_{ij}} = \frac{P_i A_j F(t)_{ij} K_{ij}}{\sum_{j=1}^{m} A_j F(t)_{ji}}$$

Tij = Trips between zones i and j

Pi = Trips produced in zone i

Aj = Trips attracted to zone j

dij= Distance between zone i and j, or the time or cost of traveling between them

K = A constant, usually independent of i

n = An exponential constant, whose value is usually found to lie between one and three

Travel production (Pi) is influenced by household income, vehicle ownership, number of working members, and members of the school. (Saxena, 1989) (Kadiyali, 2003) (Tom V. Mathew, 2007)

(B) OPPORTUNITY MODEL

Opportunity models are based on statistical probability theory as the theoretical basis. The concept was developed by schneider and developed through later studies. The two well-known models are:

1) The Intervening Opportunities Models;
2) The Competing Opportunities Model.

The opportunity models can be expressed by the general formula:

$$\mathbf{Tij} = \boldsymbol{Oi}\ (\boldsymbol{Di})$$

Where,

Tij = Predicted number of trips from zone i to j.

Oi = Total number of trips originating in zone i.

P (Dj) = Calculated probability of a trip terminating in zone j.

Dj = Total trip destinations attracted to zone j.

2.3 ROLE OF TRIP DISTRIBUTION

The decision to travel with a specific purpose is known as travel generation. these trips generated in each zone are then distributed to all other zones depending on the destination selected. this is known as travel distribution and is the second stage in modelling travel demand. different methods of distributing travel between destinations; and two of these methods are the growth factor model and the gravity model.

Travel distribution models attempt to predict the number of trips that will be made between two zones for a given purpose of travel. These models attempt to mathematically describe the target selection phase of the sequential need's analysis process. there are several models. However, most of them contain the same basic factors that affect the number of journeys between a source and a destination area. The models differ in the characterization of these factors and the assumption that these factors influence the distribution of journeys.

The factors (for any given trip purpose) which affect the numbers of trips between two zones are:

- The number of trips produced by the origin zone.
- The degrees to which the in-situ attributes of the destination zone attract trip makers.
- The attributes which gain importance varies with the trip purpose. for example, if one is modelling the number of shopping trips attracted to a zone, then the type of the attributes of the zone which assume importance this is the total area of the commercial space and the number of outlets.
- On the other hand, if one is modelling the number of work trips attracted to a zone, then the type of the attributes of the zone which assume importance will be the number of offices, the type of offices and so forth.
- The factors that inhibit travel between a pair of zones. These factors can be, travel time, travel distance, travel cost.

2.4 REVIEW OF RESEARCH PAPER

(Ryuichi Imai, 2021) Identified with recent advances in information and communication technology, trail data, that is, records of the movement of people on the road or on trains, can be captured 24 hours a day, 365 days, some of which have spawned real world applications. The generation of highly detailed source / destination travel data from the operational data of cellular networks would significantly improve the methodology for updating and expanding the scope in urban transport planning. This document proposes a method with which origin and destination journeys are estimated on the basis of operating data from the cellular network. Statistics are generated in a three-step process that includes anonymization, estimation, and restriction on disclosure. In contrast to other studies carried out to date, this study uses data from extensive personal travel surveys to validate the reliability of the estimated journey between origin and destination between regions. The analysis of the use cases shows that the proposed method has the potential of mobile spatial dynamics to complement human travel surveys. and road traffic counts.

According to **(Roshani J. Makwana, May- 2015)** travel distribution is the most complex and important model in the urban transport planning process. This document provides a framework for the calibration of a double severity model of the travel distribution phase for the AVKUDA area based on a household information survey conducted in 2014-2015. A large sample is used to calibrate the gravity model. the model is also validated by comparing the observed and calculated trips using the calibrated gravity model. The calibration is performed for various travel purposes such as homework, home schooling, and home work. shopping trips with the trans cad software.

(Abdel-Aal, 23 June 2014) Told that the distribution of trips is the most important but most misunderstood model in the urban transportation planning process (UTPP). One aspect that is overlooked is the different sensitivities in choosing destinations based on the destinations of the trip. It proposes a framework for calibrating a double constrained gravity model for Alexandria city travel distribution based on a 2002 household travel survey. The purposes of travel are estimated based on the available census data. The important

Parameters for the travel attraction model have been estimated and validated in since a small sample is used, a simple and effective weighing technique is used to reduce the bias of the sample. Purpose-Based dispersion parameters are estimated from the weighted sample. Model validation is also used. Enter the duration of the trip distribution, intra-zonal travel and distribution of travel exchanges between parts of the city. The proposed model demonstrates the different patterns of travel distribution by purpose switch to non-mandatory trips to the city of Alexandria.

(R. N. Shukla, November 2018), Transportation planning is the process of defining future policies, goals, investments, and designs in preparation for future needs. The study was carried out for Morbi (A Medium-Sized City II) in the Saurashtra region of gujarat with a population of 1.94 lakh. Morbi is the ceramic centre in India that contributes more than 70% to the total ceramic production in India. It also has some other industrial developments such as the manufacture of wall clocks, CFL lamps, and electric bicycles that create job opportunities at a remarkable rate of migration due to its industrial development. The public transport system (city bus service) was introduced in 2014, which is not enough to cope with the increasing number of trips. Morbi's lament. In order to overcome traffic problems such as increased demand for travel, traffic congestion, air pollution, sustainable development is urgently needed for the city of Morbi. the first step of the researcher is to digitize the map of the city of Morbi with the trans cad software. The study area was divided into 14 zones. The home interview survey was conducted for socio-economic data and travel information with a sample size of 1 in 35 HH. The distances from the CBD for all districts were shown on a digitized map. The travel generation model with excel regression analysis was developed for the study area focuses on the calibration of the gravity model for a medium-sized city. The calibration parameters for four different impedance factors were derived: driving distance, Euclidean distance, time travel and travel expenses. the distribution of the frequency of the journey duration of the observed journeys and the modelled journeys is shown.

(Luis A. Guzmana, July 2016), To take a step forward from the traditional rush hour models, the purpose of this thesis is to develop a strategic demand

Model (Generation and Attraction) Of A Typical day. The methodology integrates a generation of tours in terms of travel and non-travel postponements. Attraction model and a land use and traffic interaction model (LUTI) to record feedback mechanisms that can have long-term effects on the generation of trips the travel requirement model was developed based on a cross-sectional study on household mobility conducted by multiple in Bogotá in 2011. Linear regression analysis is used to study and model the effects of income, household size and structure, car ownership and travel time, and mixed land use. Used in the number of trips a household generates on an average weekday. Estimated based on zone data at best. The Bogotá LUTI model used in this methodology was compared to other published models to compare its characteristics and capabilities. The integration of the travel requirement model and the LUTI model from Bogota enables the discussion of the suitability of the proposed modelling approach for testing different scenarios with high motorization growth rates and the associated possible advantages and disadvantages. Therefore, provide useful knowledge that will inspire future research evaluating complex transport policies in developing cities.

According to **(K. M. RAHMAN, 9 - 11 February 2017)**, the generation of trips is the first step in the conventional process of traffic forecasting. Trip generation rates can affect the extent of road improvements built, E.G. B. The amount of land that must be reserved for the right to use trams and the charging of road vehicles; the duration of the maintenance costs of the road network therefore, an accurate estimate of vehicle trip generation is required to build the required road infrastructure without overbuilding it. The Mohora to Kaptai highway is an important and busy highway in Chittagong as there are some important commercial buildings, industries, and institutions along this highway. The aim of this document is to determine the generation of commercial land use drives off the Kaptai highway. To achieve the goal, our goal is to determine the number of trips generated by neighbouring commercial land uses. And relate the generation of travel to land use and the socio-economic characteristics of the Kaptai highway. The study uses a geographic information system (GIS), questionnaire survey, face-to-face interview, and multiple linear regression analysis to analyse and calculate trip generation. Travel generation surveys were conducted on a total of 10 shopping sites, covering five different shopping centres and five different banks. At another major crossing point. The results have clarified the existing land uses, the situation of travel generation with the multiple linear regression model and the travel rates of commercial land use.

(Vaibhav V. Desai, April 2017) Shown that at present, in India, the transport forecasting is carried out in a four-step sequential process, which includes the generation of trips, the distribution of trips, the division of models and the assignment of routes. In the four-stage sequential modelling process, special generators are introduced to represent certain types of facilities (E.G., military bases, universities, hospitals and large shopping malls, large-scale industry) whose travel generation characteristics are not fully captured by the module of the standard travel generation that are currently used for traffic forecasting techniques used in India. special generators are also used for traffic impact analysis to introduce new developments. Special generators have very different characteristics of travel generation and cannot be treated like normal employers. these unique features have a huge impact on the transport system, and treating them like a state capital or a major downtown employer does not realistically represent the transport system and its usage.

(Charles CHEUNG, January 2003), Have clearly shown the weaknesses in the specification of the gravity model. However, to this day, the model remains at the heart of the four-stage model (E.G., trans cad) used in the practice of the urban transport planning process. There are a number of suitable statistical measures to test the goodness of fit of the model against the source-target (DO) data of the survey, which can be used to evaluate the specifications of the calibrated model and to select the best model. However, those skilled in the art avoid the effects of inaccuracies in travel distribution models. The aggregate severity model, stratified by industry and occupation, and an intermediate opportunity model are calibrated using the Sydney commuter traffic data. Transportation network to check spatial distortion using trans cad software to determine where investment decisions may be based on overestimating or underestimating traffic flows. The effects of these findings on transport policy and investments in infrastructure are articulated.

2.5 SCOPE OF IMPROVEMENT

The majority of the trip distribution models developed was based on analytical relations through whom the trip interchanges between origin destination pairs were determined. Moreover, they do not take into account the vagueness of the human mind and the uncertainties associated with trip making.

2.6 SUMMARY

Prior to taking up any research it is necessary to scan through concerned theory part, research approach and applications carried elsewhere. This helps to build the research background and increase the confidence level in working. Keeping this in view, various chapters of urban travel demand forecasting with more focus on conventional trip distribution techniques are refined. The classical gravity trip distribution has been touched upon to highlight the merits and negative points if any. A profile of the study area, city of Vadodara in Gujarat is briefed in the following chapter to provide the necessary realistic background.

3. INTRODUCTION OF STUDY AREA

Vadodara, the magnificent city of Gujarat, also known as Baroda, is located on the banks of the Vishvamitri river. It is a densely populated city of the state and is home to some of the best universities in India. Vadodara is a celebrated tourist destination that invites a large number of people to visit the splendid city. It has a rich cultural and historical heritage. The city is known as Sanskari nagari because of its rich cultural traditions. From the city's art galleries and museums, several tourists visit this place. Vadodara is the third largest city in Gujarat with a population of over one million.

Vadodara has witnessed establishment of medium and large-scale industries. With great strides in economic field, the city has giant industrial complexes and public undertaking like gujarat refinery, Indian petrochemicals, Gujarat state fertilizers, heavy water project, oil & natural gas commission etc.

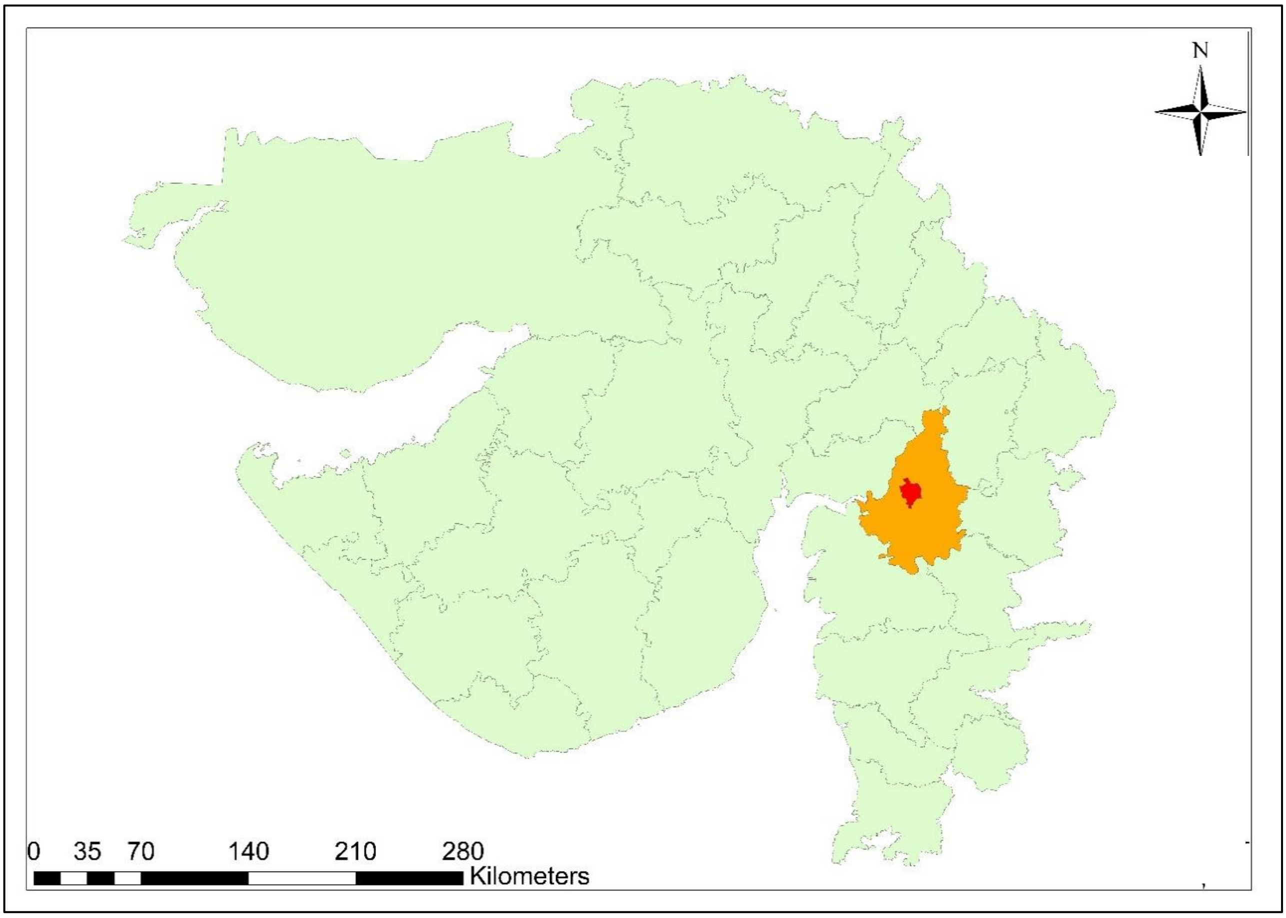


FIGURE 3:1 LOCATION OF VADODARA CITY

3.1 LINKAGES AND CONNECTIVITY

The city of Vadodara is the administrative seat of the Vadodara district and is well connected to other parts of the country by rail, road and air. The city is located on the main arteries that connect Mumbai with Delhi and Mumbai with Ahmedabad. Vadodara is known as the "gateway to the golden square".

AIR CONNECTIVITY: Vadodara airport is located northeast of the city and provides connections to major metropolitan areas in the country, including Mumbai, New Delhi, Bangalore and Hyderabad.

RAIL CONNECTIVITY: The Vadodara junction is Gujarat's busiest junction with nearly 150 daily trains. Vadodara has a rail link to almost all parts of India, where there is a level crossing from Ahmedabad, Mumbai, towards Delhi and Kota (4 Sides). Vadodara has 5 train stations, namely Vadodara junction (BRC), Pratapnagar, Vishwamitri, Makarpura and Bajwa.

ROAD CONNECTIVITY: Connection from Delhi and Gandhinagar with Ahmedabad to Mumbai through the city. Vadodara is also connected to Ahmedabad by Indian national expressway 1 (NE1).

3.2 VADODARA CITY CENSUS DATA

The city of Vadodara is governed by the urban society that belongs to the metropolitan area of Vadodara. The city of Vadodara is located in the Indian state of Gujarat. According to the 2011 census, the total population of the urban agglomeration (UA) of Vadodara is 18,17,191. This is regulated by the Vadodara municipal corporation, which was founded in 1951.

Vadodara city is a million plus city since 1991 with a population of 1.03 million which increased to 1.3 million in 2001 census. The city has witnessed maximum population growth of 57.38% in 1971-81. During this decade the population of Vadodara city increased from 4.66 lakhs to 7.34 lakhs. This rapid population growth in the city is led by the development of industrial estates like Makarpura, Sardar Estate and Nandesari.

According to the interim reports of the Indian census, the population of Vadodara in 2011 is 1,670,806; of these, male and female are 869,647 and 801,159, Respectively. Although the city of Vadodara has a population of 1,670,806; the city / metropolitan population is 1,822,221, of which 949,998 male and 872,223 females. (VADODARA CITY CENSUS 2011 DATA, 2011)

TABLE 3:1 CENSUS DATA OF VADODARA CITY

VADODARA CITY	TOTAL	MALE	FEMALE
CITY + OUT GROWTHS	1752371	912721	839650
CITY POPULATION	1670806	869647	801159
LITERATES	1364157	732121	632036
CHILDREN (0-6)	165559	89402	76157
AVERAGE LITERACY (%)	0.9063	0.9383	0.8718
SEXRATIO	921		
CHILD SEXRATIO	852		

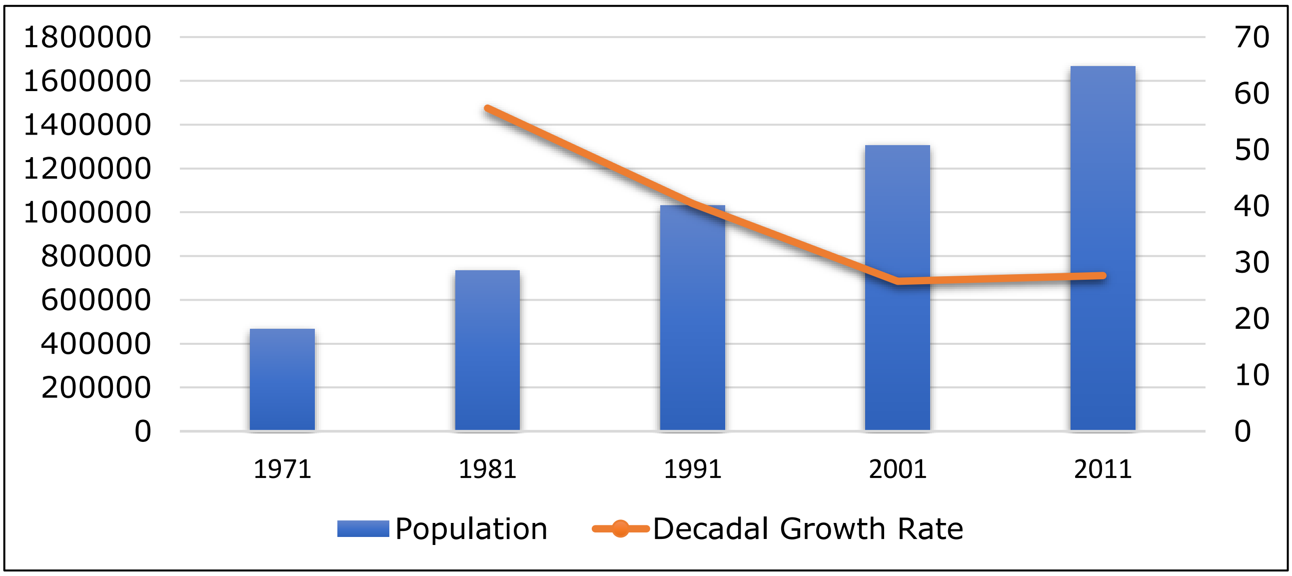


FIGURE 3:2 POPULATION AND DECADAL GROWTH RATE YEAR WISE

First preliminary data released at the 2011 Indian census shows that the density of Vadodara for 2011 is 10,871 people per km2. The area administered by Vadodara city is 260 km2. In terms of gender, the literacy rate for both male and female was 93.83% and 87.18%, respectively. The total number of literary figures in the city of Vadodara was 1,364,157, of whom 4.23.122 are male and 3.70.238 are female. In terms of the gender ratio in Vadodara, it was 921 per 1,000 males. In India, the number is 940 according to the latest reports from the directorate general of the 2011 census. In the 2011 census, the ratio of boys by gender is 852 girls per 1,000 boys. The list also collected data on children under 0-6 years of age. There was a total of 165,559 children aged 0 to 6 years.

Out of a total of 89,402 are boys and 76,157 are girls. The proportion of children by gender was 852 according to the 2011 census. Children under 0 to 6 years made up 9.91% of the total population of the city of Vadodara.

The population of Vadodara has grown at approximately 57% from 1971 to 1981 and at approximately 40% from 1981 to 1991. As compared to the last two decades (population growth rate of approximately 27-28%), the city has witnessed a higher population growth rate during the 1970s and the 1980s. This is partly attributable to the rapid industrialization that took place in Vadodara during the 1970s and the 1980s resulting from migration of people from the surrounding regions, and districts into Vadodara.

TABLE 3:2 WARD WISE POPULATION OF VADODARA CITY

WARD NO.	TOTAL POPULATION	MALE	FEMALE	TOTAL HH	AREA (KM2)	DENSITY
1	43555	22388	21167	9274	1	43555
2	122741	63771	58970	26758	14	8767
3	141314	63604	67710	31083	10	14131
4	160969	83688	77281	37659	16	10061
5	88349	45933	42416	19353	7	12621
6	130715	67976	62739	29823	14	9337
7	182568	96191	86376	40892	25	7303
8	98723	50826	47897	21882	5	19745
9	236097	122693	113404	52860	10	23610
10	177287	91687	85600	41732	10	17729
11	122645	62956	59689	28458	15	8176
12	139349	74007	65342	31547	29	4805

Over the last four decades, the average family size in urban areas has been 5.1, while it has been slightly higher in rural areas, at 5.7. In remote areas, the slum population is almost non-existent. In Padra, there are a few slum areas. These slums are located beside natural waterways. An assessment of essential services in Vadodara’s urban slums revealed that 96,000 households (2.8 lakhs) were living below the poverty line, with monthly incomes of Rs 373 per head.

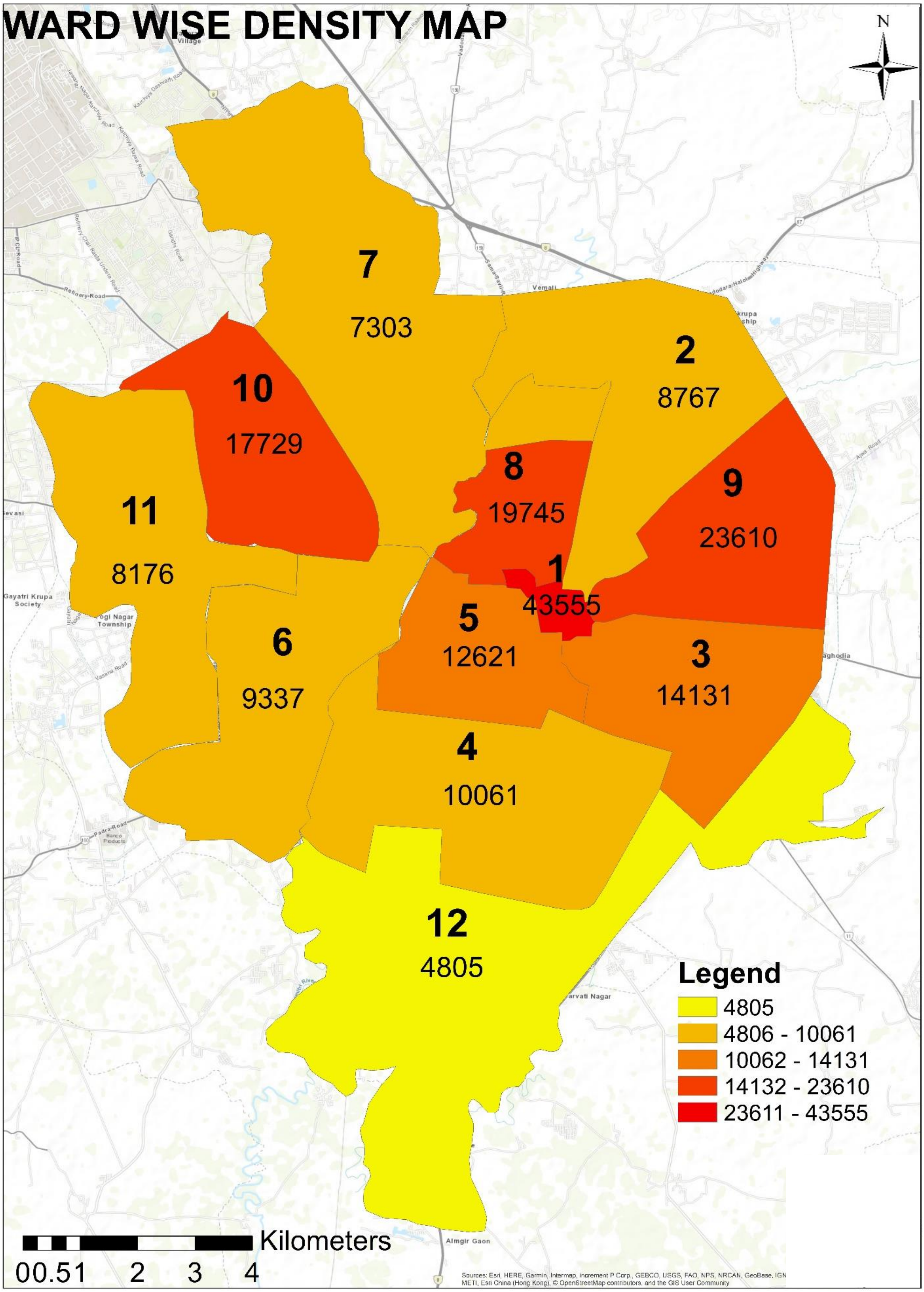


FIGURE 3:3 WARD WISE DENSITY OF VADODARA CITY

3.3 ECONOMIC PROFILE OF THE CITY

Vadodara is an important industrial centre of Gujarat. Until the early 1960s, Vadodara was considered a cultural and educational centre. The first modern factory (alembic pharmaceuticals) was established in Vadodara in 1907, followed by companies such as sarabhai chemicals, Jyoti, etc. In the 1940s, approximately 288 factories were established in Vadodara in 1962, employing around 27,510 workers. The dominant industrial groups at that time were chemicals and pharmaceuticals, cotton textiles and machine tools. The establishment of the bank of Baroda by sayajirao iii in 1908 also helped accelerate industrial growth in Vadodara.

In 1962, Vadodara saw a sudden burst of industrial activity with the establishment of the gujarat refinery and Indian oil corporation limited in Koyali village. The gujarat refinery began commercial phase 1 operations in 1965. The regional and national levels. Various factors such as the availability of raw materials, the demand for products, the skilful mobilization of human, financial and material resources by the government and private entrepreneurs all contributed to Vadodara becoming one of the most important industrial centres of India. Another factor that contributed to the growth of industrial development in gujarat was the discovery of oil and gas in Ankleshwar.

Near the gujarat refinery and other businesses, several major industries such as gujarat state fertilizers & chemicals (GSFC), Indian petrochemicals corporation limited (ipcl, now owned by reliance industries limited), and gujarat Alkalies and chemicals limited (GACL) have become major stakeholders of the public sector in Vadodara include the heavy water project, gujarat industries power company limited (GIPCL), oil and natural gas corporation (ONGC), and gas authority of India limited (GAIL). The private sector has established other large corporations for these public sector companies. Baroda also has some established manufacturing units including General Motors, ALSTOM, ABB, Philips, Panasonic, FAG, sterling biotech, sun pharmaceuticals and Areva T&D, bombardier and gagl (Gujarat automotive gears limited). There are also several glass manufacturers in and around Vadodara, including Haldyn glass, hng float glass, and Piramal glass. In addition to these large industrial companies, there are also several smaller companies in Vadodara.

In line with the city of knowledge vision of the Indian industry association, Vadodara is gradually becoming a hub for it and other development projects in gujarat. In addition, the Vadodara stock exchange (VSE) is located in Vadodara.

3.4 LAND USE CHARACHERTICSTICS

The development plan 2031 is the last development plan drawn up by Vuda in 2006. He envisages 54% of the area in the development plan as buildable area. Under the residential area. The next dominant land use in Vuda is transportation and traffic. It has been reduced from 18% as proposed in the 1990 development plan to 14% in the 2031 development plan. The agricultural area in the Vuda region was reduced from almost 70% in 1990 to 45% in 2031, implying rapid urbanization of the Vadodara region. In addition, some special areas were proposed in the development plan for 2031 (up to 12% of the buildable area). such as information technology park, technology park, community of knowledge, health and medical nodes, etc.

Thus, the primary sector accounted for 21.26 percent, the secondary sector for 35.36 percent (1.63 percent in home industry, 30.71 percent in medium scale industry, and 3.01 percent in construction), and the tertiary sector for 43.38 percent in 2001. (14.47 percent in trade and commerce, 7.5 percent in transport, storage and communication and 21.41 percent in service).

The availability of land, infrastructure, inexpensive labour, raw materials, transportation, and government incentives all influence the growth of industry and the types of industries that exist.

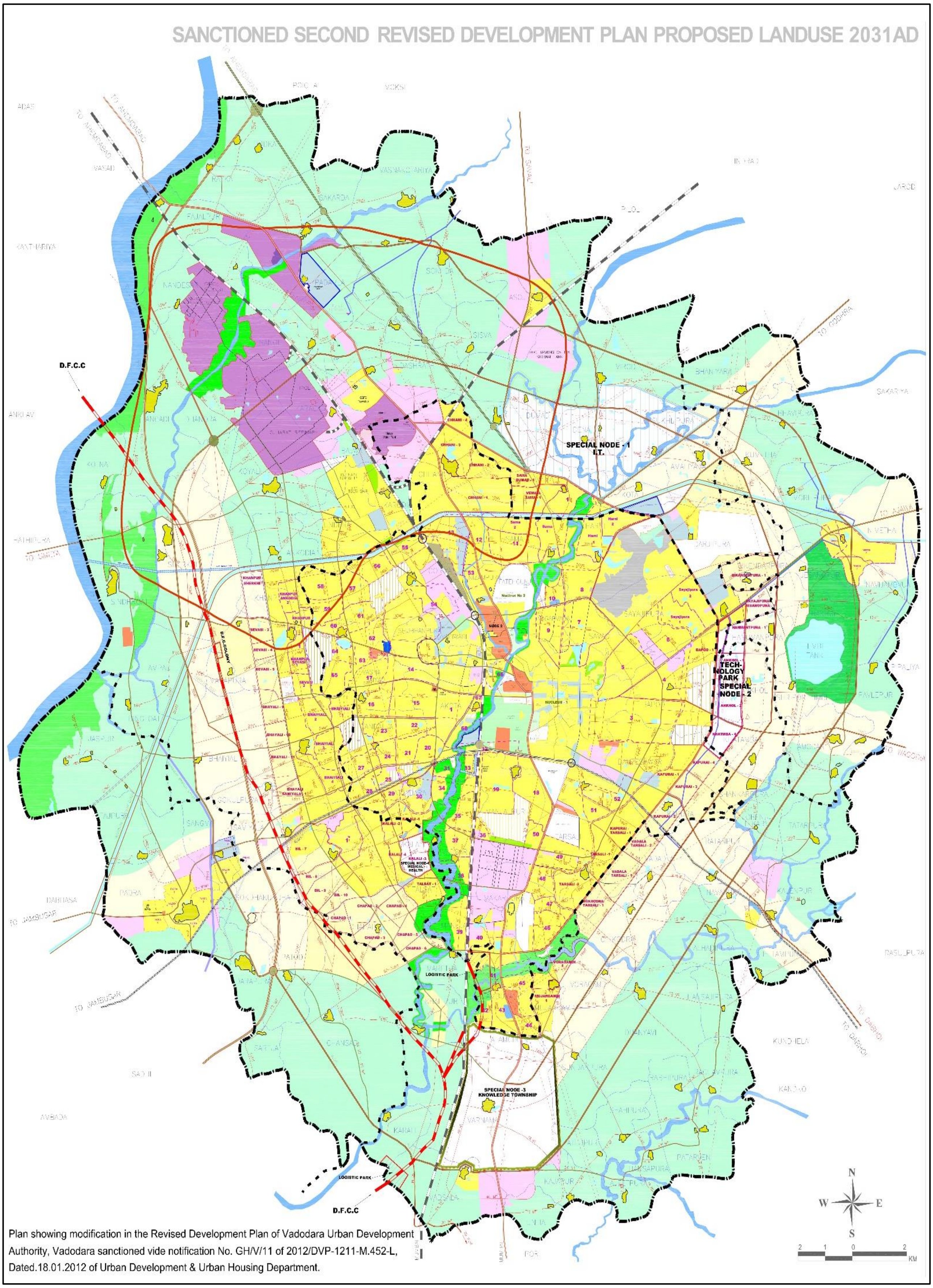


FIGURE 3:4 DEVELOPMENT PLAN OF VADODARA CITY

3.5 ZONING OF VADODARA MUNICIPAL CORPORATION

The Vadodara Mahanagar Seva Sadan (VMSS) is responsible for the government and management of the city of Vadodara. The municipality of Vadodara was founded in July 1950 and received from April 1, 1966 the status of a municipal body with a total of 37 members.

1949 regulates the operation of the VMSS. The VMSS governance structure consists of political and administrative wings. The political wing is an elected council body headed by a mayor. The service cadre (IAS) manages the administration wing and is responsible for the strategic, operational planning and administration of the VMSS. The commissioner takes decisions on behalf of the board of directors or the standing committee, which is composed of the councillors elected to perform the duties of the VMSS.

For administrative purposes, the Vmss area is divided into four zones, namely east, west, north and south. The zones are divided into districts, there are a total of 12 districts. The zone system was created in 1998; ensures the decentralization of activities and a more responsive administration at zone / district level.

- The east zone comprises wards 1, 2 and 9.
- The west zone comprises wards 6, 10 and 11.
- The north zone comprises wards 5, 7 and 8.
- The south zone comprises wards 3, 4, and 12.

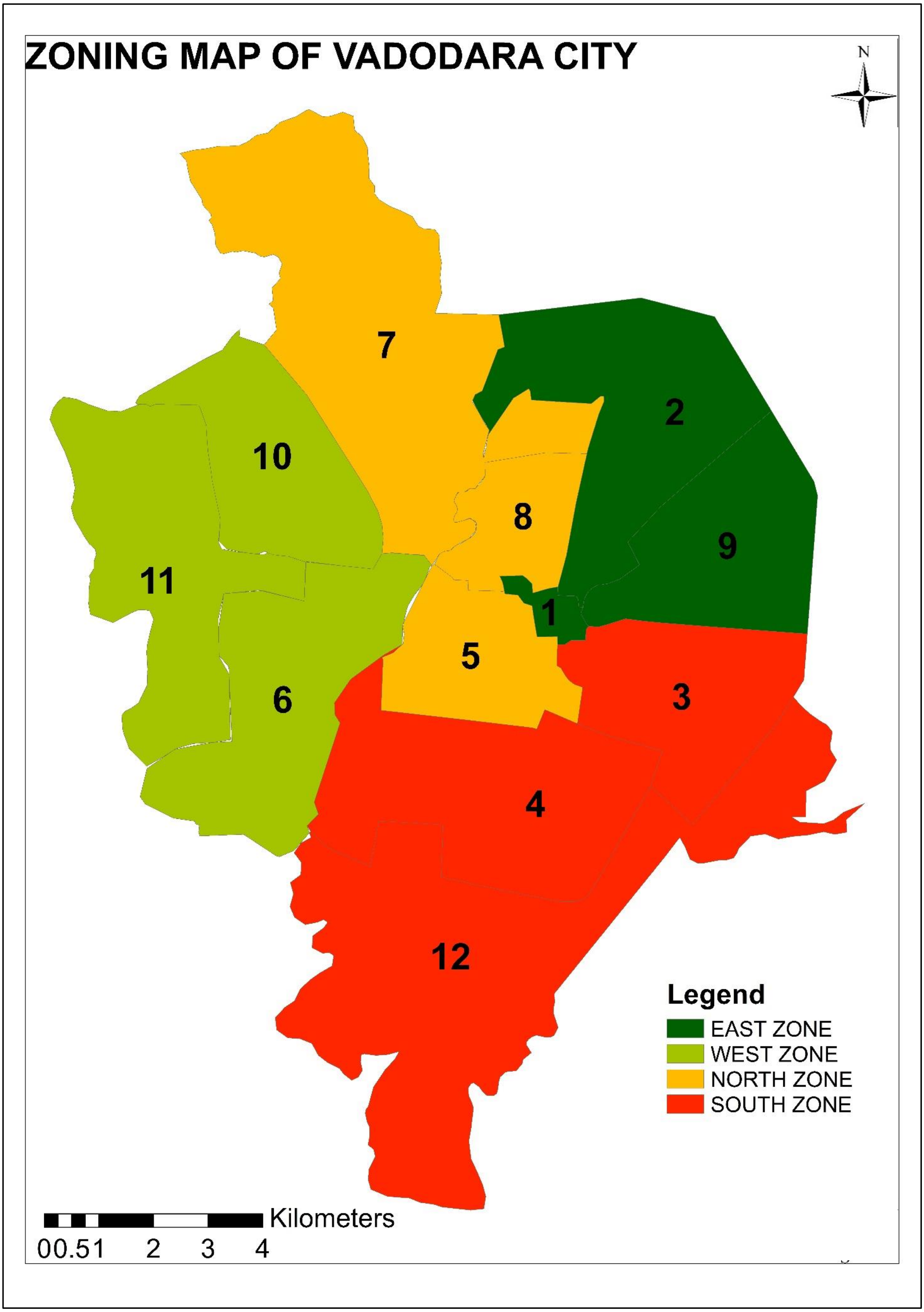


FIGURE 3:5 ZONING MAP OF VADODARA CITY

3.6 ROAD NETWORK

Planning the traffic and transportation systems in the city of Vadodara involves interacting with various government agencies including the municipal corporation, national highway authority of India (NHAI), department of public works (PWD), state roads, Indian railways and the interstate bus operator and private bus company with the development and maintenance of the road network, traffic management, public transport, management of truck operations.

The city is predominantly an administrative, commercial and industrial city. Today's rapid development and population growth have led to traffic jams and parking problems. The city is within four gates and some areas like Raopura, Dandia bazar, Chowkhandi and Bhutdizanpa are crowded, creates chaos and therefore needs special attention. The workplace and the residential area must be properly planned. A large number of people have to travel in different directions from the eastern part of the city and return to the residence at night. Heavy traffic leads to many traffic delays, high traffic accident rates, and excessive traffic on public transport during rush hour.

The city of Vadodara has a circular urban shape and a pronounced radial and circular road network. Regarding the condition of the road, 83% of the roads are paved and 17% are roads with unpaved surfaces. Of the total asphalt roads, 93% are bituminous roads, 6% water-bound gravel roads (WBM) and 1% concrete roads. The streets then meet in the newly merged areas of the VMSS boundaries. Regarding the classification of streets by width, the city has approximately 34% of streets greater than 18 m wide and approximately 66% of streets less than 18 m wide.

TABLE 3:3 DETAILS OF ROADS IN VMSS

SR. NO.	WIDTH OF ROAD (M)	SURFACE TYPE (LENGTH IN KM)				TOTAL (KM)
		CONCRETE	BLACK TOPPED	WBM	EARTHEN	
1	>= 18 m	0.50	275.19	4.63	69.20	349.51
2	North Zone (<18m)	0.50	104.54	1.40	1.20	107.64
3	South Zone (<18m)		140.12	24.24	48.92	213.28
4	East Zone (<18m)	8.49	97.32	13.50	21	140.31
5	West Zone (<18m)	0.72	166.19	5.72	32.40	205.03

Vadodara's vehicular traffic is mixed, with slow and rapid vehicles, cycles, and other types of vehicles sharing the road. This reduces the road's effective capacity. It also shows that the overall number of automobiles has nearly doubled in the last nine years.

The public transportation system has 1077 routes totalling approximately 9000 kilometres. For intra-city bus transportation, passengers can choose among 162 bus itineraries. In addition to intercity travellers, intra-city travellers are served by intercity bus services.

The goal of a public bus route network is to meet traffic demand in a traffic channel or bus corridor, allowing for higher frequencies, higher occupancy rates, and better service with fewer vehicles. This method has been widely employed in the planning of bus lines. Unfortunately, it appears that this was completely overlooked when designing the bus route system.

Based on the trend of vehicle growth between 1961 and 1971 (when slow moving vehicles saw a nearly 10% increase with cycles increasing at a faster rate, and fast-moving vehicles saw a 200 percent increase), and the actual growth between 1973 and 1978, it was estimated that the overall increase in fast moving vehicles would be 289 percent, or 100 vehicles per 1000 people.

4.DATA COLLECTION AND ANALYSIS

Information on the existing conditions in terms of urban land use, transport system, economic activity profile, travel pattern and socio-economic characteristics of the study area are crucial for any meaningful urban planning. The calibration data used. Therefore, collecting field data, whether from a primary and / or secondary source, is extremely important. Field studies emphasize the observation of actual user behaviour. Simple field studies are quick and easy to conduct. Planning for study area delineation involves collecting data to examine past and existing trips, trips, and socio-economic characteristics. This is an important activity throughout the planning process and requires a lot of resources and effort. A large and accurate database is required to clearly assess the problem and plan for the future. It is necessary that the field study program be designed to collect accurate, adequate and reliable data without prejudice and at the lowest possible cost. The various surveys proposed for data collection are described below.

4.1 OVERVIEW OF SURVEYS

Information on the existing conditions in terms of urban land use, transport system, economic activity profile, travel pattern and socio-economic characteristics of the study area are crucial for any meaningful urban planning. The calibration data used. Therefore, collecting field data, whether from a primary and / or secondary source, is extremely important. The field study program should be designed to collect accurate, adequate and reliable data without bias at the lowest possible cost. in order to collect data on the profile of economic activities, travel patterns and socio-economic characteristics of the study area, it is necessary to:

- Identify the parameters
- Questionnaire design
- Field studies

There are two types of surveys to obtain the database for the study:

- Inventory surveys
- Field surveys

4.1.1 INVENTORY SURVEYS

The information base required for the present study is developed through inventor surveys (secondary surveys) and a primary survey in the form of home interviews. The inventory data help to design the field interviews with regard to sample size, survey technique and sampling method. The current inventory data is based on the collection of relevant data for the study from various sources, divided into VMC (Vadodara Municipal Corporation), VUDA (Vadodara Urban Development Authority).

4.1.2 FIELD SURVEYS

The important part of any research study is collecting real and reliable data. The sampling and distribution of the sample should be done in such a way as to match the characteristics of each part of the general study area. The basic and main requirement for any transportation planning process is selection. The boundary of the study area (external cordon), the recording of the inventory data of the selected area, the delimitation of the study area, field investigations, etc. The complete picture of the urban travel pattern comes from origin-destination studies. Survey, postcard interview method, bumper sticker method, etc. a home interview survey can be used for this study. (Tom V. Mathew, Chapter 6, Data Collection, 2007) (Kadiyali, 2003)

4.1.3 HOME INTERVIEW SURVEY

The home interview survey (HIS) method is one of the most reliable types of surveys for collecting travel and socio-economic data. Travel patterns include the number of trips made, their origin and destination, the purpose of the trip, the type of trip, the time of departure from the original destination, the purpose of the trip, the type of trip, the time of departure from the place of departure and the time of arrival at the destination. Type of housing unit, number of residents, age, vehicle ownership and family income. (Kadiyali, 2003)

4.2 QUESTIONNAIRE DESIGN

The design of the questionnaire is the main task before the home questionnaire. It must be designed in such a way that it covers all the necessary aspects related to the aim of the study. The various factors that influence the distribution of travel are identified from the literature and included in the questionnaire. The questionnaire of the parameters affecting the distribution of trips was prepared in order to know the data on socio-economic characteristics and travel patterns.

The following are the parameters that were identified and included in the design of the questionnaire:

- Household and socio-economic information
- Data on urban travel

4.2.1 QUESTIONNAIRE DESIGNED INCLUDES

Socio-Economic and household information and travel details.

- Number of family members,
- Occupation,
- Monthly family income
- Number of vehicles owned

This is included in the household and socio-economic information. Check monthly household income. The monthly income bracket is divided into six categories for the better understanding the distribution of income in the city. It consists of the details of the city trip, including:

- Number of trips made,
- Destination and purpose of trips,
- Type of trip,
- Distance, etc.

The format of the designed questionnaire is given in the annexes.

4.2.2 OVERVIEW OF SOCIO-ECONOMIC PARAMETERS

The socio-economic analysis includes household structure, income structure and vehicle ownership.

The socio-economic analysis was carried out at the macro & micro level and the results of the study are given below.

The total 900 household's surveys are carried out in the different wards of Vadodara city on the basis of population density. From the surveys, the total respondents are 3545. Among them 70.12% are male and other 29.88% are female engaged in the survey.

4.3 HOUSEHOLD STRUCTURE

Household structure is analysed for the average household size, average number of working member, education member and non -working members.

The family structure is divided into three main categories, e.g., working members, educational members and non-working members. The members of education are further divided into members who go to school and members who go to university.

It shows that almost 55% are working members in the study area, 31% belong to the student population. The percentage of non-workers is very medium, it is 14%, so the influence of workers and students can influence the journey through behaviour.

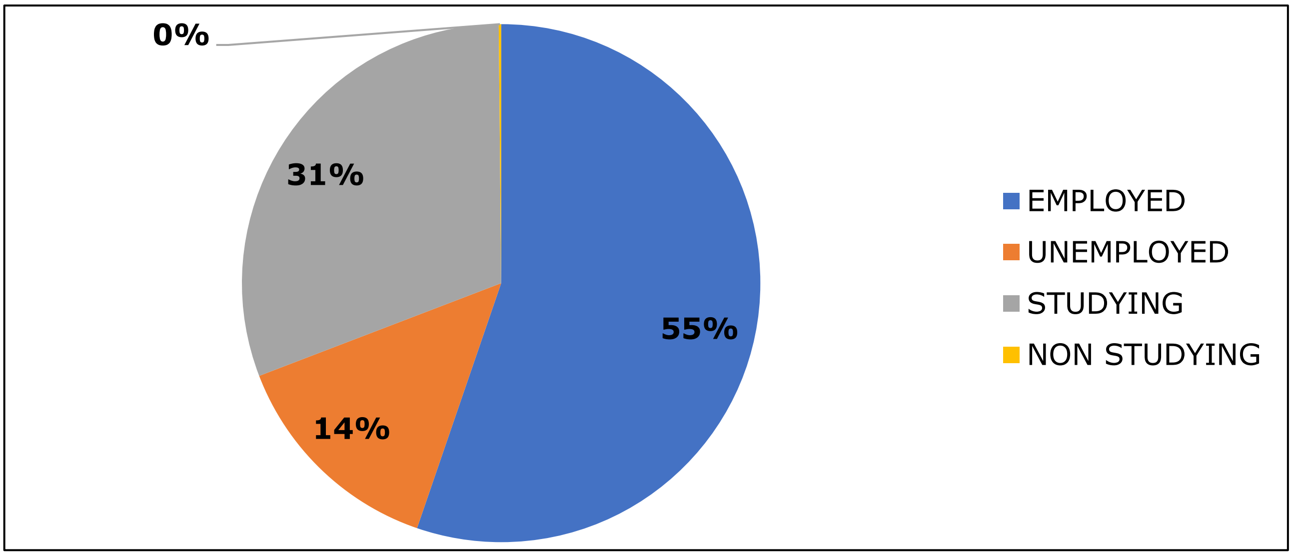


FIGURE 4:1 HOUSEHOLD STRUCTURE OF VADODARA CITY

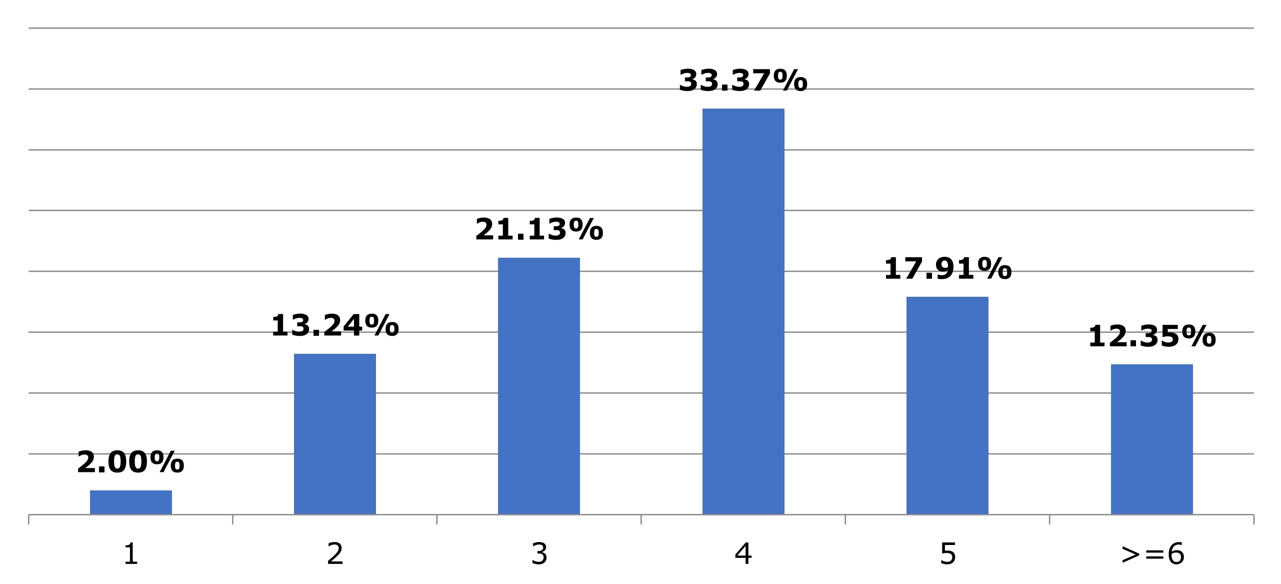


FIGURE 4:2 PERCENTAGE OF FAMILY MEMBERS IN HOUSEHOLDS

As shown in bar chart, the total number of family members are varying from 1 person to more than 6 persons. The number of 4 family members in households are highest with 33.37% in the Vadodara city. The next one is 21.13% households with 3 family members. The only 1 person in the family is very low, the percentage of it is 2%. More than 6 persons in the family are getting 12.35%.

TABLE 4:1 ZONE WISE HOUSEHOLD STRUCTURE

ZONES	NON-WORKING MEMBER	CHILD	STUDENT MEMBER	WORKING MEMBER	TOTAL
1	35	3	29	41	**108**
2	75	28	64	102	**269**
3	51	4	51	70	**176**
4	169	9	76	139	**393**
5	70	9	70	84	**233**
6	78	0	76	96	**250**
7	117	10	102	143	**372**
8	88	3	35	88	**214**
9	161	26	136	169	**492**
10	134	20	133	174	**461**
11	71	19	74	80	**244**
12	144	11	76	100	**331**
TOTAL	**1193**	**142**	**922**	**1286**	**3543**

4.3.1 AVERAGE HOUSEHOLD SIZE

The average household size of the twelve zones is calculated and shown in the table 4-3. The average household ranges from 3.41 to 4.43.

TABLE 4:2 ZONE WISE HOUSEHOLD SIZE AND NUMBER OF INDIVIDUAL PERSON

ZONE	TOTAL HOUSEHOLD SIZE	TOTAL NUMBER OF INDIVIDUAL PERSON
1	30	107
2	61	270
3	56	191
4	86	364
5	60	247
6	70	251
7	86	371
8	60	217
9	119	488
10	120	461
11	60	242
12	90	336
Total	**898**	**3545**

TABLE 4:3 ZONE WISE AVERAGE FAMILY SIZE

ZONES	AVERAGE FAMILY SIZE
1	3.57
2	4.43
3	3.41
4	4.23
5	4.12
6	3.59
7	4.31
8	3.62
9	4.10
10	3.84
11	4.03
12	3.73

The total household size for all 12 zones is 898 as per the primary survey and from the HH size, the individual person surveyed by the total number is 3545. After get this data, I generated the zone wise average family size. The highest family size is 4.43 with zone - 2 and lowest is 3.41 in zone 3.

4.3.2 AVERAGE NUMBER OF WORKING MEMBERS

The average number of working member in this zone varies from 1.11 to 1.67. ZONE – 2 and ZONE – 7 are having a greater number of working members. The Results are shown in figure 4:3.

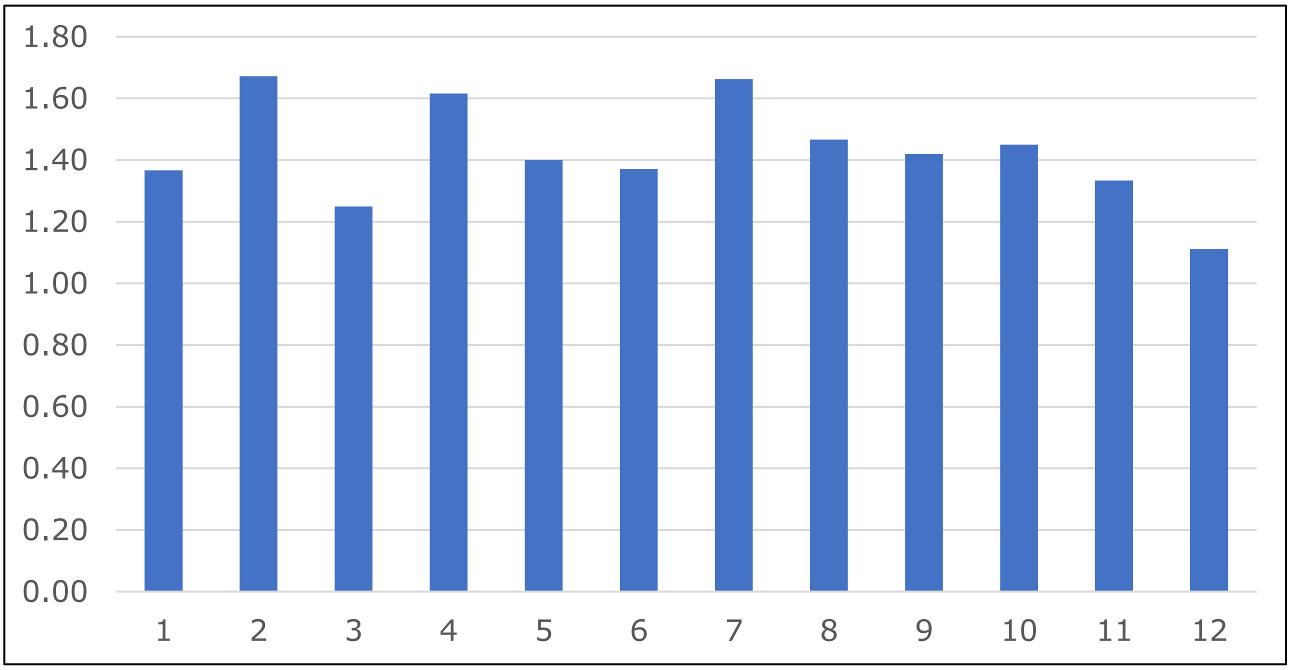


FIGURE 4:3 AVERAGE NUMBER OF WORKING MEMBERS

4.3.3 AVERAGE NUMBER OF STUDENT MEMBERS

The average number of student members varies from 0.58 to 1.23. This includes school and college going members. Highest is for ZONE - 11 and lowest is for ZONE - 8. The results of the analysis are shown in figure 4:4.

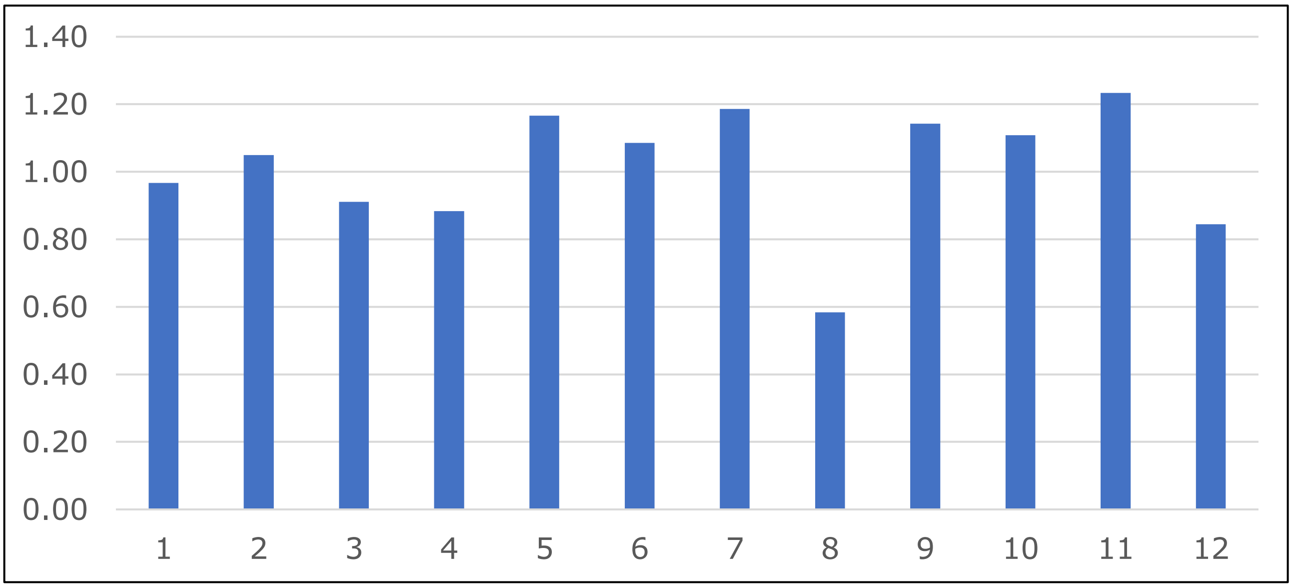


FIGURE 4:4 AVERAGE NUMBER OF STUDENT MEMBERS

4.3.4 AVERAGE NUMBER OF NON- WORKING MEMBERS

The number of non-working members affects the total number of trips produced from a household. The average number of non- working member varies from 0.91 to 1.97. The results are shown in figure. 4:5.

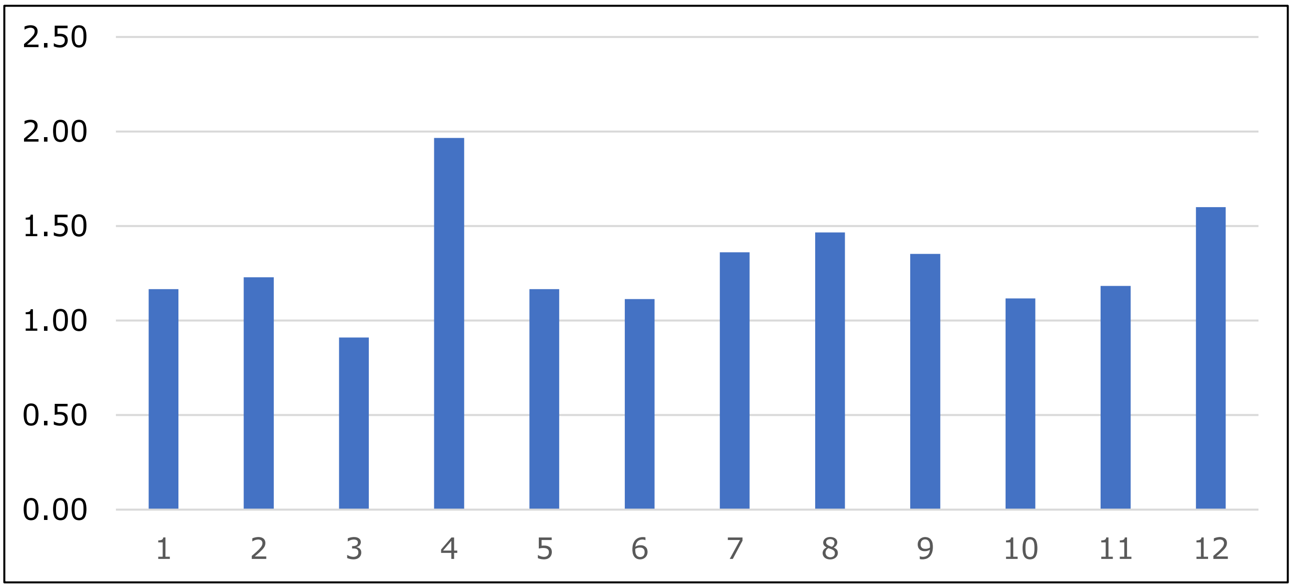


FIGURE 4:5 AVERAGE NUMBER OF NON-WORKING MEMBERS

The section summarizes about the total working, student and non-working members in the households in all 12 zones. The average number of non-working members are higher than working members in house. The number of non-working member are higher in the zone - 4 followed by zone - 12 with 1.5 to 2.0 average. The lowest average non-working members are live in the zone – 3.

At the student scenario the average number of students in the household is between 0.58 to 1.23. The zone – 11 has 1.23 students with highest number and the zone – 8 has the lowest student in household with 0.60 average. After average number of students and non-working members, the average number of working member is highest in zone – 7 followed by zone – 2 and 4. Where zone – 3 has lowest number of working members.

4.4 INCOME STRUCTURE

Income of any household shows the ability to spend. for the present study income groups are divided into four categories. The division is shown in the figure 4:6 given below.

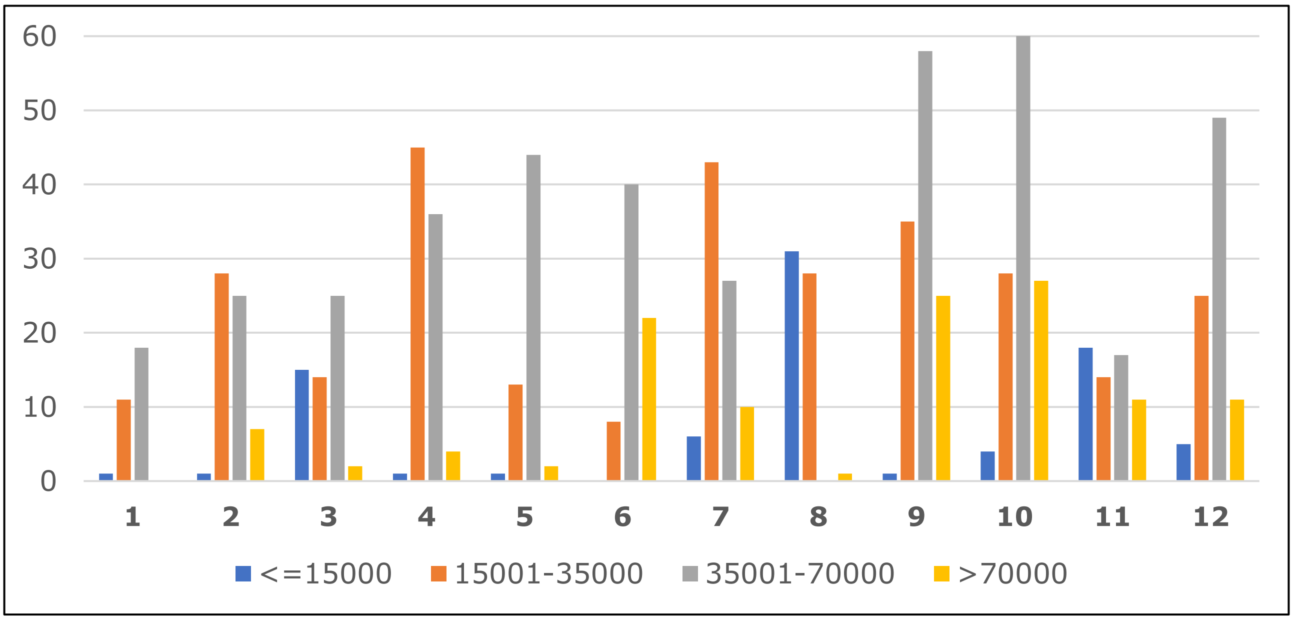


FIGURE 4:6 ZONE-WISE DIFFERENT INCOME GROUP

The average income group is categorised under 35,000 – 70,000 in middle class. The ward 10 has highest income group with the category. The lowest income distribution show in zone 1.

The below figure shows that number of employed persons distribution in the household. The 57.95% household have 1 employed person and 30.37% household have 2 employed person.

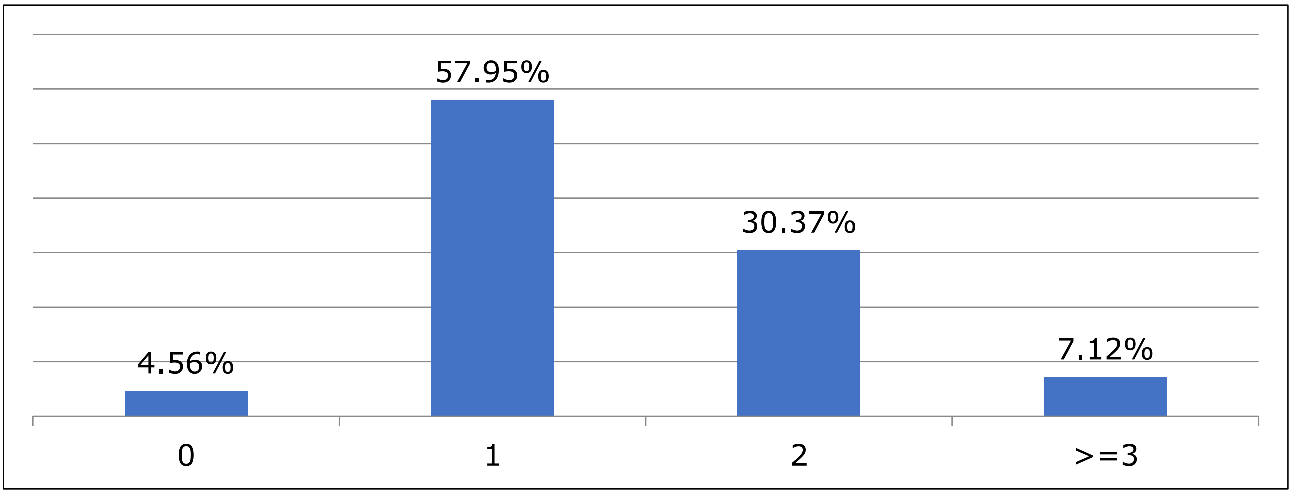


FIGURE 4:7 PERCENTAGE OF EMPLOYED PERSONS IN HOUSEHOLDS

4.5 VEHICLE OWNERSHIP

Vehicle ownership is an important planning parameter as it reflects on income level and personal trip generation. So, we have divided into five categories like families having

1) NO TWO-WHEELER
2) ONE TWO-WHEELER
3) TWO TWO-WHEELERS
4) THREE TWO-WHEELERS
5) MORE THEN THREE TWO-WHEELERS

TABLE 4:4 NUMBER OF HOUSE HOLDS HAVING DIFFERENT 2-WHEELER VEHICLE OWNERSHIP

VEHICLE OWNERSHIP CATEGORIES	NUMBER OF HOUSEHOLDS
No Two-Wheeler	68
1 Two-Wheeler	340
2 Two-Wheeler	358
3 Two-Wheeler	112
More Than 3 Two-Wheeler	20

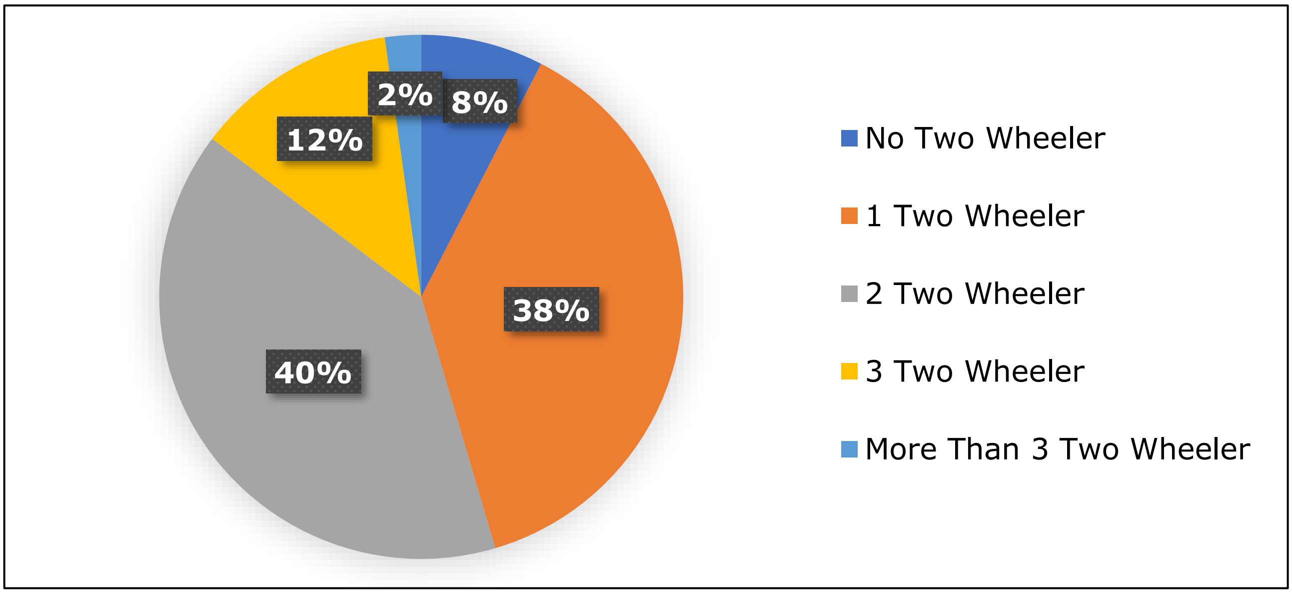


FIGURE 4:8 PERCENTAGE OF HOUSE HOLDS HAVING VEHICLE OWNERSHIP

The HH having two two-wheelers are 358 which consist 40%. 830 HH have the two-wheeler vehicle ownership in the total surveyed HH. The only 68 HH not having the two-wheeler. The 2% HH having the more than 3 two-wheelers.

TABLE 4:5 ZONE WISE VEHICLE OWNERSHIP

ZONES	2W	4W	BICYCLE
1	55	5	7
2	88	26	10
3	90	33	8
4	142	50	45
5	96	32	26
6	149	45	27
7	164	38	31
8	70	8	6
9	215	44	38
10	200	78	37
11	82	26	19
12	126	46	31

TABLE 4:6 ZONE WISE AVERAGE MOTORIZED VEHICLE OWNERSHIP

ZONES	2W	4W	TOTAL
1	1.83	0.16	**1.99**
2	1.44	0.42	**1.86**
3	1.6	0.58	**2.18**
4	1.65	0.58	**2.23**
5	1.6	0.53	**2.13**
6	2.12	0.64	**2.76**
7	1.9	0.44	**2.34**
8	1.16	0.13	**1.29**
9	1.8	0.36	**2.16**
10	1.66	0.65	**2.31**
11	1.36	0.43	**1.79**
12	1.4	0.51	**1.91**

Vehicle ownership is an important planning parameter as it reflects on income level and personal trip generation. Table 4-5 shows the vehicular ownership of different zones of the Vadodara city. The average motorized vehicle ownership is highest in zone – 6 with two-wheeler vehicle ownership 2.12 and four-wheeler vehicle ownership is 0.65. zone – 8 has the lowest average motorised vehicle ownership per household which includes car and two wheelers.

The average two-wheeler motorised vehicle ownership is 1.62 with highest in zone – 6 and followed by zone – 1 with 1.83 average and lowest one is zone – 12. The average motorised vehicle ownership for the four-wheeler is 0.45. The highest four-wheeler vehicle ownership shown in the zone – 10.

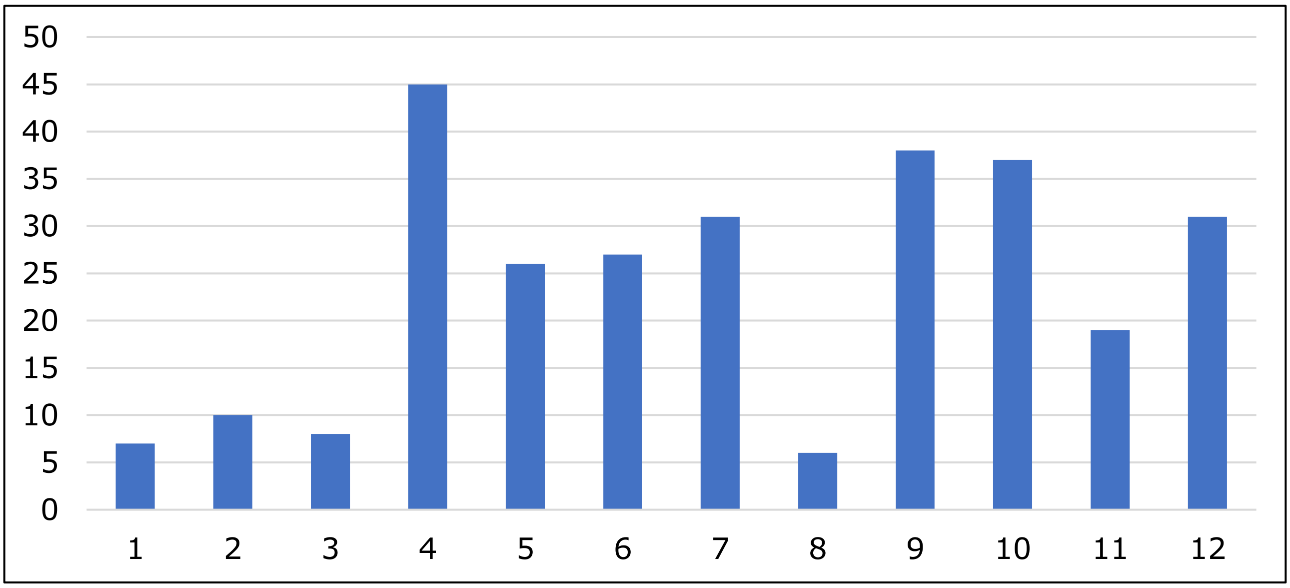


FIGURE 4:9 ZONE WISE OWNERSHIP OF BICYCLE

Micro level vehicle ownership is shown in table 4:5. Total vehicle ownership in all the zones varies in the range of 1.39 to 3.15. Car ownership varies from 0.13 to 0.65. whereas two-wheeler ownership varies from 1.4 to 2.12 per household. Bicycle ownership varies from 0.10 to 0.52 per household.

TABLE 4:7 AVERAGE VEHICULAR OWNERSHIP IN DIFFERENT ZONES

ZONES	2W	4W	BICYCLE	TOTAL
1	1.83	0.16	0.23	**2.22**
2	1.44	0.42	0.16	**2.02**
3	1.6	0.58	0.14	**2.32**
4	1.65	0.58	0.52	**2.75**
5	1.6	0.53	0.43	**2.56**
6	2.12	0.64	0.39	**3.15**
7	1.9	0.44	0.36	**2.70**
8	1.16	0.13	0.10	**1.39**
9	1.8	0.36	0.32	**2.48**
10	1.66	0.65	0.31	**2.62**
11	1.36	0.43	0.32	**2.11**
12	1.4	0.51	0.34	**2.25**

4.6 TRAVEL DATA ANALYSIS

The travel data of the south side of city is analysed at macro and micro level.

4.6.1 PURPOSE WISE TRIP DISTRIBUTION

Four major trip purposes are identified and they are work, education, shopping, and others. Purpose wise trip distribution at macro level is given below in figure 4:10. It is observed that out of all the trips 49% are work trips. 30% are educational trips. Discretionary trips including shopping and others together constitutes 21%.

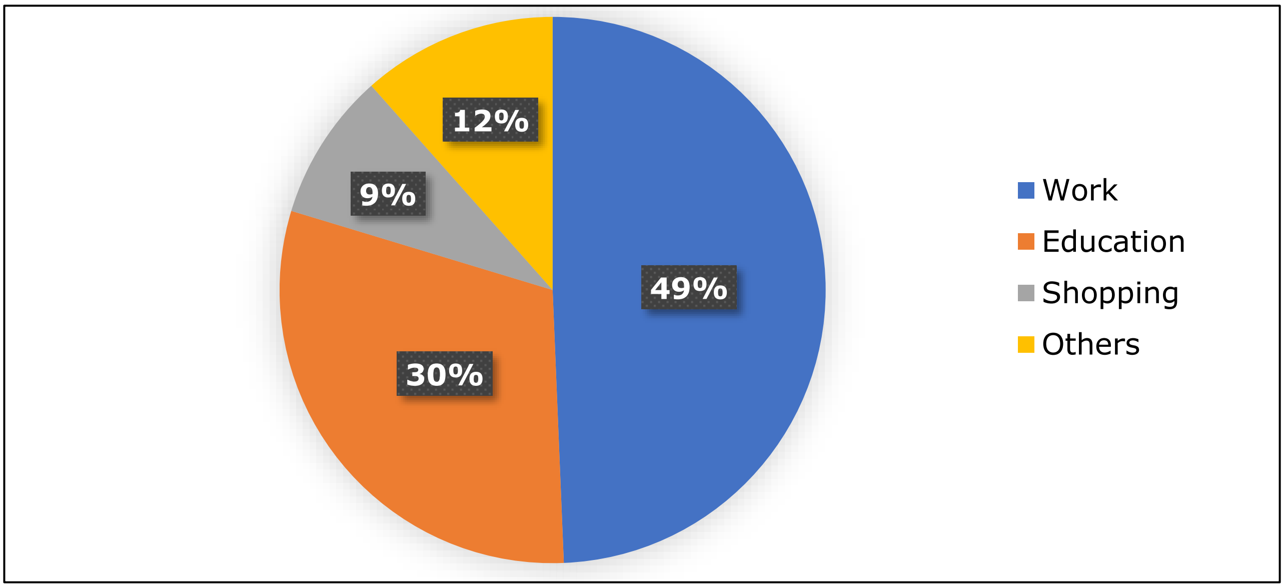


FIGURE 4:10 PURPOSE WISE TRIP DISTRIBUTION AT MACRO LEVEL

TABLE 4:8 PURPOSE WISE TRIP DISTRIBUTION AT MICRO LEVEL

ZONES	WORK	EDUCATION	SHOPPING	OTHERS
1	90	34	16	23
2	187	116	34	52
3	118	78	6	4
4	236	122	14	72
5	144	80	43	36
6	205	132	19	21
7	287	160	78	101
8	141	44	36	28
9	310	170	50	57
10	331	204	57	72
11	128	114	32	50
12	139	124	24	46
TOTAL	**2316**	**1378**	**409**	**562**

4.6.2 MODE WISE TRIP DISTRIBUTION

Nine major modes of trips are identified and they are two-wheeler, car, bicycle, bus, vanpool, taxi, auto, walking and other. Mode wise trip distribution at macro level is given below in table 4-9.

TABLE 4:9 MODE WISE NUMBER OF TRIPS FOR DIFFERENT ZONE

ZONES	2W	4W	AUTO	BUS	BICYCLE	OTHER	TAXI	VANPOOL	WALKING	TOTAL
1	134	2	2	9	4	0	0	6	6	**163**
2	201	42	24	18	4	0	0	12	88	**389**
3	110	18	20	36	4	0	0	10	8	**206**
4	219	106	16	24	28	2	0	41	8	**444**
5	176	41	24	2	7	0	0	32	21	**303**
6	241	41	13	16	2	0	0	52	12	**377**
7	357	71	51	15	10	0	0	51	71	**626**
8	123	4	28	4	4	0	0	4	82	**249**
9	381	42	27	18	36	0	0	56	27	**587**
10	323	108	42	59	38	0	2	62	30	**664**
11	152	46	8	16	8	0	2	48	44	**324**
12	175	44	4	20	28	2	0	46	14	**333**
TOTAL	**2592**	**565**	**259**	**237**	**173**	**4**	**4**	**420**	**411**	**4665**

4.6.3 TRIP RATE AND TRIP PRODUCTION

Trip rate of each zone and the trip productions are given below table 4-10. highest trip rate is in zone – 7.

TABLE 4:10 TRIP RATE AND TRIP PRODUCTION OF DIFFERENT ZONES

ZONES	OBSERVED TOTAL TRIPS	POPULATION SURVEYED	OBSERVED TRIP RATE	POPULATION OF STUDY AREA	PROJECTED TOTAL TRIP PRODUCTION
1	163	107	1.52	43555	66204
2	389	270	1.44	122741	176747
3	206	191	1.07	141314	151206
4	444	364	1.21	160969	194772
5	303	247	1.22	88349	107786
6	377	251	1.5	130715	196072
7	626	371	1.68	182568	306714
8	249	217	1.14	98723	112544
9	587	488	1.2	236097	283316
10	664	461	1.44	177287	255293
11	324	242	1.33	122645	163118
12	333	336	0.99	139349	137956

4.6.4 PURPOSE WISE DISTRIBUTION OF TRIPS

Purposes are strongly associated with land use pattern and accordingly purpose wise trips can be quantified. Study analysis purpose wise trip distribution covering both the intra sub regions of the study area and outside the study area. Total trips calculated in following table are considered as two times the observed trips for each zone. It has been done with assumption that every forward trip will have return trip.

TABLE 4:11 TOTAL TRIP ORIGIN - DESTINATION MATRIX FOR STUDY AREA

ZONES	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1	36	1	16	3	32	9	17	7	14	5	2	6	**148**
2	1	80	14	5	14	17	28	15	51	10	7	3	**245**
3	16	15	18	6	19	28	5	3	32	8	0	4	**154**
4	3	5	6	94	33	29	20	7	7	12	17	74	**307**
5	32	14	20	33	86	27	43	34	12	46	15	30	**392**
6	6	17	27	29	27	206	50	15	23	70	19	22	**511**
7	17	28	3	19	41	51	272	37	28	67	23	8	**594**
8	7	15	3	7	34	15	36	92	7	12	6	3	**237**
9	14	51	33	7	12	23	27	7	116	14	7	16	**327**
10	5	11	8	12	47	71	69	12	13	224	76	11	**559**
11	2	7	0	17	17	19	21	6	7	76	118	5	**295**
12	4	3	4	74	30	21	8	3	16	12	3	176	**354**
TOTAL	**143**	**247**	**152**	**306**	**392**	**516**	**596**	**238**	**326**	**556**	**293**	**358**	**4123**

TABLE 4:12 TOTAL TRIP DISTRIBUTION OF INTER - INTRA ZONES

ZONES	INTER ZONAL TRIPS INSIDE THE STUDY AREA	INTER ZONAL TRIPS GOING OUTSIDE STUDY AREA
1	148 (90%)	16 (10%)
2	245 (87%)	36 (13%)
3	154 (79%)	40 (21%)
4	307 (84%)	58 (16%)
5	392 (96%)	16 (4%)
6	511 (91%)	49 (9%)
7	594 (92%)	52 (8%)
8	237 (94%)	16 (6%)
9	327 (81%)	78 (19%)
10	559 (88%)	76 (12%)
11	295 (86%)	50 (14%)
12	354 (93%)	25 (7%)

TABLE 4:13 TOTAL WORK TRIP ORIGIN - DESTINATION MATRIX FOR STUDY AREA

ZONES	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1	18	1	7	1	14	5	15	5	9	5	1	2	**83**
2	1	31	6	4	10	9	9	10	29	8	4	2	**123**
3	7	6	26	5	6	11	3	2	16	6	0	4	**92**
4	1	4	5	20	19	17	10	5	6	10	9	44	**150**
5	14	10	7	19	33	12	14	17	9	23	6	17	**181**
6	4	9	11	17	12	101	16	8	11	45	10	10	**254**
7	15	9	1	10	12	18	102	17	15	46	9	4	**258**
8	5	10	2	5	18	7	17	45	7	10	4	2	**132**
9	9	29	17	6	8	12	15	7	53	11	6	15	**188**
10	5	8	6	10	24	45	48	10	10	85	34	9	**294**
11	1	4	0	9	6	10	10	4	6	34	38	2	**124**
12	1	3	4	44	17	9	4	2	15	10	2	77	**188**
TOTAL	**81**	**124**	**92**	**150**	**179**	**256**	**263**	**132**	**186**	**293**	**123**	**188**	**2067**

Table 4:14 TRIP DISTRIBUTION OF INTER - INTRA ZONES FOR WORK PURPOSE

ZONES	INTER ZONAL TRIPS INSIDE THE STUDY AREA	INTER ZONAL TRIPS GOING OUTSIDE STUDY AREA
1	83 (87%)	12 (13%)
2	123 (89%)	15 (11%)
3	92 (75%)	30 (25%)
4	150 (84%)	28 (16%)
5	181 (94%)	11 (6%)
6	254 (91%)	25 (9%)
7	258 (93%)	18 (7%)
8	132 (93%)	10 (7%)
9	188 (87%)	27 (13%)
10	294 (89%)	36 (11%)
11	124 (84%)	24 (16%)
12	188 (94%)	13 (6%)

The total trips in 12 zones are 4123, among them 2067 trips are generated for the work purpose. It means 50% work trips are occur to the total trips. The highest trips produced from zone – 7 and attracted in zone – 10. The 80% to 90% trips are distributed in the study area. The others are going outside the study area.

TABLE 4:15 TOTAL EDUCATION TRIP ORIGIN - DESTINATION MATRIX FOR STUDY AREA

ZONES	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1	8	0	5	0	8	0	1	1	0	0	0	1	**24**
2	0	14	6	1	4	2	15	4	13	1	2	1	**63**
3	5	7	18	1	12	15	2	0	12	0	0	0	**72**
4	0	1	1	38	9	8	6	1	1	2	0	22	**89**
5	8	4	12	9	18	13	21	8	3	15	8	10	**129**
6	0	2	15	8	13	78	24	4	7	18	3	11	**183**
7	1	15	2	5	21	23	73	3	9	3	4	1	**160**
8	1	4	0	1	6	5	3	23	0	1	0	1	**45**
9	0	13	12	1	4	7	8	0	38	3	1	0	**87**
10	0	2	0	2	15	18	3	1	3	74	22	0	**140**
11	0	2	0	0	8	3	4	0	1	22	58	0	**98**
12	1	0	0	22	10	11	1	1	0	0	0	57	**103**
TOTAL	**24**	**64**	**71**	**88**	**128**	**183**	**161**	**46**	**87**	**139**	**98**	**104**	**1193**

TABLE 4:16 TRIP DISTRIBUTION OF INTER - INTRA ZONES FOR EDUCATION PURPOSE

ZONES	INTER ZONAL TRIPS INSIDE THE STUDY AREA	INTER ZONAL TRIPS GOING OUTSIDE STUDY AREA
1	24 (92%)	2 (8%)
2	63 (81%)	15 (19%)
3	72 (88%)	10 (12%)
4	89 (80%)	22 (20%)
5	129 (98%)	2 (2%)
6	183 (91%)	18 (9%)
7	160 (89%)	20 (11%)
8	45 (96%)	2 (4%)
9	87 (65%)	46 (35%)
10	140 (85%)	24 (15%)
11	98 (84%)	18 (16%)
12	103 (94%)	6 (6%)

The total trips in 12 zones are 4123, among them 1193 trips are generated for the education purpose. It means 29% education trips are occur to the total trips. The highest trips produced from zone – 6 and attracted in zone – 6 due to availability of measures school and collages. The 85% to 95% trips are distributed in the study area. The others are going outside the study area.

TABLE 4:17 TOTAL SHOPPING TRIP ORIGIN - DESTINATION MATRIX FOR STUDY AREA

ZONES	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1	10	0	2	1	6	1	0	1	5	0	0	1	**27**
2	0	20	0	0	0	0	0	1	4	1	0	0	**26**
3	2	0	2	0	1	1	0	1	2	1	0	0	**10**
4	1	0	0	6	1	1	3	0	0	0	2	3	**17**
5	6	0	1	1	19	2	1	6	0	4	1	1	**42**
6	1	0	1	1	2	14	5	2	0	2	5	0	**33**
7	0	0	0	3	1	5	46	6	2	7	1	0	**71**
8	1	1	1	0	7	2	5	14	0	0	0	0	**31**
9	5	4	2	0	0	0	2	0	8	0	0	0	**21**
10	0	1	1	0	4	2	7	0	0	41	5	1	**62**
11	0	0	0	2	3	5	1	0	0	5	10	1	**27**
12	2	0	0	3	1	0	0	0	0	1	1	10	**18**
TOTAL	**28**	**26**	**10**	**17**	**45**	**33**	**70**	**31**	**21**	**62**	**25**	**17**	**385**

TABLE 4:18 TRIP DISTRIBUTION OF INTER - INTRA ZONES FOR SHOPPING PURPOSE

ZONES	INTER ZONAL TRIPS INSIDE THE STUDY AREA	INTER ZONAL TRIPS GOING OUTSIDE STUDY AREA
1	27 (100%)	0 (0%)
2	26 (93%)	2 (7%)
3	10 (100%)	0 (0%)
4	17 (100%)	0 (0%)
5	42 (100%)	0 (0%)
6	33 (94%)	2 (6%)
7	71 (86%)	12 (14%)
8	31 (100%)	0 (0%)
9	21 (84%)	4 (16%)
10	62 (94%)	4 (6%)
11	27 (100%)	0 (0%)
12	18 (100%)	0 (0%)

The total trips in 12 zones are 4123, among them 385 trips are generated for the shopping purpose. It means 9% shopping trips are occur to the total trips. The highest trips produced from zone – 7 and attracted in zone – 7. The 98% to 100% trips are distributed in the study area. Very few trips are going outside the study area for the shopping purpose.

TABLE 4:19 TOTAL OTHERS TRIP ORIGIN - DESTINATION MATRIX FOR STUDY AREA

ZONES	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1	0	0	2	1	4	3	1	0	0	0	1	2	**14**
2	0	15	2	0	0	6	4	0	5	0	1	0	**33**
3	2	2	2	0	0	1	0	0	2	1	0	0	**10**
4	1	0	0	30	4	3	1	1	0	0	6	5	**51**
5	4	0	0	4	16	0	7	3	0	4	0	2	**40**
6	1	6	0	3	0	13	5	1	5	5	1	1	**41**
7	1	4	0	1	7	5	51	11	2	11	9	3	**105**
8	0	0	0	1	3	1	11	10	0	1	2	0	**29**
9	0	5	2	0	0	4	2	0	17	0	0	1	**31**
10	0	0	1	0	4	6	11	1	0	24	15	1	**63**
11	1	1	0	6	0	1	6	2	0	15	12	2	**46**
12	0	0	0	5	2	1	3	0	1	1	0	32	**45**
TOTAL	**10**	**33**	**9**	**51**	**40**	**44**	**102**	**29**	**32**	**62**	**47**	**49**	**508**

TABLE 4:20 TRIP DISTRIBUTION OF INTER - INTRA ZONES FOR OTHERS PURPOSE

ZONES	INTER ZONAL TRIPS INSIDE THE STUDY AREA	INTER ZONAL TRIPS GOING OUTSIDE STUDY AREA
1	14 (87%)	2 (13%)
2	33 (89%)	4 (11%)
3	10 (100%)	0 (0%)
4	51 (86%)	8 (14%)
5	40 (93%)	3 (7%)
6	41 (91%)	4 (9%)
7	105 (98%)	2 (2%)
8	29 (88%)	4 (12%)
9	31 (97%)	1 (3%)
10	63 (84%)	12 (16%)
11	46 (85%)	8 (15%)
12	45 (88%)	6 (12%)

The total trips in 12 zones are 4123, among them 508 trips are generated for the others purpose. It means 12% others trips are occur to the total trips. The highest trips produced from zone – 7 and attracted in zone – 7. The 85% to 90% trips are distributed in the study area. Other purpose trips include social and recreational activities.

5. DEVELOPMENT OF GRAVITY BASED URBAN TRIP DISTRIBUTION

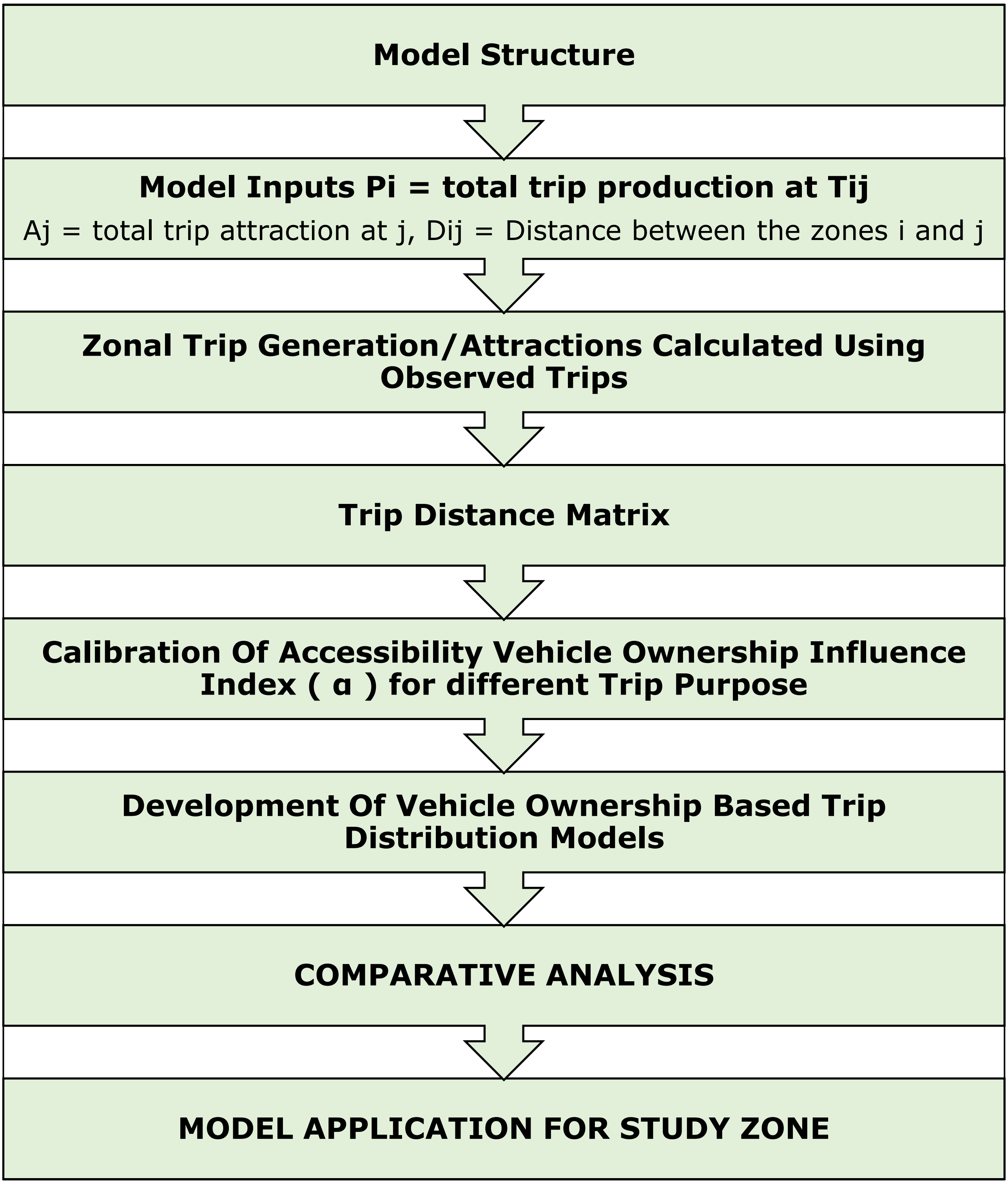


FIGURE 5:1 FLOW OF METHODOLOGY

5.1 MODEL STRUCTURE

The gravity model is the most commonly used synthetic travel distribution model. The synthetic gravity model derives its basis from newton's law of gravity. It is assumed that the number of journeys between the two zones is directly related to the activities in the two zones and that the driving impedance between the zones can be measured in terms of distance, travel time and travel costs, etc. In this study, the travel distance between the zones considered as a function of impedance. "Friction Factor (F)" of the model represents the reluctance or impedance of people to make journeys of different lengths or distances. The total friction factor shows that travellers take trips of this length less and less with increasing travel times. To calibrate the gravity model, the friction factor must be adjusted. The socio-economic adjustment factor is an adjustment factor for the individual travel exchange. The gravity model has the form:

$$\mathbf{T}_{\mathbf{ij}} = \frac{P_i A_j F(t)_{ij} K_{ij}}{\sum_{j=1}^{m} A_j F(t)_{ji}}$$

Where:

Tij = Trips produced at i and attracted at j

Pi = Total trip production at i

Aj = Total trip attraction at j

F(t) ij = Friction factor or travel time factor (F(t) ij =1/Dij$^{\alpha}$.)

Dij= Distance between the zones i and j

α = Exponent to influence accessibility

Kij = A socioeconomic adjustment factor for interchange Tij

Model calibration is done by adjusting the various factors within the gravity model until the model can double the travel distribution for a known base year. (Kadiyali, 2003) (Allen, 1984) (Saxena, 1989)

5.2 MODEL INPUTS

The most important qualified inputs for the models are

- Trip generation at i_{th} zone
- Trip attraction by j_{th} zone
- Zonal separation measured in terms of distance/ travel time/travel Cost

These parameters influence the journeys between two zones: For the current model, the generation of journeys, the attraction of the journey and the distance of the journey (km) between two different zones ij the investigation zone, which represents the Vadodara city, cover all twelve zones, such as mentioned above.

5.2.1 ZONAL TRIP GENERATION AND ATTRACTION

TABLE 5:1 OBSERVED TRIP INTERCHANGE MATRIX

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	36	1	16	3	32	9	17	7	14	5	2	6	**148**	**0.97**
2	1	80	14	5	14	17	28	15	51	10	7	3	**245**	**1.01**
3	16	15	18	6	19	28	5	3	32	8	0	4	**154**	**0.99**
4	3	5	6	94	33	29	20	7	7	12	17	74	**307**	**1.00**
5	32	14	20	33	86	27	43	34	12	46	15	30	**392**	**1.00**
6	6	17	27	29	27	206	50	15	23	70	19	22	**511**	**1.01**
7	17	28	3	19	41	51	272	37	28	67	23	8	**594**	**1.00**
8	7	15	3	7	34	15	36	92	7	12	6	3	**237**	**1.00**
9	14	51	33	7	12	23	27	7	116	14	7	16	**327**	**1.00**
10	5	11	8	12	47	71	69	12	13	224	76	11	**559**	**0.99**
11	2	7	0	17	17	19	21	6	7	76	118	5	**295**	**0.99**
12	4	3	4	74	30	21	8	3	16	12	3	176	**354**	**1.01**
Aj	**143**	**247**	**152**	**306**	**392**	**516**	**596**	**238**	**326**	**556**	**293**	**358**	**4123**	

The zonal travel generations for the all zones depend on the trip rate and zonal population. Rare trigger values are calculated from the survey database. The total number of trips generated and attracted is 4123 numbers. The upper table shows that total number of trip attraction and production from each ward in Vadodara city. The ratio of attraction vs production is also calculated and shown in the table.

TABLE 5:2 INTRA ZONAL GENERATIONS/ ATTRACTIONS

	Pi	Ai	Ai/Pi
1	148	143	0.97
2	245	247	1.01
3	154	152	0.99
4	307	306	1.00
5	392	392	1.00
6	511	516	1.01
7	594	596	1.00
8	237	238	1.00
9	327	326	1.00
10	559	556	0.99
11	295	293	0.99
12	354	358	1.01
TOTAL	4123	4123	

Where: Pi=Trip productions of ith zone, Ai=Trip attractions of jth zone

The Ai/Pi ratio of each zone is illustrated in the Figure given below.

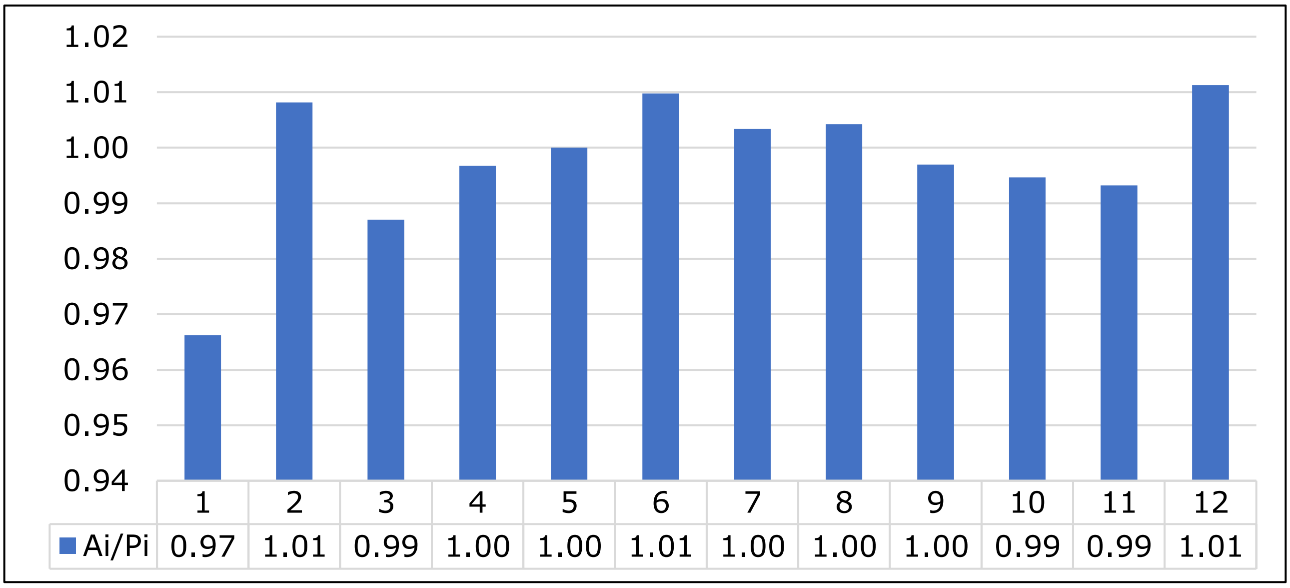


FIGURE 5:2 AI/PI RATIO OF EACH ZONE

Intra zonal trips means which trips are classified I their origin and destination are contained within the same TAZ. The table shows that total intrazonal trips occurred in 12 zones. The most trips are produced from zone – 7 followed by zone – 10 with 594 and 559. The zone - 7 also attracted the more trips. The lowest trips production and attraction in zone – 1. The production/attraction ratio is higher in zone – 2,6 and 12. The lowest is in zone – 1.

5.2.2 TRIP DISTANCE MATRIX

Average distance is calculated for each trip mode then weighted average of average distance is found out by formula. Following table shows the method by which the distance between each zone is found out.

TABLE 5:3 TRIP DISTANCE O-D MATRIX IN KM

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.92	12	2.05	5.00	1.71	4.11	4.84	1.04	5.30	5.20	3.65	8.50
2	12	1.72	3.47	11.20	8.97	6.26	3.12	3.33	3.20	8.42	10	12.66
3	3.08	3.90	3.06	11.16	6.65	10.26	7.00	7.53	3.28	8.38	0	6.75
4	5.00	11.20	11.16	1.67	6.05	8.63	7.10	7.42	11.31	11.50	9.73	3.38
5	1.58	9.04	6.88	6.05	2.07	4.55	4.59	1.90	5.45	6.55	6.53	8.93
6	3.83	6.26	10.50	8.63	4.62	6.16	5.04	2.92	8.95	5.80	4.21	9.06
7	4.84	3.16	8.33	7.21	4.54	5.04	2.73	3.15	6.63	5.56	6.91	13.13
8	1.04	3.33	7.53	7.42	1.67	3.62	3.20	2.29	5.85	7.20	6.78	14.33
9	5.30	3.20	3.29	11.31	5.73	9.03	6.55	5.85	3.47	16.39	12	11.71
10	5.20	8.20	8.38	11.50	6.60	6.10	5.61	7.20	16.73	3.50	3.59	12.63
11	3.65	10.60	0.00	9.73	6.55	4.21	6.93	7.11	12.00	3.59	1.70	8.80
12	7.75	10.70	6.75	3.36	8.93	8.88	13.13	14.33	11.71	12.58	8.00	3.99

Average distance based on survey data is considered for the intra sub zonal trips. The maximum distance of 16.73 Km is between ZONE-10 and ZONE-9. The minimum distance of 0.92 is observed between ZONE-1 and ZONE-1. Lower distances are observed in a diagonal way within sub zonal trips.

5.2.3 TRAVEL TIME MATRIX

TABLE 5:4 TRAVEL TIME O-D MATRIX IN MINUTES

	1	2	3	4	5	6	7	8	9	10	11	12
1	7.8	30.0	9.8	21.7	10.0	14.8	16.6	12.9	20.1	16.0	18.5	22.5
2	25.0	9.4	11.9	36.0	22.9	17.8	14.8	10.7	13.9	21.9	25.1	23.3
3	43.1	15.7	13.7	23.3	20.5	30.8	19.0	28.0	12.7	20.3	0.0	20.0
4	21.7	29.0	24.2	9.4	20.5	27.1	20.1	22.9	23.6	27.5	60.7	13.1
5	9.7	23.3	21.0	19.9	11.1	16.6	18.1	10.0	26.2	20.8	20.7	24.2
6	14.7	20.3	33.2	26.1	16.6	17.9	31.5	14.9	40.3	17.6	12.5	26.3
7	16.6	15.2	23.3	21.9	18.4	17.8	13.5	13.4	21.2	18.0	19.1	31.9
8	12.9	11.8	25.7	22.9	9.9	16.2	13.2	14.0	16.4	21.9	26.8	25.0
9	19.4	14.1	12.6	23.6	25.0	40.1	21.0	16.4	11.1	21.8	26.4	26.8
10	14.0	24.1	20.3	28.3	22.0	18.1	17.0	21.5	21.9	11.7	12.8	27.0
11	18.5	27.4	0.0	62.5	20.7	12.9	18.6	26.8	26.4	12.5	7.6	20.0
12	18.8	18.3	20.0	13.3	25.1	26.2	31.3	25.0	27.1	25.8	21.7	13.9

Travel time is a degree of the duration of time vital to transport from one region to another. In occupational contexts, it could seek advice from the time vital for an employee to tour to his or her administrative centre from home (and vice-versa), the duration of time spent travelling as a part of the paintings itself, or the duration of time spent travelling from the doorway of his or her enterprise establishment (e.g., an office) to the area wherein the paintings is truly done (e.g., a worksite or facility).

5.2.4 TRAVEL COST MATRIX

TABLE 5:5 TRAVEL COST O-D MATRIX IN RUPEES

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.081	18.4	4.5	25.62	3.82	14.08	7.5	1.82	8.12	10.96	5.59	13.03
2	18.4	3.58	8.12	26.13	22.73	11.44	7.83	8.48	5.72	23.33	15.94	24.35
3	6.96	8.85	9.15	22.72	11.69	13.26	18.18	15.42	7.43	19.88	0	10.35
4	28.95	26.13	22.72	5.36	13.19	17.47	12.5	16.95	24.6	29.24	24.46	10.12
5	3.63	22.13	11.95	13.67	5.48	8.42	9.18	5.84	11.32	13.07	12.53	17.73
6	6.26	11.44	13.52	17.47	8.72	13.93	8.72	5.85	14.8	12.05	12.61	22.47
7	7.5	7.83	25.2	12.76	9.22	8.43	8.25	5.35	12.99	11.97	12.82	32.6
8	1.82	8.48	15.42	16.95	5.48	6.92	5.43	4.01	8.98	14.58	11.87	24.84
9	8.12	5.72	7.39	24.6	11.48	14.93	12.96	8.98	7.97	32.09	22.4	19.34
10	10.96	23.39	19.88	29.24	13.02	12.82	12.21	14.58	33.14	10.24	8.19	26.16
11	5.59	15.94	0	24.46	12.26	11.29	13.06	12.39	22.4	8.25	7.38	29.92
12	11.88	16.35	10.35	10.22	17.73	21.7	32.6	24.84	19.34	25.51	27.2	9.28

Travel expenses are the price paid by the user for transport services; they are the negotiated monetary costs of transporting a passenger or cargo unit between a specific point of departure and destination; The tariffs are often visible to consumers as transport service providers have to provide this information in order to secure transactions.

The value of travel time can be defined as the price people are willing to pay to buy an additional unit of time. The value of travel time was most often determined by estimating modes of transport choice and assessing the marginal rate of substitution between cost and travel time alternative modes.

5.3 MACRO SAMPLE ANALYSIS: CALIBRATION OF 'α'

Before developing trip distribution model for various Two-Wheeler categories, a macro level analysis of trip distribution has been carried out. For the macro level analysis of trip distribution accessibility influence factor'α' is adopted as 2. (Kadiyali, 2003) (Saxena, 1989) Gravity model for trip distribution is calibrated with the same alpha value. Actual trip interchanges between the zones and the model output by adopting a single accessibility influence factor are given in Table 5-6 and Table 5-7.

Total trips calculated in following table are considered as two times the observed trips for each zone. It has been done with assumption that every forward trip will have return trip.

TABLE 5:6 TRIP INTERCHANGE: OBSERVED*

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	36	1	16	3	32	9	17	7	14	5	2	6	**148**	**0.97**
2	1	80	14	5	14	17	28	15	51	10	7	3	**245**	**1.01**
3	16	15	18	6	19	28	5	3	32	8	0	4	**154**	**0.99**
4	3	5	6	94	33	29	20	7	7	12	17	74	**307**	**1.00**
5	32	14	20	33	86	27	43	34	12	46	15	30	**392**	**1.00**
6	6	17	27	29	27	206	50	15	23	70	19	22	**511**	**1.01**
7	17	28	3	19	41	51	272	37	28	67	23	8	**594**	**1.00**
8	7	15	3	7	34	15	36	92	7	12	6	3	**237**	**1.00**
9	14	51	33	7	12	23	27	7	116	14	7	16	**327**	**1.00**
10	5	11	8	12	47	71	69	12	13	224	76	11	**559**	**0.99**
11	2	7	0	17	17	19	21	6	7	76	118	5	**295**	**0.99**
12	4	3	4	74	30	21	8	3	16	12	3	176	**354**	**1.01**
Ai	**143**	**247**	**152**	**306**	**392**	**516**	**596**	**238**	**326**	**556**	**293**	**358**	**4123**	

The above table shows that the total trips distribution in 12 zones as per the primary survey for all the purposes. It also called OD matrix. In this table, each zone considers as an origin & destination point to attract and produce the trip. The total 4123 household trips generated and attracted within the 12 wards of Vadodara city. The zone – 7 is highest trip production and attraction. The 2nd highest production and attraction can be done in zone 10 because of Industrial Location, mixed land use and Highley commercial area. Zone – 1 has lowest trip attraction and production followed by zone - 3. Some zone has 0 trips.

TABLE 5:7 TRIP INTERCHANGE: GRAVITY MODEL OUTPUTS

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	13	2	14	6	28	21	18	9	8	16	5	8	**148**	**0.97**
2	3	41	19	4	11	29	45	25	32	18	6	14	**245**	**1.01**
3	1	13	13	9	12	9	25	3	34	18	0	17	**154**	**0.99**
4	5	7	7	95	21	20	38	8	17	17	2	70	**307**	**1.00**
5	29	11	10	23	77	57	51	48	15	33	15	22	**392**	**1.00**
6	23	27	8	24	64	89	31	39	12	85	74	35	**511**	**1.01**
7	16	44	14	32	47	82	153	44	38	73	28	21	**594**	**1.00**
8	8	23	4	9	50	31	50	13	20	15	4	11	**237**	**1.00**
9	8	33	31	18	16	10	41	19	89	32	10	20	**327**	**1.00**
10	21	16	17	17	30	73	89	16	33	159	59	28	**559**	**0.99**
11	5	5	0	2	15	64	33	4	10	62	73	22	**295**	**0.99**
12	10	24	15	68	20	30	23	10	18	28	18	90	**354**	**1.01**
Ai	**143**	**247**	**152**	**306**	**392**	**516**	**596**	**238**	**326**	**556**	**293**	**358**	**4123**	

The table 5-7 is all about origin-destination matrix which is calculated on the basis of Gravity model. It is showing the predicted future trips with the help of observed trips. In the observed trips more attracted zone was zone 7, because of it has educational zone and main transportation hub of the city, so people travel more from this place but here it is zone 10 due to its Industrial area and commercial area with few schools. Same for the production, the production of trips from different zone is similar as always. Only attracted trips number can be varies from zone to zone. The lowest attracted trips can be done in zone 1 where in the observed trips it was zone 3. It means in the present condition, the zone 1 attracted and produced less trips in comparison with other zones. But in future scenario zone 1 produced same trips but the attraction number can be increase and zone 3 became the less attracted zones in the study area. For the whole population and purpose wise trips with using different modes of travel are considered and calculated below.

5.4 CALIBRATION OF ACCESSIBILITY VEHICLE OWNERSHIP INFLUENCE INDEX FOR DIFFERENT TRIP PURPOSE (α)

The denominator of the gravity model, i.e., Dij_{α}, representing the distance between the origin and destination and 'α' is the accessibility influencer. Accessibility is defined as $1/Dij_{\alpha}$. Apart from distance Dij the 'α' value influences the accessibility between the origin and destination significantly. Higher the 'α' value lesser will be the accessibility and vice versa. In most of the trip distribution model 'α' is considered as a single value for the whole geographical area and in most of the studies it varies from 1 to 3 at macro level.

From the analysis of the survey data, vehicle ownership is found as one of the important influencing factors of accessibility. For analysing the impact of vehicle ownership on trip distribution 'α' and accessibility value for all the vehicle ownership categories have been calibrated using different types of trip purpose. Trips going outside the study area are not considered for the development of the model. Actual number of trips generated and the number of trips considered for the model development for each vehicle ownership and mode wise categories are given in below Table. Actual trip interchange matrices for all the, vehicle ownership categories are given below in as per the home interview survey.

TABLE 5:8 ACCESSIBILITY VEHICLE OWNERSHIP INFLUENCE INDEX (α) FOR WORK PURPOSE

VEHICLE OWNERSHIP CATEGORIES	α VALUES
TWO-WHEELER	1.8
FOUR-WHEELER	1.4
AUTO	1.1
BUS	1.3
WALKING	1

Accessibility vehicle ownership Influence Index is high for two-wheeler for different trip purposes compared to other vehicle ownership categories. Since the index is high for two-wheeler their accessibility decreases significantly compared to other income classes. In other words, two-wheeler people would like to be nearer to their residence.

Accessibility vehicle ownership influence index 'α' value is calibrated by trial-and-error method. Different Accessibility vehicle ownership Influence Indices are observed for TWO-WHEELER, FOUR-WHEELER, AUTO, BUS, BICYCLE, WALKING, VANPOOL instead of taking a single value regardless of vehicle ownership categories according to different types of travel purpose like work, education, shopping and other.

TABLE 5:9 ACCESSIBILITY VEHICLE OWNERSHIP INFLUENCE INDEX (α) FOR EDUCATION PURPOSE

VEHICLE OWNERSHIP CATEGORIES	α VALUES
TWO-WHEELER	1.9
AUTO	1.4
BUS	1
BICYCLE	1.2
WALKING	1.5
VANPOOL	2

TABLE 5:10 ACCESSIBILITY VEHICLE OWNERSHIP INFLUENCE INDEX (α) FOR SHOPPING PURPOSE

VEHICLE OWNERSHIP CATEGORIES	α VALUES
TWO-WHEELER	1.6
AUTO	1.2
WALKING	1.3

TABLE 5:11 ACCESSIBILITY VEHICLE OWNERSHIP INFLUENCE INDEX (α) FOR OTHER PURPOSE

VEHICLE OWNERSHIP CATEGORIES	α VALUES
TWO-WHEELER	1.8
FOUR-WHEELER	1.7
AUTO	1
WALKING	1.4

No difference in 'α' has been observed in case of shopping purpose using two-wheeler, auto and walking group. The sum of total two-wheeler also observed in the study. The calculation of 'α' for the all-two-wheeler ownership is 1.75 for all trip purpose, which is higher than four-wheelers, auto, bus and walking.

TABLE 5:12 TOTAL INTER AND INTRA ZONAL TRIPS FOR WORK PURPOSE

VEHICLE OWNERSHIP CATAGORIES	INTRA ZONAL TRIPS	TRIPS OUTSIDE STUDY AREA	TOTAL TRIPS
TWO-WHEELER	1432 (92%)	132 (8%)	1564
FOUR-WHEELER	337 (81%)	77 (19%)	414
AUTO	78 (98%)	2 (2%)	80
BUS	70 (71%)	29 (29%)	99
WALKING	101 (97%)	3 (3%)	104

TABLE 5:13 TOTAL INTER AND INTRA ZONAL TRIPS FOR EDUCATION PURPOSE

VEHICLE OWNERSHIP CATAGORIES	INTRA ZONAL TRIPS	TRIPS OUTSIDE STUDY AREA	TOTAL TRIPS
TWO-WHEELER	429 (85%)	78 (15%)	507
AUTO	76 (90%)	8 (10%)	84
BUS	69 (63%)	41 (37%)	110
BICYCLE	119 (100%)	0 (0%)	119
WALKING	132 (97%)	4 (3%)	136
VANPOOL	364 (88%)	48 (12%)	412

TABLE 5:14 TOTAL INTER AND INTRA ZONAL TRIPS FOR SHOPPING PURPOSE

VEHICLE OWNERSHIP CATAGORIES	INTRA ZONAL TRIPS	TRIPS OUTSIDE STUDY AREA	TOTAL TRIPS
TWO-WHEELER	199 (96%)	8 (4%)	207
AUTO	51 (96%)	2 (4%)	53
WALKING	94 (100%)	0 (0%)	94

TABLE 5:15 TOTAL INTER AND INTRA ZONAL TRIPS FOR OTHER PURPOSE

VEHICLE OWNERSHIP CATAGORIES	INTRA ZONAL TRIPS	TRIPS OUTSIDE STUDY AREA	TOTAL TRIPS
TWO-WHEELER	287 (93%)	23 (7%)	310
FOUR-WHEELER	86 (82%)	19 (18%)	105
AUTO	37 (88%)	5 (12%)	42
WALKING	76 (100%)	0 (0%)	76

5.5 DEVELOPMENT OF VEHICLE OWNERSHIP BASED TRIP DISTRIBUTION MODELS

There are four models have been developed based on trip purpose and vehicle ownership as listed below.

1) **DEVELOPMENT OF SG-UTDM- USING HOUSEHOLD TRIPS OF DIFFERENT TRIP MODES FOR WORK PURPOSE**
2) **DEVELOPMENT OF SG-UTDM- USING HOUSEHOLD TRIPS OF DIFFERENT TRIP MODES FOR EDUCATION PURPOSE**
3) **DEVELOPMENT OF SG-UTDM- USING HOUSEHOLD TRIPS OF DIFFERENT TRIP MODES FOR SHOPPING PURPOSE**
4) **DEVELOPMENT OF SG-UTDM- USING HOUSEHOLD TRIPS OF DIFFERENT TRIP MODES FOR OTHERS PURPOSE**

First, I observed the trip distribution pattern with in the Vadodara city with the help of Primary Survey. After the Development of Gravity model, I calculated the future trip distribution pattern in the study area. The calculation for final and better result, I calculated same model with four times, it called fourth Iteration. Here I put only final result, other can be go on the Annexure part.

5.5.1 MODEL I: DEVELOPMENT OF SG-UTDM- USING HOUSEHOLD TRIPS FOR WORK PURPOSE TRIP DISTRIBUTION

(A) TRIP DISTRIBUTION FOR TWO-WHEELER

TABLE 5:16 OBSERVED TRIP INTERCHANGE O-D MATRIX (TWO-WHEELER)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	14	1	5	1	13	4	14	1	9	3	1	2	**68**	**0.94**
2	1	12	5	2	4	8	6	9	25	5	4	2	**83**	**1.00**
3	5	5	16	2	5	8	3	1	14	3	0	4	**66**	**1.00**
4	1	2	2	10	15	13	5	4	4	6	5	30	**97**	**1.00**
5	13	4	6	15	19	9	11	12	6	16	3	10	**124**	**0.98**
6	3	8	8	13	9	71	13	6	9	25	5	5	**175**	**1.01**
7	14	6	1	5	9	15	62	14	11	27	4	3	**171**	**1.02**
8	1	9	1	4	13	5	14	33	7	7	3	2	**99**	**1.00**
9	9	25	15	4	5	10	11	7	34	9	5	13	**147**	**0.99**
10	1	5	3	6	17	24	28	7	8	56	27	7	**189**	**1.02**
11	1	4	0	5	3	5	5	3	5	27	24	0	**82**	**0.99**
12	1	2	4	30	10	5	3	2	13	8	0	53	**131**	**1.00**
Ai	**64**	**83**	**66**	**97**	**122**	**177**	**175**	**99**	**145**	**192**	**81**	**131**	**1432**	

The total 1432 trips are generate using two-wheeler. The most trips are generated from the zone – 10 and lowest in zone – 1.

TABLE 5:17 ACCESSIBILITY MATRIX FOR TWO WHEELERS

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.21	0.01	0.11	0.05	0.36	0.07	0.05	3.48	0.05	0.04	0.03	0.01
2	0.01	0.09	0.04	0.01	0.02	0.02	0.08	0.09	0.10	0.03	0.01	0.01
3	0.11	0.04	0.29	0.00	0.03	0.02	0.02	0.08	0.12	0.01	0.00	0.03
4	0.05	0.01	0.00	0.61	0.02	0.02	0.01	0.03	0.01	0.02	0.02	0.10
5	0.36	0.02	0.03	0.02	0.21	0.11	0.07	0.43	0.04	0.04	0.04	0.03
6	0.08	0.02	0.02	0.02	0.10	0.03	0.05	0.17	0.02	0.04	0.11	0.04
7	0.05	0.08	0.01	0.01	0.07	0.05	0.14	0.05	0.03	0.04	0.02	0.01
8	3.48	0.09	0.08	0.03	0.43	0.17	0.05	0.08	0.04	0.02	0.03	0.02
9	0.05	0.10	0.11	0.01	0.05	0.02	0.03	0.04	0.05	0.00	0.01	0.01
10	0.04	0.03	0.01	0.02	0.04	0.04	0.04	0.02	0.00	0.07	0.07	0.01
11	0.03	0.01	0.00	0.02	0.04	0.11	0.02	0.03	0.01	0.07	0.17	0.00
12	0.02	0.01	0.03	0.10	0.03	0.04	0.01	0.02	0.01	0.01	0.00	0.06

The highest accessibility observed for the zone – 1 to 8. Some zones have 0 accessibility matrix for two-wheeler.

Sample Calculation for Accessibility

Accessibility for Trips $= \frac{1}{Dij\propto}$

Where α=1.8

Dij= Distance between the zones i and j from Distance matrix

Sample calculation for 1.21

Accessibility for Trips 1-1 $= \frac{1}{Dij\propto}$

$= \frac{1}{0.9^{1.8}}$

= 1.21

TABLE 5:18 ATTRACTION PROBABILITY MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.09	0.00	0.03	0.01	0.12	0.05	0.04	0.55	0.04	0.04	0.01	0.01
2	0.00	0.12	0.04	0.01	0.02	0.05	0.20	0.05	0.34	0.11	0.01	0.02
3	0.03	0.05	0.27	0.00	0.03	0.04	0.04	0.04	0.34	0.05	0.00	0.10
4	0.01	0.01	0.00	0.53	0.02	0.04	0.03	0.01	0.03	0.05	0.02	0.25
5	0.06	0.02	0.02	0.02	0.16	0.19	0.11	0.16	0.08	0.10	0.03	0.06
6	0.02	0.03	0.02	0.02	0.12	0.08	0.13	0.10	0.06	0.16	0.14	0.12
7	0.01	0.10	0.01	0.01	0.08	0.14	0.36	0.03	0.08	0.14	0.02	0.03
8	0.36	0.05	0.03	0.01	0.20	0.16	0.05	0.02	0.05	0.03	0.01	0.03
9	0.02	0.19	0.16	0.02	0.08	0.08	0.09	0.03	0.24	0.02	0.02	0.05
10	0.01	0.05	0.02	0.03	0.06	0.13	0.13	0.02	0.02	0.36	0.12	0.05
11	0.01	0.02	0.00	0.02	0.04	0.29	0.06	0.01	0.04	0.29	0.22	0.00
12	0.01	0.01	0.05	0.18	0.05	0.18	0.04	0.02	0.06	0.07	0.00	0.32

For this matrix of two-wheeler for work purpose is highest in zone – 1 to 8 trip and lowest for the zone – 2, and 11. It means these wards have more or less attraction probability of the trips.

Sample Calculation for Attraction Probability

Attraction probability of trips = $\frac{1}{Dij\propto} \times \frac{Aj}{\sum Aj}$

Sample calculation for 0.09

Attraction probability of trips from A – A = $\frac{1}{Dij\propto} \times \frac{Aj}{\sum Aj}$

$= \frac{1}{0.9^{1.8}} \times \frac{64}{1432}$

$= 0.09$

TABLE 5:19 TRIP INTERCHANGE FOR TWO-WHEELER (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	6	0	2	1	8	3	3	37	3	3	1	1	**68**	**0.96**
2	0	10	4	1	2	5	17	4	28	9	1	2	**83**	**1.00**
3	2	3	17	0	2	2	3	3	23	3	0	7	**66**	**1.00**
4	1	1	0	51	2	4	3	1	2	5	2	24	**97**	**0.99**
5	8	2	2	2	20	23	13	19	10	13	4	8	**124**	**0.99**
6	4	5	3	4	21	15	23	17	11	27	24	21	**175**	**1.01**
7	2	17	1	2	14	23	61	5	13	24	4	5	**171**	**1.02**
8	35	5	3	1	19	16	5	2	5	3	1	3	**99**	**1.01**
9	2	28	23	2	12	12	13	5	35	4	3	8	**147**	**0.99**
10	3	9	4	5	12	25	24	3	3	68	23	9	**189**	**1.02**
11	1	1	0	2	4	24	5	1	3	24	18	0	**82**	**0.99**
12	1	2	7	23	7	24	5	3	8	9	0	42	**131**	**0.99**
Ai	**65**	**83**	**66**	**96**	**123**	**177**	**175**	**100**	**145**	**192**	**81**	**130**	**1432**	

The interchange for two-wheeler total trips is 1432 for the study area. The highest attraction probability shown in zone 10 and lowest in zone 1. And for production of trips highest in zone 10 and lowest in zone 3.

Sample Calculation for Gravity Model Output

The formula used in above matrix is

$$Tij = \frac{PiAjF(t)ijKij}{\sum AjF(t)ij}$$

Where:

Tij = trips produced at i and attracted at j

Pi = total trip production at j

Ai = total trip attraction at j

F(t) ij = friction factor or travel time factor (F(t) ij =1/Dijα).

Dij= Distance between the zones i and j

α = Exponent to influence accessibility

Kij = a socioeconomic adjustment factor for interchange

Sample calculation for 6

$$Tij = \frac{PiAjF(t)ijKij}{\sum AjF(t)ij}$$

$$Tij = \frac{68 \times 64 \times \frac{1}{0.9^{1.8}} \times 1}{\begin{gathered}64 \times \frac{1}{0.9^{1.8}} \times 83 \times \frac{1}{12^{1.8}} \times 66 \times \frac{1}{3.4^{1.8}} \times 97 \times \frac{1}{5.5^{1.8}} \times 122 \times \frac{1}{1.7^{1.8}} \times 177 \times \frac{1}{4.5^{1.8}} \times 175 \times \frac{1}{5.1^{1.8}} \times \\ 99 \times \frac{1}{0.5^{1.8}} \times 145 \times \frac{1}{5.5^{1.8}} \times 192 \times \frac{1}{6^{1.8}} \times 81 \times \frac{1}{6.5^{1.8}} \times 131 \times \frac{1}{11^{1.8}}\end{gathered}}$$

$= 6$

(B) TRIP DISTRIBUTION FOR FOUR-WHEELER

TABLE 5:20 OBSERVED TRIP INTERCHANGE O-D MATRIX (FOUR-WHEELER)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	1	0	0	0	0	0	0	2	0	0	**3**	**1.00**
2	0	8	1	2	6	0	2	1	1	3	0	0	**24**	**1.00**
3	1	1	0	3	1	1	0	0	0	3	0	0	**10**	**1.00**
4	0	2	3	2	3	4	1	1	1	4	3	10	**34**	**1.00**
5	0	6	1	3	8	1	3	0	0	6	1	6	**35**	**1.00**
6	0	0	1	4	1	20	3	1	0	11	3	5	**49**	**0.98**
7	0	2	0	1	3	3	18	1	2	13	5	0	**48**	**1.02**
8	0	1	0	1	0	1	1	0	0	0	0	0	**4**	**1.00**
9	0	1	0	1	0	0	2	0	2	2	1	1	**10**	**1.00**
10	2	3	3	4	6	11	14	0	2	13	1	2	**61**	**0.98**
11	0	0	0	3	1	3	5	0	1	1	2	2	**18**	**1.00**
12	0	0	0	10	6	4	0	0	1	2	2	16	**41**	**1.02**
Ai	**3**	**24**	**10**	**34**	**35**	**48**	**49**	**4**	**10**	**60**	**18**	**42**	**337**	

The total 337 trips are generate using four-wheeler. The most trips are generated from the zone – 10 and lowest in zone – 1.

TABLE 5:21 ACCESSIBILITY MATRIX FOR FOUR-WHEELERS

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.16	0.07	0.03	0.04	0.00	0.06	0.38	0.11	0.02	0.00	0.00
3	0.08	0.07	0.00	0.08	0.08	0.07	0.00	0.00	0.00	0.04	0.00	0.00
4	0.00	0.03	0.08	0.21	0.13	0.07	0.07	0.08	0.04	0.02	0.04	0.16
5	0.00	0.04	0.08	0.13	0.30	0.08	0.05	0.00	0.00	0.05	0.07	0.05
6	0.00	0.00	0.07	0.07	0.08	0.08	0.08	0.05	0.00	0.11	0.06	0.03
7	0.00	0.06	0.00	0.07	0.05	0.08	0.11	0.38	0.15	0.07	0.09	0.00
8	0.00	0.38	0.00	0.08	0.00	0.05	0.38	0.00	0.00	0.00	0.00	0.00
9	0.00	0.11	0.00	0.04	0.00	0.00	0.15	0.00	0.02	0.03	0.02	0.03
10	0.07	0.02	0.04	0.02	0.05	0.09	0.07	0.00	0.03	0.08	0.21	0.03
11	0.00	0.00	0.00	0.04	0.07	0.06	0.09	0.00	0.02	0.21	0.14	0.04
12	0.00	0.00	0.00	0.16	0.05	0.03	0.00	0.00	0.03	0.03	0.04	0.06

The highest accessibility observed for the zone – 2 to 8 and 7 to 8. Some zones have 0 accessibility matrix for four-wheeler.

TABLE 5:22 ATTRACTION PROBABILITY MATRIX FOR FOUR-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.36	0.05	0.05	0.08	0.00	0.19	0.06	0.09	0.10	0.00	0.00
3	0.07	0.17	0.00	0.15	0.17	0.27	0.00	0.00	0.00	0.17	0.00	0.00
4	0.00	0.03	0.03	0.17	0.11	0.11	0.10	0.01	0.02	0.04	0.02	0.35
5	0.00	0.05	0.04	0.11	0.30	0.15	0.08	0.00	0.00	0.12	0.03	0.12
6	0.00	0.00	0.04	0.08	0.10	0.18	0.17	0.01	0.00	0.29	0.04	0.10
7	0.00	0.09	0.00	0.07	0.06	0.17	0.23	0.04	0.09	0.18	0.06	0.00
8	0.00	0.37	0.00	0.06	0.00	0.06	0.51	0.00	0.00	0.00	0.00	0.00
9	0.00	0.22	0.00	0.06	0.00	0.00	0.45	0.00	0.01	0.11	0.02	0.13
10	0.04	0.04	0.02	0.02	0.07	0.20	0.15	0.00	0.02	0.22	0.14	0.09
11	0.00	0.00	0.00	0.04	0.06	0.11	0.15	0.00	0.01	0.45	0.07	0.10
12	0.00	0.00	0.00	0.29	0.09	0.12	0.00	0.00	0.03	0.12	0.04	0.31

For this matrix is highest in zone – 11 to 10 trip and lowest for the zone – 1, 3, 8, and 11. It means these wards have more or less attraction probability of the trips.

TABLE 5:23 TRIP INTERCHANGE FOR FOUR-WHEELER (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	3	0	0	0	0	0	0	0	0	0	**3**	**1.00**
2	0	9	1	1	2	0	5	2	2	2	0	0	**24**	**1.00**
3	1	2	0	1	2	3	0	0	0	2	0	0	**10**	**1.00**
4	0	1	1	6	4	4	3	0	1	1	1	12	**34**	**1.00**
5	0	2	1	4	10	5	3	0	0	4	1	4	**35**	**1.00**
6	0	0	2	4	5	9	8	0	0	14	2	5	**49**	**0.98**
7	0	4	0	3	3	8	11	2	4	9	3	0	**48**	**1.02**
8	0	1	0	0	0	0	2	0	0	0	0	0	**4**	**1.00**
9	0	2	0	1	0	0	5	0	0	1	0	1	**10**	**1.00**
10	2	2	1	1	4	12	9	0	1	13	8	5	**61**	**0.98**
11	0	0	0	1	1	2	3	0	0	8	1	2	**18**	**1.00**
12	0	0	0	12	4	5	0	0	1	5	2	13	**41**	**1.02**
Ai	**3**	**24**	**10**	**34**	**35**	**48**	**49**	**4**	**10**	**60**	**18**	**42**	**337**	

The interchange for four-wheeler total trips is 337 for the study area. The highest attraction probability shown in zone 10 and lowest in zone 1. And for production of trips highest in zone 10 and lowest in zone 1.

(C) TRIP DISTRIBUTION FOR AUTO

TABLE 5:24 OBSERVED TRIP INTERCHANGE O-D MATRIX (AUTO)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**1.00**
2	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**1.00**
3	0	0	2	0	0	0	0	0	0	0	0	0	**2**	**1.00**
4	0	0	0	0	0	0	1	0	0	0	0	1	**2**	**1.00**
5	0	0	0	0	0	1	0	3	1	1	0	0	**6**	**1.17**
6	1	1	0	0	1	6	0	0	0	2	1	0	**12**	**1.08**
7	0	0	0	1	0	0	16	1	1	2	0	1	**22**	**1.00**
8	0	0	0	0	3	0	1	2	0	2	1	0	**9**	**1.00**
9	0	0	0	0	2	0	1	0	2	0	0	0	**5**	**0.80**
10	0	0	0	0	1	3	2	2	0	1	1	0	**10**	**1.00**
11	0	0	0	0	0	1	0	1	0	2	2	0	**6**	**0.83**
12	0	0	0	1	0	0	1	0	0	0	0	0	**2**	**1.00**
Ai	**1**	**1**	**2**	**2**	**7**	**13**	**22**	**9**	**4**	**10**	**5**	**2**	**78**	

The total 78 trips are generate using auto. The most trips are generated from the zone – 7 and lowest in zone – 1 & 2.

TABLE 5:25 ACCESSIBILITY MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.22
5	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.82	0.36	0.14	0.00	0.00
6	0.17	0.09	0.00	0.00	0.64	0.06	0.00	0.00	0.00	0.25	0.14	0.00
7	0.00	0.00	0.00	0.08	0.00	0.00	0.35	0.52	0.25	0.64	0.00	0.06
8	0.00	0.00	0.00	0.00	0.82	0.00	0.52	0.30	0.00	0.28	0.22	0.00
9	0.00	0.00	0.00	0.00	0.19	0.00	0.25	0.00	0.36	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.14	0.20	0.64	0.28	0.00	0.17	0.25	0.00
11	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.22	0.00	0.27	0.47	0.00
12	0.00	0.00	0.00	0.22	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00

The highest accessibility observed for the zone – 5 to 8 followed by zone 10 to 7. Some zones have 0 accessibility matrix for auto.

TABLE 5:26 ATTRACTION PROBABILITY MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.59
5	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.22	0.09	0.03	0.00	0.00
6	0.08	0.08	0.00	0.00	0.35	0.19	0.00	0.00	0.00	0.18	0.11	0.00
7	0.00	0.00	0.00	0.04	0.00	0.00	0.37	0.22	0.09	0.24	0.00	0.04
8	0.00	0.00	0.00	0.00	0.21	0.00	0.50	0.11	0.00	0.10	0.09	0.00
9	0.00	0.00	0.00	0.00	0.12	0.00	0.58	0.00	0.29	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.03	0.24	0.51	0.09	0.00	0.05	0.08	0.00
11	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.15	0.00	0.17	0.33	0.00
12	0.00	0.00	0.00	0.59	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00

For this matrix is highest in zone – 9 to 7 trips. And it is observed zero probability for most of the zone trips. It means these wards have more or less attraction probability of the trips.

TABLE 5:27 TRIP INTERCHANGE FOR AUTO (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**1.00**
2	0	0	0	0	0	1	0	0	0	0	0	0	**1**	**1.00**
3	0	0	2	0	0	0	0	0	0	0	0	0	**2**	**1.00**
4	0	0	0	0	0	0	1	0	0	0	0	1	**2**	**1.00**
5	0	0	0	0	0	4	0	1	1	0	0	0	**6**	**1.17**
6	1	1	0	0	4	2	0	0	0	2	1	0	**12**	**1.08**
7	0	0	0	1	0	0	8	5	2	5	0	1	**22**	**1.00**
8	0	0	0	0	2	0	4	1	0	1	1	0	**9**	**1.00**
9	0	0	0	0	1	0	3	0	1	0	0	0	**5**	**0.80**
10	0	0	0	0	0	2	5	1	0	0	1	0	**10**	**1.00**
11	0	0	0	0	0	2	0	1	0	1	2	0	**6**	**0.83**
12	0	0	0	1	0	0	1	0	0	0	0	0	**2**	**1.00**
Ai	**1**	**1**	**2**	**2**	**7**	**13**	**22**	**9**	**4**	**10**	**5**	**2**	**78**	

The interchange for auto total trips is 78 for the study area. The highest attraction probability shown in zone 7 and lowest in zone 1 & 2. And for production of trips highest in zone 7 and lowest in zone 1 & 2.

(D) TRIP DISTRIBUTION FOR BUS

TABLE 5:28 OBSERVED TRIP INTERCHANGE O-D MATRIX (BUS)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	1	0	0	0	0	1	0	0	0	0	**2**	**1.50**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	1	0	4	0	0	2	0	1	0	0	0	0	**8**	**1.00**
4	0	0	0	0	0	0	0	0	0	0	1	1	**2**	**1.00**
5	0	0	0	0	0	1	0	0	2	0	2	0	**5**	**0.80**
6	0	0	2	0	1	2	0	0	2	7	1	0	**15**	**1.00**
7	1	0	0	0	0	0	0	0	0	2	0	0	**3**	**0.67**
8	1	0	1	0	0	0	0	0	0	1	0	0	**3**	**1.00**
9	0	0	0	0	1	2	0	0	0	0	0	1	**4**	**1.25**
10	0	0	0	0	0	7	2	1	0	7	2	0	**19**	**0.95**
11	0	0	0	1	2	1	0	0	0	1	0	0	**5**	**1.20**
12	0	0	0	1	0	0	0	0	1	0	0	2	**4**	**1.00**
Ai	**3**	**0**	**8**	**2**	**4**	**15**	**2**	**3**	**5**	**18**	**6**	**4**	**70**	

The total 70 trips are generate using bus. The most trips are generated from the zone – 10 and lowest in zone – 2.

TABLE 5:29 ACCESSIBILITY MATRIX FOR BUS

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.16	0.00	0.00	0.00	0.08	0.24	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.16	0.00	0.05	0.00	0.00	0.04	0.00	0.03	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.16
5	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.20	0.00	0.07	0.00
6	0.00	0.00	0.04	0.00	0.08	0.08	0.00	0.00	0.03	0.07	0.07	0.00
7	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00
8	0.24	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00
9	0.00	0.00	0.00	0.00	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.04
10	0.00	0.00	0.00	0.00	0.00	0.06	0.12	0.12	0.00	0.11	0.18	0.00
11	0.00	0.00	0.00	0.04	0.07	0.07	0.00	0.00	0.00	0.14	0.00	0.00
12	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.12

The highest accessibility observed for the zone – 8 to 1. Some zones have 0 accessibility matrix for bus.

TABLE 5:30 ATTRACTION PROBABILITY MATRIX FOR BUS

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.71	0.00	0.00	0.00	0.07	0.22	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.36	0.00	0.37	0.00	0.00	0.22	0.00	0.05	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.81
5	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.57	0.00	0.09	0.00
6	0.00	0.00	0.17	0.00	0.11	0.30	0.00	0.00	0.07	0.26	0.09	0.00
7	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.00
8	0.52	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.00
9	0.00	0.00	0.00	0.00	0.47	0.35	0.00	0.00	0.00	0.00	0.00	0.18
10	0.00	0.00	0.00	0.00	0.00	0.20	0.10	0.11	0.00	0.38	0.20	0.00
11	0.00	0.00	0.00	0.05	0.10	0.29	0.00	0.00	0.00	0.57	0.00	0.00
12	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.36

For this matrix is highest in zone – 4 to 12 and 11 to 10 trip and lowest for the zone – 2, 4, 8, and 10. It means these wards have more or less attraction probability of the trips.

TABLE 5:31 TRIP INTERCHANGE FOR BUS (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/PI
1	0	0	1	0	0	0	0	0	0	0	0	0	**2**	**2.50**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	3	0	3	0	0	2	0	0	0	0	0	0	**8**	**0.88**
4	0	0	0	0	0	0	0	0	0	0	0	2	**2**	**1.00**
5	0	0	0	0	0	2	0	0	3	0	0	0	**5**	**0.80**
6	0	0	3	0	2	5	0	0	1	4	1	0	**15**	**1.00**
7	1	0	0	0	0	0	0	0	0	2	0	0	**3**	**0.67**
8	2	0	0	0	0	0	0	0	0	1	0	0	**3**	**1.00**
9	0	0	0	0	2	1	0	0	0	0	0	1	**4**	**1.25**
10	0	0	0	0	0	4	2	2	0	7	4	0	**19**	**0.89**
11	0	0	0	0	0	1	0	0	0	3	0	0	**5**	**1.20**
12	0	0	0	2	0	0	0	0	1	0	0	1	**4**	**1.00**
Ai	**5**	**0**	**7**	**2**	**4**	**15**	**2**	**3**	**5**	**17**	**6**	**4**	**70**	

The interchange for bus total trips is 70 for the study area. The highest attraction probability shown in zone 10 and lowest in zone 2. And for production of trips highest in zone 10 and lowest in zone 2.

(E) TRIP DISTRIBUTION FOR WALKING

TABLE 5:32 OBSERVED TRIP INTERCHANGE O-D MATRIX (WALKING)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	2	0	0	0	0	0	0	3	0	0	0	0	**5**	**1.00**
2	0	9	0	0	0	0	1	0	2	0	0	0	**12**	**1.00**
3	0	0	4	0	0	0	0	0	1	0	0	0	**5**	**1.00**
4	0	0	0	6	0	0	3	0	0	0	0	0	**9**	**1.00**
5	0	0	0	0	4	0	0	2	0	0	0	0	**6**	**1.00**
6	0	0	0	0	0	2	0	1	0	0	0	0	**3**	**1.00**
7	0	1	0	3	0	0	6	0	0	2	0	0	**12**	**1.00**
8	3	0	0	0	2	1	0	10	0	0	0	0	**16**	**1.00**
9	0	2	1	0	0	0	0	0	15	0	0	0	**18**	**1.00**
10	0	0	0	0	0	0	2	0	0	4	0	0	**6**	**1.00**
11	0	0	0	0	0	0	0	0	0	0	8	0	**8**	**1.00**
12	0	0	0	0	0	0	0	0	0	0	0	1	**1**	**1.00**
Ai	**5**	**12**	**5**	**9**	**6**	**3**	**12**	**16**	**18**	**6**	**8**	**1**	**101**	

The total 101 trips are generate using walking. The most trips are generated from the zone – 9 and lowest in zone – 12.

TABLE 5:33 ACCESSIBILITY MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12
1	2.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79	0.00	0.00	0.00	0.00
2	0.00	1.23	0.00	0.00	0.00	0.00	10.0	0.00	0.67	0.00	0.00	0.00
3	0.00	0.00	1.25	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00
4	0.00	0.00	0.00	3.33	0.00	0.00	20.0	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	2.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.71	0.00	0.00	0.00	0.00
7	0.00	1.00	0.00	20.0	0.00	0.00	6.67	0.00	0.00	0.33	0.00	0.00
8	1.79	0.00	0.00	0.00	1.33	0.71	0.00	0.76	0.00	0.00	0.00	0.00
9	0.00	0.67	0.33	0.00	0.00	0.00	0.00	0.00	0.82	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	5.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	0.00
12	0.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The highest accessibility observed for the zone – 7 to 4. Some zones have 0 accessibility matrix for walking. For the Work purpose people prefer walking mode with comparison to other modes.

TABLE 5:34 ATTRACTION PROBABILITY MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00
2	0.00	0.31	0.00	0.00	0.00	0.00	0.43	0.00	0.27	0.00	0.00	0.00
3	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00
4	0.00	0.00	0.00	0.23	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.66	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.56	0.00	0.00	0.00	0.00
7	0.00	0.12	0.00	0.73	0.00	0.00	0.13	0.00	0.00	0.02	0.00	0.00
8	0.24	0.00	0.00	0.00	0.25	0.11	0.00	0.40	0.00	0.00	0.00	0.00
9	0.00	0.31	0.08	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.95	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For this matrix is highest in zone – 4 to 7 trip and lowest for the zone – 6, 10, 11, and 12. It means these wards have more or less attraction probability of the trips.

TABLE 5:35 TRIP INTERCHANGE FOR WALKING (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	1	0	0	0	0	0	0	4	0	0	0	0	**5**	**1.00**
2	0	4	0	0	0	0	5	0	3	0	0	0	**12**	**1.00**
3	0	0	3	0	0	0	0	0	2	0	0	0	**5**	**0.80**
4	0	0	0	2	0	0	7	0	0	0	0	0	**9**	**1.22**
5	0	0	0	0	2	0	0	4	0	0	0	0	**6**	**1.00**
6	0	0	0	0	0	1	0	2	0	0	0	0	**3**	**1.00**
7	0	1	0	9	0	0	2	0	0	0	0	0	**12**	**1.17**
8	4	0	0	0	4	2	0	6	0	0	0	0	**16**	**1.00**
9	0	6	1	0	0	0	0	0	11	0	0	0	**18**	**0.89**
10	0	0	0	0	0	0	0	0	0	6	0	0	**6**	**1.00**
11	0	0	0	0	0	0	0	0	0	0	8	0	**8**	**1.00**
12	0	1	0	0	0	0	0	0	0	0	0	0	**1**	**0.00**
Ai	**5**	**12**	**4**	**11**	**6**	**3**	**14**	**16**	**16**	**6**	**8**	**0**	**101**	

The interchange for walking total trips is 101 for the study area. The highest attraction probability shown in zone 8 & 9 and lowest in zone 12. And for production of trips highest in zone 9 and lowest in zone 12.

5.5.2 MODEL II: DEVELOPMENT OF SG-UTDM- USING HOUSEHOLD TRIPS FOR EDUCATION PURPOSE TRIP DISTRIBUTION

(A) TRIP DISTRIBUTION FOR TWO-WHEELER

TABLE 5:36 OBSERVED TRIP INTERCHANGE O-D MATRIX (TWO-WHEELER)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	4	0	2	0	8	0	1	0	0	0	0	1	**16**	**1.00**
2	0	4	1	1	3	1	2	1	4	0	0	0	**17**	**1.00**
3	2	1	2	1	11	7	0	0	2	0	0	0	**26**	**1.00**
4	0	1	1	2	2	3	5	0	0	1	0	4	**19**	**0.89**
5	8	3	11	1	12	11	12	4	3	9	7	9	**90**	**1.00**
6	0	1	7	3	11	25	16	0	2	15	2	4	**86**	**1.00**
7	1	2	0	4	12	15	19	0	5	2	3	0	**63**	**1.02**
8	0	1	0	0	2	1	0	1	0	0	0	0	**5**	**1.20**
9	0	4	2	0	4	2	4	0	6	0	1	0	**23**	**1.00**
10	0	0	0	1	9	15	2	0	0	6	5	0	**38**	**1.00**
11	0	0	0	0	7	2	3	0	1	5	2	0	**20**	**1.00**
12	1	0	0	4	9	4	0	0	0	0	0	8	**26**	**1.00**
Ai	**16**	**17**	**26**	**17**	**90**	**86**	**64**	**6**	**23**	**38**	**20**	**26**	**429**	

The total 429 trips are generate using two-wheeler. The most trips are generated from the zone – 5 and lowest in zone – 8.

TABLE 5:37 ACCESSIBILITY MATRIX FOR TWO-WHEELERS

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.53	0.00	0.28	0.00	0.20	0.00	0.09	0.00	0.00	0.00	0.00	0.02
2	0.00	0.46	0.71	0.02	0.02	0.02	0.12	0.09	0.05	0.00	0.00	0.00
3	0.28	0.71	0.27	0.02	0.03	0.01	0.00	0.00	0.09	0.00	0.00	0.00
4	0.00	0.02	0.02	1.00	0.12	0.03	0.02	0.00	0.00	0.02	0.00	0.16
5	0.20	0.02	0.03	0.07	0.32	0.04	0.08	0.06	0.03	0.02	0.03	0.01
6	0.00	0.02	0.01	0.03	0.04	0.02	0.07	0.00	0.04	0.04	0.03	0.01
7	0.09	0.12	0.00	0.02	0.08	0.07	0.07	0.00	0.02	0.04	0.03	0.00
8	0.00	0.09	0.00	0.00	0.49	0.01	0.00	0.27	0.00	0.00	0.00	0.00
9	0.00	0.05	0.09	0.00	0.03	0.03	0.03	0.00	0.12	0.00	0.01	0.00
10	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.00	0.00	0.38	0.19	0.00
11	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.00	0.01	0.19	0.03	0.00
12	0.02	0.00	0.00	0.16	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.05

The highest accessibility observed for the zone – 4 to 4. Some zones have 0 accessibility matrix for two-wheeler.

TABLE 5:38 ATTRACTION PROBABILITY MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.35	0.00	0.18	0.00	0.28	0.00	0.14	0.00	0.00	0.00	0.00	0.05
2	0.00	0.13	0.47	0.00	0.03	0.07	0.19	0.06	0.04	0.00	0.00	0.00
3	0.11	0.32	0.28	0.01	0.07	0.09	0.00	0.00	0.12	0.00	0.00	0.00
4	0.00	0.00	0.02	0.29	0.18	0.13	0.03	0.00	0.00	0.01	0.00	0.33
5	0.05	0.01	0.02	0.02	0.47	0.16	0.13	0.04	0.02	0.02	0.03	0.02
6	0.00	0.02	0.03	0.03	0.16	0.18	0.30	0.00	0.09	0.09	0.07	0.04
7	0.04	0.06	0.00	0.01	0.19	0.41	0.19	0.00	0.03	0.06	0.03	0.00
8	0.00	0.03	0.00	0.00	0.75	0.03	0.00	0.20	0.00	0.00	0.00	0.00
9	0.00	0.04	0.15	0.00	0.10	0.29	0.12	0.00	0.28	0.00	0.02	0.00
10	0.00	0.00	0.00	0.01	0.05	0.20	0.10	0.00	0.00	0.45	0.20	0.00
11	0.00	0.00	0.00	0.00	0.12	0.32	0.10	0.00	0.02	0.38	0.06	0.00
12	0.03	0.00	0.00	0.23	0.07	0.16	0.00	0.00	0.00	0.00	0.00	0.51

For this matrix is highest in zone – 5 to 5 trip and lowest for the zone – 1, 4, 8, and 11. It means these wards have more or less attraction probability of the trips.

TABLE 5:39 TRIP INTERCHANGE FOR TWO-WHEELER (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	6	0	3	0	4	0	2	0	0	0	0	1	**16**	**1.00**
2	0	2	8	0	0	1	3	1	1	0	0	0	**17**	**1.00**
3	3	8	7	0	2	2	0	0	3	0	0	0	**26**	**1.00**
4	0	0	0	5	4	3	1	0	0	0	0	6	**19**	**0.89**
5	5	0	2	2	43	14	12	4	2	2	2	2	**90**	**1.00**
6	0	1	2	2	14	15	26	0	8	7	6	4	**86**	**1.00**
7	2	4	0	0	12	26	12	0	2	4	2	0	**63**	**1.02**
8	0	0	0	0	4	0	0	1	0	0	0	0	**5**	**1.20**
9	0	1	4	0	2	7	3	0	6	0	0	0	**23**	**1.00**
10	0	0	0	0	2	7	4	0	0	17	8	0	**38**	**1.00**
11	0	0	0	0	2	6	2	0	0	8	1	0	**20**	**1.00**
12	1	0	0	6	2	4	0	0	0	0	0	13	**26**	**1.00**
Ai	**16**	**17**	**26**	**17**	**90**	**86**	**64**	**6**	**23**	**38**	**20**	**26**	**429**	

The interchange for two-wheeler total trips is 429 for the study area. The highest attraction probability shown in zone 5 and lowest in zone 8. And for production of trips highest in zone 5 and lowest in zone 8.

(B) TRIP DISTRIBUTION FOR AUTO

TABLE 5:40 OBSERVED TRIP INTERCHANGE O-D MATRIX (AUTO)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	2	4	0	1	0	1	1	4	0	0	0	**13**	**1.00**
3	0	4	10	0	0	1	0	0	1	0	0	0	**16**	**1.00**
4	0	0	0	0	1	0	0	0	0	0	0	2	**3**	**1.00**
5	0	1	0	1	0	1	2	0	0	2	0	0	**7**	**1.00**
6	0	0	1	0	1	4	3	1	2	0	0	0	**12**	**1.00**
7	0	1	0	0	2	3	2	0	1	0	0	0	**9**	**1.00**
8	0	1	0	0	0	1	0	0	0	0	0	0	**2**	**1.00**
9	0	4	1	0	0	2	1	0	0	0	0	0	**8**	**1.00**
10	0	0	0	0	2	0	0	0	0	2	0	0	**4**	**1.00**
11	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
12	0	0	0	2	0	0	0	0	0	0	0	0	**2**	**1.00**
Ai	**0**	**13**	**16**	**3**	**7**	**12**	**9**	**2**	**8**	**4**	**0**	**2**	**76**	

The total 76 trips are generate using auto. The most trips are generated from the zone – 3 and lowest in zone – 1 & 11.

TABLE 5:41 ACCESSIBILITY MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.77	0.38	0.00	0.05	0.00	0.05	0.08	0.14	0.00	0.00	0.00
3	0.00	0.38	0.18	0.00	0.00	0.03	0.00	0.00	0.21	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.38
5	0.00	0.05	0.00	0.14	0.00	0.38	0.13	0.00	0.00	0.10	0.00	0.00
6	0.00	0.00	0.03	0.00	0.38	0.07	0.13	0.62	0.05	0.00	0.00	0.00
7	0.00	0.05	0.00	0.00	0.13	0.13	0.14	0.00	0.02	0.00	0.00	0.00
8	0.00	0.08	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.14	0.21	0.00	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.21	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The highest accessibility observed for the zone – 2 to 2. Some zones have 0 accessibility matrix for auto.

TABLE 5:42 ATTRACTION PROBABILITY MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.40	0.40	0.00	0.02	0.00	0.05	0.01	0.12	0.00	0.00	0.00
3	0.00	0.33	0.32	0.00	0.00	0.05	0.00	0.00	0.31	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.64
5	0.00	0.04	0.00	0.09	0.00	0.57	0.21	0.00	0.00	0.08	0.00	0.00
6	0.00	0.00	0.08	0.00	0.29	0.12	0.25	0.16	0.09	0.00	0.00	0.00
7	0.00	0.09	0.00	0.00	0.14	0.33	0.39	0.00	0.06	0.00	0.00	0.00
8	0.00	0.08	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.21	0.64	0.00	0.00	0.11	0.05	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.79	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For this matrix is highest in zone – 9 to 3 trips. The zones 1, 10 and 11 has no trips for auto mode. It means these wards have more or less attraction probability of the trips.

TABLE 5:43 TRIP INTERCHANGE FOR AUTO (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	5	5	0	0	0	1	0	2	0	0	0	**13**	**1.00**
3	0	5	5	0	0	1	0	0	5	0	0	0	**16**	**1.00**
4	0	0	0	0	1	0	0	0	0	0	0	2	**3**	**1.00**
5	0	0	0	1	0	4	1	0	0	1	0	0	**7**	**1.00**
6	0	0	1	0	3	1	3	2	1	0	0	0	**12**	**1.00**
7	0	1	0	0	1	3	3	0	1	0	0	0	**9**	**1.00**
8	0	0	0	0	0	2	0	0	0	0	0	0	**2**	**1.00**
9	0	2	5	0	0	1	0	0	0	0	0	0	**8**	**1.00**
10	0	0	0	0	1	0	0	0	0	3	0	0	**4**	**1.00**
11	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
12	0	0	0	2	0	0	0	0	0	0	0	0	**2**	**1.00**
Ai	**0**	**13**	**16**	**3**	**7**	**12**	**9**	**2**	**8**	**4**	**0**	**2**	**76**	

The interchange for auto total trips is 76 for the study area. The highest attraction probability shown in zone 3 and lowest in zone 1 & 11. And for production of trips highest in zone 3 and lowest in zone 1 & 11.

(C) TRIP DISTRIBUTION FOR BUS

TABLE 5:44 OBSERVED TRIP INTERCHANGE O-D MATRIX (BUS)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	1	1	0	0	0	2	0	**4**	**1.25**
3	0	1	0	0	1	7	0	0	0	0	0	0	**9**	**0.89**
4	0	0	0	0	1	2	1	0	0	0	0	0	**4**	**1.00**
5	0	0	1	1	0	0	1	0	0	3	0	1	**7**	**1.00**
6	0	1	7	2	0	4	1	0	2	0	0	2	**19**	**1.00**
7	0	1	0	1	1	1	2	1	0	0	0	1	**8**	**1.00**
8	0	0	0	0	0	0	1	0	0	0	0	0	**1**	**1.00**
9	0	0	0	0	0	2	0	0	0	0	0	0	**2**	**1.00**
10	0	0	0	0	3	0	0	0	0	4	1	0	**8**	**1.00**
11	0	2	0	0	0	0	0	0	0	1	0	0	**3**	**1.00**
12	0	0	0	0	1	2	1	0	0	0	0	0	**4**	**1.00**
Ai	**0**	**5**	**8**	**4**	**7**	**19**	**8**	**1**	**2**	**8**	**3**	**4**	**69**	

The total 69 trips are generate using bus. The most trips are generated from the zone – 6 and lowest in zone – 1.

TABLE 5:45 ACCESSIBILITY MATRIX FOR BUS

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.00	0.00	0.00	0.08	0.00
3	0.00	0.10	0.00	0.00	0.14	0.08	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.14	0.04	0.10	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.14	0.14	0.00	0.00	0.20	0.00	0.00	0.13	0.00	0.12
6	0.00	0.13	0.08	0.04	0.00	0.80	0.03	0.00	0.10	0.00	0.00	0.11
7	0.00	0.13	0.00	0.10	0.20	0.03	2.00	0.43	0.00	0.00	0.00	0.08
8	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.10	0.40	0.00
11	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00
12	0.00	0.00	0.00	0.00	0.12	0.11	0.08	0.00	0.00	0.00	0.00	0.00

The highest accessibility observed for the zone – 7 to 7. Some zones have 0 accessibility matrix for bus. Zone 1 and 11 has no trips for educational purpose using the Bus. And lowest trips observed in zone 6.

TABLE 5:46 ATTRACTION PROBABILITY MATRIX FOR BUS

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.64	0.26	0.00	0.00	0.00	0.09	0.00
3	0.00	0.36	0.00	0.00	0.28	0.36	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.44	0.29	0.28	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.46	0.22	0.00	0.00	0.05	0.00	0.00	0.12	0.00	0.14
6	0.00	0.06	0.22	0.06	0.00	0.44	0.01	0.00	0.10	0.00	0.00	0.11
7	0.00	0.06	0.00	0.15	0.06	0.02	0.50	0.13	0.00	0.00	0.00	0.09
8	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.48	0.32	0.00
11	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.00
12	0.00	0.00	0.00	0.00	0.27	0.56	0.17	0.00	0.00	0.00	0.00	0.00

For this matrix is highest in zone – 8 to 7 and zone – 9 to 6 trip and lowest for the zone – 1, 3, 9, and 11. It means these wards have more or less attraction probability of the trips.

TABLE 5:47 TRIP INTERCHANGE FOR BUS (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	3	1	0	0	0	0	0	**4**	**1.25**
3	0	3	0	0	3	3	0	0	0	0	0	0	**9**	**0.78**
4	0	0	0	0	2	1	1	0	0	0	0	0	**4**	**1.00**
5	0	0	3	2	0	0	0	0	0	1	0	1	**7**	**1.00**
6	0	1	4	1	0	8	0	0	2	0	0	2	**19**	**1.05**
7	0	1	0	1	0	0	4	1	0	0	0	1	**8**	**1.00**
8	0	0	0	0	0	0	1	0	0	0	0	0	**1**	**1.00**
9	0	0	0	0	0	2	0	0	0	0	0	0	**2**	**1.00**
10	0	0	0	0	2	0	0	0	0	4	3	0	**8**	**0.88**
11	0	0	0	0	0	0	0	0	0	3	0	0	**3**	**1.00**
12	0	0	0	0	1	2	1	0	0	0	0	0	**4**	**1.00**
Ai	**0**	**5**	**7**	**4**	**7**	**20**	**8**	**1**	**2**	**7**	**3**	**4**	**69**	

The interchange for bus total trips is 69 for the study area. The highest attraction probability shown in zone 6 and lowest in zone 1. And for production of trips highest in zone 6 and lowest in zone 1.

(D) TRIP DISTRIBUTION FOR BICYCLE

TABLE 5:48 OBSERVED TRIP INTERCHANGE O-D MATRIX (BICYCLE)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	0	0	0	0	0	0	0	0	4	0	0	0	**4**	**1.00**
4	0	0	0	22	1	0	0	0	0	0	0	1	**24**	**1.00**
5	0	0	0	1	0	0	1	0	0	0	0	1	**3**	**0.67**
6	0	0	0	0	0	2	0	1	0	0	0	0	**3**	**1.00**
7	0	0	0	0	1	0	4	1	1	0	0	0	**7**	**1.00**
8	0	0	0	0	0	1	1	0	0	0	0	0	**2**	**1.00**
9	0	0	4	0	0	0	1	0	20	0	0	0	**25**	**1.00**
10	0	0	0	0	0	0	0	0	0	18	6	0	**24**	**1.00**
11	0	0	0	0	0	0	0	0	0	6	2	0	**8**	**1.00**
12	0	0	0	1	0	0	0	0	0	0	0	18	**19**	**1.05**
Ai	**0**	**0**	**4**	**24**	**2**	**3**	**7**	**2**	**25**	**24**	**8**	**20**	**119**	

The total 119 trips are generate using bicycle. The most trips are generated from the zone – 9 and lowest in zone – 1 & 2.

TABLE 5:49 ACCESSIBILITY MATRIX FOR BICYCLE

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00
4	0.00	0.00	0.00	0.45	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.33
5	0.00	0.00	0.00	0.22	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	1.00	0.00	4.24	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.10	0.00	0.38	0.12	0.27	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	4.24	0.12	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.35	0.00	0.00	0.00	0.27	0.00	0.99	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.48	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.39	0.00
12	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29

The highest accessibility observed for the zone – 8 to 6 with vies versa. Some zones have 0 accessibility matrix for bicycle. People using more Bicycle for the Educational purpose, so the accessibility and attraction probability get high.

TABLE 5:50 ATTRACTION PROBABILITY MATRIX FOR BICYCLE

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.50	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.43
5	0.00	0.00	0.00	0.79	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.63	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.05	0.00	0.45	0.02	0.49	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.92	0.08	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.16	0.00	0.00	0.00	0.12	0.00	0.71	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.27	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.18	0.00
12	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50

For this matrix is highest in zone – 8 to 6 trip and lowest for the zone – 1, 2, and 11. It means these wards have more or less attraction probability of the trips.

TABLE 5:51 TRIP INTERCHANGE FOR BICYCLE (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	0	0	0	0	0	0	0	0	4	0	0	0	**4**	**1.00**
4	0	0	0	12	2	0	0	0	0	0	0	10	**24**	**1.00**
5	0	0	0	2	0	0	1	0	0	0	0	0	**3**	**0.67**
6	0	0	0	0	0	1	0	2	0	0	0	0	**3**	**1.00**
7	0	0	0	0	0	0	3	0	3	0	0	0	**7**	**1.00**
8	0	0	0	0	0	2	0	0	0	0	0	0	**2**	**1.00**
9	0	0	4	0	0	0	3	0	18	0	0	0	**25**	**1.00**
10	0	0	0	0	0	0	0	0	0	17	7	0	**24**	**1.00**
11	0	0	0	0	0	0	0	0	0	7	1	0	**8**	**1.00**
12	0	0	0	9	0	0	0	0	0	0	0	10	**19**	**1.05**
Ai	**0**	**0**	**4**	**24**	**2**	**3**	**7**	**2**	**25**	**24**	**8**	**20**	**119**	

The interchange for bicycle total trips is 119 for the study area. The highest attraction probability shown in zone 9 and lowest in zone 1 & 2. And for production of trips highest in zone 9 and lowest in zone 1 & 2.

(E) TRIP DISTRIBUTION FOR WALKING

TABLE 5:52 OBSERVED TRIP INTERCHANGE O-D MATRIX (WALKING)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	4	0	0	0	0	0	0	1	0	0	0	0	**5**	**1.00**
2	0	6	1	0	0	0	8	0	4	0	0	0	**19**	**1.00**
3	0	1	0	0	0	0	0	0	0	0	0	0	**1**	**1.00**
4	0	0	0	2	0	0	0	0	0	0	0	0	**2**	**1.00**
5	0	0	0	0	0	0	2	0	0	0	0	0	**2**	**1.00**
6	0	0	0	0	0	0	4	2	0	0	0	0	**6**	**1.00**
7	0	8	0	0	2	4	5	0	0	0	1	0	**20**	**0.95**
8	1	0	0	0	0	2	0	20	0	0	0	0	**23**	**1.00**
9	0	4	0	0	0	0	0	0	0	0	0	0	**4**	**1.00**
10	0	0	0	0	0	0	0	0	0	0	2	0	**2**	**1.00**
11	0	0	0	0	0	0	0	0	0	2	36	0	**38**	**1.03**
12	0	0	0	0	0	0	0	0	0	0	0	10	**10**	**1.00**
Ai	**5**	**19**	**1**	**2**	**2**	**6**	**19**	**23**	**4**	**2**	**39**	**10**	**132**	

The total 132 trips are generate using walking. The most trips are generated from the zone – 11 and lowest in zone – 3.

TABLE 5:53 ACCESSIBILITY MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.76	0.00	0.00	0.00	0.00	0.00	0.00	1.40	0.00	0.00	0.00	0.00
2	0.00	1.32	1.00	0.00	0.00	0.00	1.54	0.00	2.02	0.00	0.00	0.00
3	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	1.80	2.83	0.00	0.00	0.00	0.00
7	0.00	1.54	0.00	0.00	0.49	1.80	0.63	0.00	0.00	0.00	0.00	0.00
8	1.40	0.00	0.00	0.00	0.00	2.83	0.00	1.67	0.00	0.00	0.00	0.00
9	0.00	2.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.71	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	1.40	0.00	0.00	1.71	3.55	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40

The highest accessibility observed for the zone – 8 to 6. Some zones have 0 accessibility matrix for walking.

TABLE 5:54 ATTRACTION PROBABILITY MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.00	0.00	0.00	0.00
2	0.00	0.30	0.06	0.00	0.00	0.00	0.42	0.00	0.23	0.00	0.00	0.00
3	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.71	0.00	0.00	0.00	0.00
7	0.00	0.50	0.00	0.00	0.11	0.15	0.24	0.00	0.00	0.00	0.00	0.00
8	0.19	0.00	0.00	0.00	0.00	0.15	0.00	0.66	0.00	0.00	0.00	0.00
9	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.05	0.87	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

For this matrix is highest in zone – 10 to 11 trip and lowest for the zone – 2, 4, 5, and 12. It means these wards have more or less attraction probability of the trips.

TABLE 5:55 TRIP INTERCHANGE FOR WALKING (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	1	0	0	0	0	0	0	4	0	0	0	0	**5**	**1.00**
2	0	6	1	0	0	0	8	0	4	0	0	0	**19**	**1.11**
3	0	1	0	0	0	0	0	0	0	0	0	0	**1**	**1.00**
4	0	0	0	2	0	0	0	0	0	0	0	0	**2**	**1.00**
5	0	0	0	0	0	0	2	0	0	0	0	0	**2**	**1.00**
6	0	0	0	0	0	0	2	4	0	0	0	0	**6**	**1.00**
7	0	10	0	0	2	3	5	0	0	0	0	0	**20**	**1.00**
8	4	0	0	0	0	3	0	15	0	0	0	0	**23**	**1.04**
9	0	4	0	0	0	0	0	0	0	0	0	0	**4**	**1.00**
10	0	0	0	0	0	0	0	0	0	0	2	0	**2**	**1.00**
11	0	0	0	0	0	0	3	0	0	2	33	0	**38**	**0.92**
12	0	0	0	0	0	0	0	0	0	0	0	10	**10**	**1.00**
Ai	**5**	**21**	**1**	**2**	**2**	**6**	**20**	**24**	**4**	**2**	**35**	**10**	**132**	

The interchange for walking total trips is 132 for the study area. The highest attraction probability shown in zone 11 and lowest in zone 3. And for production of trips highest in zone 11 and lowest in zone 3.

(F) TRIP DISTRIBUTION FOR VANPOOL

TABLE 5:56 OBSERVED TRIP INTERCHANGE O-D MATRIX (VANPOOL)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	3	0	0	0	0	0	0	0	0	0	**3**	**1.00**
2	0	2	0	0	0	0	3	2	1	1	0	1	**10**	**1.00**
3	3	0	6	0	0	0	2	0	5	0	0	0	**16**	**1.00**
4	0	0	0	12	4	3	0	1	1	1	0	15	**37**	**1.02**
5	0	0	0	5	6	1	3	4	0	1	1	0	**21**	**0.95**
6	0	0	0	3	1	41	0	0	1	3	1	5	**55**	**1.00**
7	0	3	2	0	3	0	39	1	2	1	0	0	**51**	**1.00**
8	0	2	0	1	4	0	1	2	0	1	0	1	**12**	**1.00**
9	0	1	5	1	0	1	2	0	12	3	0	0	**25**	**1.00**
10	0	2	0	1	1	3	1	1	3	44	8	0	**64**	**0.98**
11	0	0	0	0	1	1	0	0	0	8	18	0	**28**	**1.00**
12	0	0	0	15	0	5	0	1	0	0	0	21	**42**	**1.02**
Ai	**3**	**10**	**16**	**38**	**20**	**55**	**51**	**12**	**25**	**63**	**28**	**43**	**364**	

The total 364 trips are generate using vanpool. The most trips are generated from the zone – 10 and lowest in zone – 1.

TABLE 5:57 ACCESSIBILITY MATRIX FOR VANPOOL

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.25	0.00	0.00	0.00	0.00	0.09	0.25	0.02	0.25	0.00	0.03
3	0.10	0.00	0.06	0.00	0.00	0.00	0.08	0.00	0.07	0.00	0.00	0.00
4	0.00	0.00	0.00	0.17	0.10	0.03	0.00	0.01	0.04	0.05	0.00	0.10
5	0.00	0.00	0.00	0.11	0.66	0.05	0.05	0.09	0.00	0.02	0.02	0.00
6	0.00	0.00	0.00	0.03	0.05	0.03	0.00	0.00	0.02	0.04	1.23	0.02
7	0.00	0.09	0.08	0.00	0.05	0.00	0.06	0.03	0.04	0.02	0.00	0.00
8	0.00	0.25	0.00	0.01	0.09	0.00	0.03	0.04	0.00	0.01	0.00	0.00
9	0.00	0.02	0.07	0.04	0.00	0.02	0.04	0.00	0.15	0.02	0.00	0.00
10	0.00	0.06	0.00	0.05	0.02	0.04	0.02	0.01	0.02	0.06	0.04	0.00
11	0.00	0.00	0.00	0.00	0.02	1.23	0.00	0.00	0.00	0.04	1.00	0.00
12	0.00	0.00	0.00	0.10	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.05

The highest accessibility observed for the zone – 6 to 11. Some zones have 0 accessibility matrix for vanpool.

TABLE 5:58 ATTRACTION PROBABILITY MATRIX FOR VANPOOL

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.05	0.00	0.00	0.00	0.00	0.16	0.18	0.02	0.53	0.00	0.06
3	0.17	0.00	0.11	0.00	0.00	0.00	0.53	0.00	0.18	0.00	0.00	0.00
4	0.00	0.00	0.00	0.21	0.06	0.08	0.00	0.01	0.05	0.18	0.00	0.40
5	0.00	0.00	0.00	0.14	0.41	0.13	0.14	0.11	0.00	0.06	0.00	0.00
6	0.00	0.00	0.00	0.05	0.04	0.11	0.00	0.00	0.03	0.20	0.49	0.10
7	0.00	0.06	0.15	0.00	0.06	0.00	0.39	0.07	0.10	0.16	0.00	0.00
8	0.00	0.25	0.00	0.04	0.18	0.00	0.26	0.15	0.00	0.11	0.00	0.02
9	0.00	0.01	0.10	0.08	0.00	0.07	0.21	0.00	0.37	0.14	0.00	0.00
10	0.00	0.04	0.00	0.12	0.02	0.21	0.12	0.02	0.05	0.40	0.02	0.00
11	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00	0.04	0.09	0.00
12	0.00	0.00	0.00	0.34	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.52

For this matrix is highest in zone – 1 to 3 trip and lowest for the zone – 1,11, and 12. It means these wards have more or less attraction probability of the trips.

TABLE 5:59 TRIP INTERCHANGE FOR VANPOOL (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	3	0	0	0	0	0	0	0	0	0	**3**	**1.00**
2	0	0	0	0	0	0	2	2	0	5	0	1	**10**	**1.00**
3	3	0	2	0	0	0	9	0	3	0	0	0	**16**	**0.94**
4	0	0	0	8	2	3	0	0	2	7	0	15	**37**	**1.03**
5	0	0	0	3	9	3	3	2	0	1	0	0	**21**	**0.95**
6	0	0	0	3	2	6	0	0	1	11	27	5	**55**	**1.04**
7	0	3	8	0	3	0	20	4	5	8	0	0	**51**	**0.96**
8	0	3	0	0	2	0	3	2	0	1	0	0	**12**	**1.00**
9	0	0	3	2	0	2	5	0	9	4	0	0	**25**	**0.96**
10	0	3	0	7	1	13	8	1	3	25	2	0	**64**	**0.98**
11	0	0	0	0	0	24	0	0	0	1	2	0	**28**	**1.11**
12	0	0	0	14	0	6	0	0	0	0	0	22	**42**	**1.02**
Ai	**3**	**10**	**15**	**38**	**20**	**57**	**49**	**12**	**24**	**63**	**31**	**43**	**364**	

The interchange for vanpool total trips is 364 for the study area. The highest attraction probability shown in zone 10 and lowest in zone 1. And for production of trips highest in zone 10 and lowest in zone 1.

5.5.3 MODEL III: DEVELOPMENT OF SG-UTDM- USING HOUSEHOLD TRIPS FOR SHOPPING PURPOSE TRIP DISTRIBUTION

(A) TRIP DISTRIBUTION FOR TWO-WHEELER

TABLE 5:60 OBSERVED TRIP INTERCHANGE O-D MATRIX (TWO-WHEELER)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	10	0	1	1	2	1	0	0	5	0	0	1	**21**	**1.05**
2	0	10	0	0	0	0	0	0	0	0	0	0	**10**	**1.00**
3	1	0	0	0	0	0	0	0	1	0	0	0	**2**	**1.00**
4	1	0	0	6	1	1	3	0	0	0	2	3	**17**	**1.00**
5	2	0	0	1	13	0	1	1	0	3	1	0	**22**	**1.14**
6	1	0	0	1	0	10	0	2	0	1	4	0	**19**	**1.00**
7	0	0	0	3	1	0	16	5	1	5	1	0	**32**	**0.97**
8	0	0	0	0	2	2	4	0	0	0	0	0	**8**	**1.00**
9	5	0	1	0	0	0	1	0	6	0	0	0	**13**	**1.00**
10	0	0	0	0	3	1	5	0	0	13	3	1	**26**	**1.00**
11	0	0	0	2	3	4	1	0	0	3	6	0	**19**	**0.89**
12	2	0	0	3	0	0	0	0	0	1	0	4	**10**	**0.90**
Ai	**22**	**10**	**2**	**17**	**25**	**19**	**31**	**8**	**13**	**26**	**17**	**9**	**199**	

The total 199 trips are generate using two-wheeler. The most trips are generated from the zone – 7 and lowest in zone – 3.

TABLE 5:61 ACCESSIBILITY MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.07	0.00	5.36	0.07	0.31	0.17	0.00	0.00	0.08	0.00	0.00	0.06
2	0.00	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	5.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00
4	0.07	0.00	0.00	0.52	0.04	0.04	0.13	0.00	0.00	0.00	0.03	0.21
5	0.31	0.00	0.00	0.04	0.47	0.00	0.02	0.23	0.00	0.06	0.04	0.00
6	0.17	0.00	0.00	0.04	0.00	0.35	0.00	0.36	0.00	0.11	0.27	0.00
7	0.00	0.00	0.00	0.13	0.02	0.00	0.35	0.40	0.04	0.21	0.04	0.00
8	0.00	0.00	0.00	0.00	0.12	0.36	0.38	0.00	0.00	0.00	0.00	0.00
9	0.08	0.00	0.17	0.00	0.00	0.00	0.04	0.00	0.63	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.06	0.11	0.11	0.00	0.00	0.33	0.11	0.02
11	0.00	0.00	0.00	0.03	0.05	0.27	0.04	0.00	0.00	0.11	1.94	0.00
12	0.04	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.02	0.00	1.58

The highest accessibility observed for the zone – 3 to 1 and vice versa. Some zones have 0 accessibility matrix for two-wheeler.

TABLE 5:62 ATTRACTION PROBABILITY MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.48	0.00	0.09	0.03	0.25	0.09	0.00	0.00	0.04	0.00	0.00	0.01
2	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
4	0.06	0.00	0.00	0.50	0.07	0.05	0.22	0.00	0.00	0.00	0.01	0.09
5	0.21	0.00	0.00	0.03	0.58	0.00	0.03	0.07	0.00	0.06	0.02	0.00
6	0.15	0.00	0.00	0.04	0.00	0.38	0.00	0.14	0.00	0.15	0.14	0.00
7	0.00	0.00	0.00	0.10	0.03	0.00	0.47	0.12	0.03	0.23	0.02	0.00
8	0.00	0.00	0.00	0.00	0.16	0.32	0.52	0.00	0.00	0.00	0.00	0.00
9	0.09	0.00	0.01	0.00	0.00	0.00	0.10	0.00	0.80	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.11	0.13	0.20	0.00	0.00	0.49	0.06	0.01
11	0.00	0.00	0.00	0.01	0.05	0.18	0.04	0.00	0.00	0.09	0.63	0.00
12	0.04	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.68

For this matrix is highest in zone – 1 to 3 trip and lowest for the zone – 2, 3, and 12. It means these wards have more or less attraction probability of the trips.

TABLE 5:63 TRIP INTERCHANGE FOR TWO-WHEELER (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	10	0	2	1	5	2	0	0	1	0	0	0	**21**	**1.05**
2	0	10	0	0	0	0	0	0	0	0	0	0	**10**	**1.00**
3	2	0	0	0	0	0	0	0	0	0	0	0	**2**	**1.00**
4	1	0	0	8	1	1	4	0	0	0	0	2	**17**	**1.00**
5	5	0	0	1	13	0	1	1	0	1	0	0	**22**	**1.14**
6	3	0	0	1	0	7	0	3	0	3	3	0	**19**	**1.00**
7	0	0	0	3	1	0	15	4	1	7	1	0	**32**	**0.97**
8	0	0	0	0	1	3	4	0	0	0	0	0	**8**	**1.00**
9	1	0	0	0	0	0	1	0	10	0	0	0	**13**	**0.92**
10	0	0	0	0	3	3	5	0	0	13	2	0	**26**	**1.00**
11	0	0	0	0	1	3	1	0	0	2	12	0	**19**	**0.89**
12	0	0	0	3	0	0	0	0	0	0	0	7	**10**	**0.90**
Ai	**22**	**10**	**2**	**17**	**25**	**19**	**31**	**8**	**12**	**26**	**17**	**9**	**199**	

The interchange for two-wheeler total trips is 199 for the study area. The highest attraction probability shown in zone 7 and lowest in zone 3. And for production of trips highest in zone 7 and lowest in zone 3.

(B) TRIP DISTRIBUTION FOR AUTO

TABLE 5:64 OBSERVED TRIP INTERCHANGE O-D MATRIX (AUTO)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	1	0	4	0	0	0	0	0	0	0	**5**	**1.00**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	1	0	0	0	1	0	0	1	1	0	0	0	**4**	**1.00**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
5	4	0	1	0	0	1	0	0	0	0	0	0	**6**	**1.00**
6	0	0	0	0	1	0	2	0	0	1	1	0	**5**	**1.40**
7	0	0	0	0	0	4	7	0	0	1	0	0	**12**	**0.83**
8	0	0	1	0	0	0	0	0	0	0	0	0	**1**	**1.00**
9	0	0	1	0	0	0	0	0	0	0	0	0	**1**	**1.00**
10	0	0	0	0	0	1	1	0	0	12	0	0	**14**	**1.00**
11	0	0	0	0	0	1	0	0	0	0	2	0	**3**	**1.00**
12	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
Ai	**5**	**0**	**4**	**0**	**6**	**7**	**10**	**1**	**1**	**14**	**3**	**0**	**51**	

The total 51 trips are generate using auto. The most trips are generated from the zone – 10 and lowest in zone – 2 & 4.

TABLE 5:65 ACCESSIBILITY MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.07	0.00	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.05	0.00	0.00	0.00	0.08	0.00	0.00	0.33	0.27	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.61	0.00	0.08	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.22	0.00	0.46	0.00	0.00	0.12	0.19	0.00
7	0.00	0.00	0.00	0.00	0.00	0.29	0.55	0.00	0.00	0.19	0.00	0.00
8	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.12	0.19	0.00	0.00	0.35	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	1.22	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The highest accessibility observed for the zone – 1 to 5 and vice versa. Some zones have 0 accessibility matrix for auto.

TABLE 5:66 ATTRACTION PROBABILITY MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.18	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.24	0.00	0.00	0.00	0.27	0.00	0.00	0.25	0.25	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.63	0.00	0.11	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.16	0.00	0.48	0.00	0.00	0.24	0.12	0.00
7	0.00	0.00	0.00	0.00	0.00	0.25	0.44	0.00	0.00	0.30	0.00	0.00
8	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.13	0.19	0.00	0.00	0.69	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.78	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For this matrix is highest in zone – 1 to 1 trip and lowest for the zone – 2, 4, 8, and 12. It means these wards have more or less attraction probability of the trips.

TABLE 5:67 TRIP INTERCHANGE FOR AUTO (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	1	0	4	0	0	0	0	0	0	0	**5**	**1**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
3	1	0	0	0	1	0	0	1	1	0	0	0	**4**	**1**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
5	4	0	1	0	0	2	0	0	0	0	0	0	**6**	**1**
6	0	0	0	0	1	0	2	0	0	1	1	0	**5**	**1**
7	0	0	0	0	0	3	5	0	0	4	0	0	**12**	**1**
8	0	0	1	0	0	0	0	0	0	0	0	0	**1**	**1**
9	0	0	1	0	0	0	0	0	0	0	0	0	**1**	**1**
10	0	0	0	0	0	2	3	0	0	10	0	0	**14**	**1**
11	0	0	0	0	0	1	0	0	0	0	2	0	**3**	**1**
12	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
Ai	**5**	**0**	**4**	**0**	**6**	**7**	**10**	**1**	**1**	**14**	**3**	**0**	**51**	

The interchange for auto total trips is 51 for the study area. The highest attraction probability shown in zone 10 and lowest in zone 2, 4 & 12. And for production of trips highest in zone 10 and lowest in zone 2, 4 & 12.

(C) TRIP DISTRIBUTION FOR WALKING

TABLE 5:68 OBSERVED TRIP INTERCHANGE O-D MATRIX (WALKING)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	1	0	0	0	0	**1**	**1.00**
2	0	10	0	0	0	0	0	1	4	0	0	0	**15**	**1.00**
3	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
5	0	0	0	0	4	1	0	5	0	0	0	0	**10**	**1.00**
6	0	0	0	0	1	4	0	0	0	0	0	0	**5**	**1.00**
7	0	0	0	0	0	0	18	1	1	0	0	0	**20**	**1.00**
8	1	1	0	0	5	0	1	14	0	0	0	0	**22**	**1.00**
9	0	4	0	0	0	0	1	0	0	0	0	0	**5**	**1.00**
10	0	0	0	0	0	0	0	0	0	14	0	0	**14**	**1.00**
11	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
12	0	0	0	0	0	0	0	0	0	0	0	2	**2**	**1.00**
Ai	**1**	**15**	**0**	**0**	**10**	**5**	**20**	**22**	**5**	**14**	**0**	**2**	**94**	

The total 94 trips are generate using walking. The most trips are generated from the zone – 8 and lowest in zone – 3, 4 & 11.

TABLE 5:69 ACCESSIBILITY MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00
2	0.00	1.43	0.00	0.00	0.00	0.00	0.00	2.46	3.04	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	1.75	0.06	0.00	1.25	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	3.00	2.46	19.9	0.00	0.00	0.00
8	0.71	2.46	0.00	0.00	1.25	0.00	2.46	1.38	0.00	0.00	0.00	0.00
9	0.00	3.04	0.00	0.00	0.00	0.00	19.9	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29

The highest accessibility observed for the zone – 2 to 8 and vice versa. Some zones have 0 accessibility matrix for walking.

TABLE 5:70 ATTRACTION PROBABILITY MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
2	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.52	0.06	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.53	0.04	0.00	0.43	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.30	0.70	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.31	0.22	0.00	0.00	0.00
8	0.05	0.37	0.00	0.00	0.12	0.00	0.32	0.15	0.00	0.00	0.00	0.00
9	0.00	0.15	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

For this matrix is highest in zone – 1 to 8 trip and lowest for the zone – 3, 4, 11, and 12. It means these wards have more or less attraction probability of the trips.

TABLE 5:71 TRIP INTERCHANGE FOR WALKING (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	1	0	0	0	0	**1**	**1.00**
2	0	6	0	0	0	0	0	8	1	0	0	0	**15**	**1.00**
3	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
5	0	0	0	0	5	0	0	4	0	0	0	0	**10**	**0.90**
6	0	0	0	0	2	3	0	0	0	0	0	0	**5**	**0.80**
7	0	0	0	0	0	0	9	6	4	0	0	0	**20**	**1.05**
8	1	8	0	0	3	0	7	3	0	0	0	0	**22**	**1.00**
9	0	1	0	0	0	0	4	0	0	0	0	0	**5**	**1.00**
10	0	0	0	0	0	0	0	0	0	14	0	0	**14**	**1.00**
11	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
12	0	0	0	0	0	0	0	0	0	0	0	2	**2**	**1.00**
Ai	**1**	**15**	**0**	**0**	**9**	**4**	**21**	**22**	**5**	**14**	**0**	**2**	**94**	

The interchange for walking total trips is 94 for the study area. The highest attraction probability shown in zone 8 and lowest in zone 3, 4 & 11. And for production of trips highest in zone 8 and lowest in zone 3, 4 & 11.

5.5.4 MODEL IV: DEVELOPMENT OF SG-UTDM- USING HOUSEHOLD TRIPS FOR OTHER PURPOSE TRIP DISTRIBUTION

(A) TRIP DISTRIBUTION FOR TWO-WHEELERS

TABLE 5:72 OBSERVED TRIP INTERCHANGE O-D MATRIX (TWO-WHEELER)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	1	0	3	1	1	0	0	0	1	2	**9**	**0.78**
2	0	8	2	0	0	0	3	0	4	0	0	0	**17**	**1.00**
3	1	2	0	0	0	0	0	0	2	1	0	0	**6**	**1.00**
4	0	0	0	14	2	2	1	0	0	0	0	5	**24**	**1.00**
5	3	0	0	2	2	0	6	1	0	4	0	0	**18**	**1.00**
6	1	0	0	2	0	13	4	1	2	3	1	1	**28**	**1.00**
7	1	3	0	1	6	4	24	8	2	6	9	1	**65**	**0.95**
8	0	0	0	0	1	1	8	4	0	1	2	0	**17**	**1.00**
9	0	4	2	0	0	1	2	0	11	0	0	1	**21**	**1.05**
10	0	0	1	0	4	4	6	1	0	10	9	0	**35**	**0.97**
11	1	0	0	0	0	1	6	2	0	9	2	0	**21**	**1.14**
12	0	0	0	5	0	1	1	0	1	0	0	18	**26**	**1.08**
Ai	**7**	**17**	**6**	**24**	**18**	**28**	**62**	**17**	**22**	**34**	**24**	**28**	**287**	

The total 287 trips are generate using two-wheeler. The most trips are generated from the zone – 7 and lowest in zone – 3.

TABLE 5:73 ACCESSIBILITY MATRIX FOR TWO-WHEELERS

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.29	0.00	0.72	0.14	0.07	0.00	0.00	0.00	1.49	0.02
2	0.00	0.29	0.72	0.00	0.00	0.00	0.14	0.00	0.08	0.00	0.00	0.00
3	0.29	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.14	0.00	0.00
4	0.00	0.00	0.00	0.56	0.04	0.02	0.02	0.00	0.00	0.00	0.00	0.11
5	0.72	0.00	0.00	0.04	0.29	0.00	0.08	0.35	0.00	0.05	0.00	0.00
6	0.14	0.00	0.00	0.02	0.00	0.17	0.03	0.01	0.04	0.04	0.29	0.04
7	0.07	0.14	0.00	0.02	0.08	0.03	0.16	0.48	0.02	0.06	0.03	0.01
8	0.00	0.00	0.00	0.00	0.35	0.01	0.48	1.00	0.00	0.03	0.03	0.00
9	0.00	0.08	0.11	0.00	0.00	0.01	0.02	0.00	0.03	0.00	0.00	0.06
10	0.00	0.00	0.14	0.00	0.05	0.03	0.06	0.03	0.00	0.16	0.19	0.00
11	1.49	0.00	0.00	0.00	0.00	0.29	0.02	0.02	0.00	0.19	18.1	0.00
12	0.00	0.00	0.00	0.11	0.00	0.04	0.01	0.00	0.06	0.00	0.00	0.20

The highest accessibility observed for the zone – 11 to 11 with 18.1. Some zones have 0 accessibility matrix for two-wheeler.

TABLE 5:74 ATTRACTION PROBABILITY MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.04	0.00	0.37	0.17	0.10	0.00	0.00	0.00	0.29	0.02
2	0.00	0.23	0.16	0.00	0.00	0.00	0.38	0.00	0.23	0.00	0.00	0.00
3	0.06	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.26	0.00	0.00
4	0.00	0.00	0.00	0.67	0.04	0.04	0.05	0.00	0.00	0.00	0.00	0.21
5	0.20	0.00	0.00	0.05	0.28	0.00	0.22	0.14	0.00	0.12	0.00	0.00
6	0.04	0.00	0.00	0.02	0.00	0.43	0.09	0.01	0.11	0.11	0.11	0.08
7	0.02	0.09	0.00	0.02	0.07	0.06	0.37	0.17	0.06	0.14	0.01	0.01
8	0.00	0.00	0.00	0.00	0.15	0.01	0.61	0.18	0.00	0.03	0.01	0.00
9	0.00	0.19	0.07	0.00	0.00	0.08	0.18	0.00	0.20	0.00	0.00	0.28
10	0.00	0.00	0.04	0.00	0.06	0.09	0.22	0.02	0.00	0.49	0.08	0.00
11	0.05	0.00	0.00	0.00	0.00	0.08	0.01	0.00	0.00	0.06	0.80	0.00
12	0.00	0.00	0.00	0.17	0.00	0.12	0.03	0.00	0.20	0.00	0.00	0.48

For this matrix is highest in zone – 11 to 11 trip and lowest for the zone – 3, 11, and 12. It means these wards have more or less attraction probability of the trips.

TABLE 5:75 TRIP INTERCHANGE FOR TWO-WHEELER (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/PI
1	0	0	0	0	3	2	1	0	0	0	3	0	**9**	**0.78**
2	0	4	3	0	0	0	6	0	4	0	0	0	**17**	**1.00**
3	0	3	0	0	0	0	0	0	1	2	0	0	**6**	**1.00**
4	0	0	0	16	1	1	1	0	0	0	0	5	**24**	**0.96**
5	4	0	0	1	5	0	4	2	0	2	0	0	**18**	**1.00**
6	1	0	0	1	0	12	2	0	3	3	3	2	**28**	**1.00**
7	1	6	0	1	4	4	24	11	4	9	1	1	**65**	**0.95**
8	0	0	0	0	3	0	10	3	0	1	0	0	**17**	**1.00**
9	0	4	1	0	0	2	4	0	4	0	0	6	**21**	**1.00**
10	0	0	1	0	2	3	8	1	0	17	3	0	**35**	**1.00**
11	1	0	0	0	0	2	0	0	0	1	17	0	**21**	**1.24**
12	0	0	0	4	0	3	1	0	5	0	0	12	**26**	**1.04**
Ai	**7**	**17**	**6**	**23**	**18**	**28**	**62**	**17**	**21**	**35**	**26**	**27**	**287**	

The interchange for two-wheeler total trips is 287 for the study area. The highest attraction probability shown in zone 7 and lowest in zone 3. And for production of trips highest in zone 7 and lowest in zone 3.

(B) TRIP DISTRIBUTION FOR FOUR-WHEELERS

TABLE 5:76 OBSERVED TRIP INTERCHANGE O-D MATRIX (FOUR-WHEELER)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	6	0	0	0	0	0	0	**6**	**1.00**
3	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
4	0	0	0	14	2	1	0	1	0	0	6	0	**24**	**1.13**
5	0	0	0	2	1	0	0	0	0	0	0	1	**4**	**2.50**
6	0	6	0	1	0	0	0	0	0	0	0	0	**7**	**1.00**
7	0	0	0	0	5	0	0	0	0	0	0	2	**7**	**0.00**
8	0	0	0	1	0	0	0	0	0	0	0	0	**1**	**1.00**
9	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
10	0	0	0	0	0	0	0	0	0	6	2	1	**9**	**1.22**
11	0	0	0	6	0	0	0	0	0	2	8	2	**18**	**1.00**
12	0	0	0	3	2	0	0	0	0	3	2	0	**10**	**0.60**
Ai	**0**	**6**	**0**	**27**	**10**	**7**	**0**	**1**	**0**	**11**	**18**	**6**	**86**	

The total 86 trips are generate using four-wheeler. The most trips are generated from the zone – 4 and lowest in zone – 1,3,7 & 9.

TABLE 5:77 ACCESSIBILITY MATRIX FOR FOUR-WHEELERS

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.29	0.09	0.06	0.00	0.04	0.00	0.00	0.02	0.00
5	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
6	0.00	0.31	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.01
8	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.06	0.01
11	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.06	0.12	0.02
12	0.00	0.00	0.00	0.00	0.04	0.00	0.01	0.00	0.00	0.01	0.00	0.11

The highest accessibility observed for the zone – 2 to 6 and zone 10 to 10. Some zones have 0 accessibility matrix for four-wheeler.

TABLE 5:78 ATTRACTION PROBABILITY MATRIX FOR FOUR-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.72	0.14	0.04	0.00	0.04	0.00	0.00	0.05	0.00
5	0.00	0.00	0.00	0.97	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02
6	0.00	0.74	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
8	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.32	0.00
11	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.17	0.71	0.00
12	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.14	0.00	0.13

For this matrix is highest in zone – 2 to 6 trip and lowest for the zone – 1, 3, 7, 8 and 9. It means these wards have more or less attraction probability of the trips.

TABLE 5:79 TRIP INTERCHANGE FOR FOUR-WHEELER (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/PI
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	6	0	0	0	0	0	0	**6**	**0.83**
3	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
4	0	0	0	17	3	1	0	1	0	0	1	0	**24**	**1.08**
5	0	0	0	4	0	0	0	0	0	0	0	0	**4**	**2.75**
6	0	5	0	2	0	0	0	0	0	0	0	0	**7**	**1.00**
7	0	0	0	0	0	0	0	0	0	0	0	7	**7**	**0.00**
8	0	0	0	1	0	0	0	0	0	0	0	0	**1**	**1.00**
9	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
10	0	0	0	0	0	0	0	0	0	6	3	0	**9**	**1.22**
11	0	0	0	2	0	0	0	0	0	3	13	0	**18**	**0.94**
12	0	0	0	0	7	0	0	0	0	1	0	1	**10**	**0.80**
Ai	**0**	**5**	**0**	**26**	**11**	**7**	**0**	**1**	**0**	**11**	**17**	**8**	**86**	

The interchange for four-wheeler total trips is 86 for the study area. The highest attraction probability shown in zone 4 and lowest in zone 1, 3, 7 & 9. And for production of trips highest in zone 4 and lowest in zone 1, 3 & 9.

(C) TRIP DISTRIBUTION FOR AUTO

TABLE 5:80 OBSERVED TRIP INTERCHANGE O-D MATRIX (AUTO)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	1	1	1	2	0	0	0	0	0	0	**5**	**0.60**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	1	0	0	0	0	0	0	0	0	0	0	0	**1**	**1.00**
4	1	0	0	2	0	0	0	0	0	0	0	0	**3**	**1.00**
5	1	0	0	0	1	0	0	1	0	0	0	0	**3**	**1.00**
6	0	0	0	0	0	0	1	0	0	1	0	0	**2**	**2.00**
7	0	0	0	0	0	1	2	0	0	4	0	0	**7**	**1.00**
8	0	0	0	0	1	0	0	2	0	0	0	0	**3**	**1.00**
9	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
10	0	0	0	0	0	1	4	0	0	2	3	0	**10**	**1.00**
11	0	0	0	0	0	0	0	0	0	3	0	0	**3**	**1.00**
12	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
Ai	**3**	**0**	**1**	**3**	**3**	**4**	**7**	**3**	**0**	**10**	**3**	**0**	**37**	

The total 37 trips are generate using auto. The most trips are generated from the zone – 10 and lowest in zone – 3, 9 & 12.

TABLE 5:81 ACCESSIBILITY MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.20	0.25	1.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.25	0.00	0.00	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.83	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.20	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.67	0.25	0.00	0.00	0.14	0.00	0.00
8	0.00	0.00	0.00	0.00	0.83	0.00	0.00	0.25	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.20	0.14	0.00	0.00	0.50	0.27	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The highest accessibility observed for the zone – 4 to 4. Some zones have 0 accessibility matrix for auto.

TABLE 5:82 ATTRACTION PROBABILITY MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.22	0.19	0.35	0.24	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.26	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.43	0.00	0.00	0.00	0.11	0.00	0.00	0.46	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.19	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.31	0.48	0.00	0.00	0.21	0.00	0.00
8	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.60	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.06	0.18	0.00	0.00	0.47	0.29	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For this matrix is highest in zone – 4 to 4 trip and lowest for the zone – 2, 9, 11, and 12. It means these wards have more or less attraction probability of the trips.

TABLE 5:83 TRIP INTERCHANGE FOR AUTO (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/PI
1	0	0	1	1	2	1	0	0	0	0	0	0	**5**	**0.60**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	1	0	0	0	0	0	0	0	0	0	0	0	**1**	**1.00**
4	1	0	0	2	0	0	0	0	0	0	0	0	**3**	**1.00**
5	1	0	0	0	0	0	0	1	0	0	0	0	**3**	**1.00**
6	0	0	0	0	0	0	2	0	0	0	0	0	**2**	**2.00**
7	0	0	0	0	0	2	3	0	0	1	0	0	**7**	**1.00**
8	0	0	0	0	1	0	0	2	0	0	0	0	**3**	**1.00**
9	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
10	0	0	0	0	0	1	2	0	0	5	3	0	**10**	**1.00**
11	0	0	0	0	0	0	0	0	0	3	0	0	**3**	**1.00**
12	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
Ai	**3**	**0**	**1**	**3**	**3**	**4**	**7**	**3**	**0**	**10**	**3**	**0**	**37**	

The interchange for auto total trips is 37 for the study area. The highest attraction probability shown in zone 10 and lowest in zone 2, 9 & 12. And for production of trips highest in zone 10 and lowest in zone 2, 9 & 12.

(D) TRIP DISTRIBUTION FOR WALKING

TABLE 5:84 OBSERVED TRIP INTERCHANGE O-D MATRIX (WALKING)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	7	0	0	0	0	1	0	1	0	1	0	**10**	**1.00**
3	0	0	2	0	0	0	0	0	0	0	0	0	**2**	**1.00**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
5	0	0	0	0	11	0	0	1	0	0	0	0	**12**	**1.00**
6	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
7	0	1	0	0	0	0	20	3	0	1	0	0	**25**	**1.00**
8	0	0	0	0	1	0	3	4	0	0	0	0	**8**	**1.00**
9	0	1	0	0	0	0	0	0	6	0	0	0	**7**	**1.00**
10	0	0	0	0	0	0	1	0	0	6	1	0	**8**	**1.00**
11	0	1	0	0	0	0	0	0	0	1	0	0	**2**	**1.00**
12	0	0	0	0	0	0	0	0	0	0	0	2	**2**	**1.00**
Ai	**0**	**10**	**2**	**0**	**12**	**0**	**25**	**8**	**7**	**8**	**2**	**2**	**76**	

The total 76 trips are generate using walking. The most trips are generated from the zone – 7 and lowest in zone – 1, 4, & 6.

TABLE 5:85 ACCESSIBILITY MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	2.88	0.00	0.00	0.00	0.00	2.64	0.00	2.64	0.00	9.52	0.00
3	0.00	0.00	9.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	2.04	0.00	0.00	2.64	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	2.64	0.00	0.00	0.00	0.00	1.69	1.30	0.00	5.40	0.00	0.00
8	0.00	0.00	0.00	0.00	2.64	0.00	1.30	1.07	0.00	0.00	0.00	0.00
9	0.00	2.64	0.00	0.00	0.00	0.00	0.00	0.00	1.55	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	5.40	0.00	0.00	2.25	1.00	0.00
11	0.00	9.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57

The highest accessibility observed for the zone – 2 to 11 and vice versa. Some zones have 0 accessibility matrix for walking.

TABLE 5:86 ATTRACTION PROBABILITY MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.12	0.00	0.00	0.00	0.00	0.42	0.00	0.27	0.00	0.18	0.00
3	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.62	0.00	0.00	0.38	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.17	0.00	0.00	0.00	0.00	0.43	0.10	0.00	0.30	0.00	0.00
8	0.00	0.00	0.00	0.00	0.52	0.00	0.39	0.10	0.00	0.00	0.00	0.00
9	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.08	0.02	0.00
11	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

For this matrix is highest in zone – 11 to 2 trip and lowest for the zone – 1, 4, 11, and 12. It means these wards have more or less attraction probability of the trips.

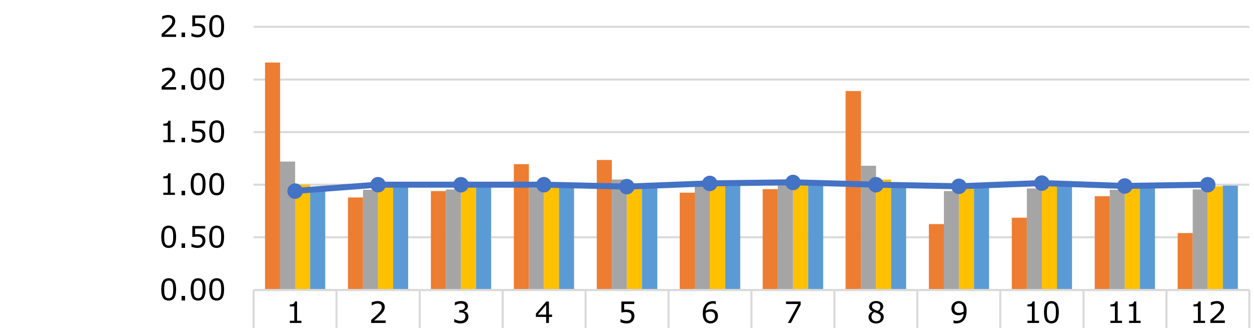
TABLE 5:87 TRIP INTERCHANGE FOR WALKING (GRAVITY MODEL OUTPUT)

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	1	0	0	0	0	4	0	3	0	2	0	**10**	**1.00**
3	0	0	2	0	0	0	0	0	0	0	0	0	**2**	**1.00**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
5	0	0	0	0	7	0	0	5	0	0	0	0	**12**	**1.00**
6	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
7	0	4	0	0	0	0	11	3	0	7	0	0	**25**	**1.00**
8	0	0	0	0	4	0	3	1	0	0	0	0	**8**	**1.00**
9	0	3	0	0	0	0	0	0	4	0	0	0	**7**	**1.00**
10	0	0	0	0	0	0	7	0	0	1	0	0	**8**	**1.00**
11	0	2	0	0	0	0	0	0	0	0	0	0	**2**	**1.00**
12	0	0	0	0	0	0	0	0	0	0	0	2	**2**	**1.00**
Ai	**0**	**10**	**2**	**0**	**12**	**0**	**25**	**8**	**7**	**8**	**2**	**2**	**76**	

The interchange for walking total trips is 76 for the study area. The highest attraction probability shown in zone 7 and lowest in zone 1, 4 & 6. And for production of trips highest in zone 7 and lowest in zone 1, 4 & 6.

5.6 COMPARATIVE ANALYSIS

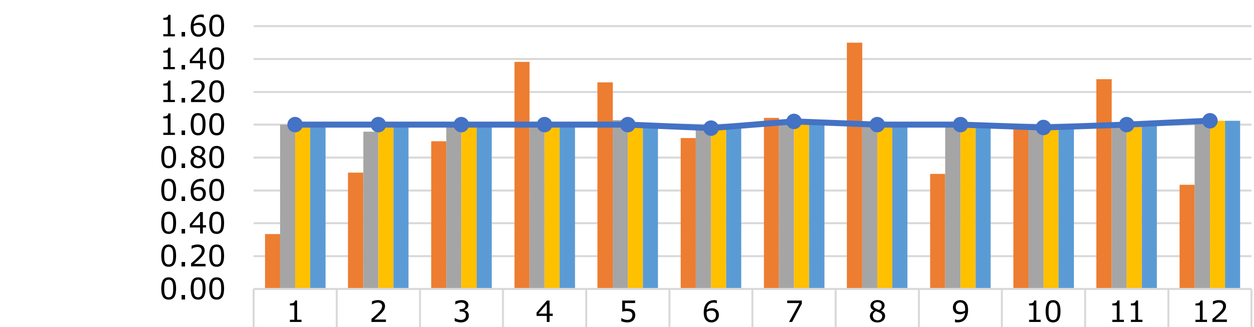
5.6.1 OBSERVED AND GRAVITY MODEL OUTPUT FOR WORK PURPOSE



	1	2	3	4	5	6	7	8	9	10	11	12
1	2.16	0.88	0.94	1.20	1.23	0.93	0.96	1.89	0.63	0.69	0.89	0.54
2	1.22	0.95	0.95	0.97	1.05	1.00	0.99	1.18	0.94	0.96	0.95	0.95
3	1.00	0.99	0.98	0.98	1.00	1.01	1.02	1.05	0.98	1.01	0.98	0.98
4	0.96	1.00	1.00	0.99	0.99	1.01	1.02	1.01	0.99	1.02	0.99	0.99
Observed	0.94	1.00	1.00	1.00	0.98	1.01	1.02	1.00	0.99	1.02	0.99	1.00

FIGURE 5:3 AI/PI RATIO FOR TWO-WHEELERS

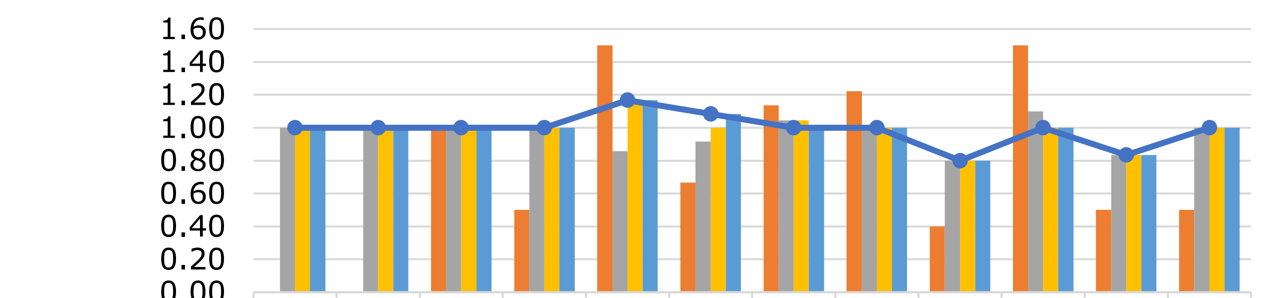
The Ai/Pi for two-wheelers for the 12 different zones, the observed ratio is same in the all zones and calculated is higher in zone – 7 and 10 and lower in zone – 1 with comparison of all other three iterations.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.33	0.71	0.90	1.38	1.26	0.92	1.04	1.50	0.70	1.00	1.28	0.63
2	1.00	0.96	1.00	1.00	1.03	0.98	1.02	1.00	1.00	1.00	1.00	1.02
3	1.00	1.00	1.00	1.00	1.00	0.98	1.02	1.00	1.00	0.98	1.00	1.02
4	1.00	1.00	1.00	1.00	1.00	0.98	1.02	1.00	1.00	0.98	1.00	1.02
Observed	1.00	1.00	1.00	1.00	1.00	0.98	1.02	1.00	1.00	0.98	1.00	1.02

FIGURE 5:4 AI/PI RATIO FOR FOUR-WHEELERS

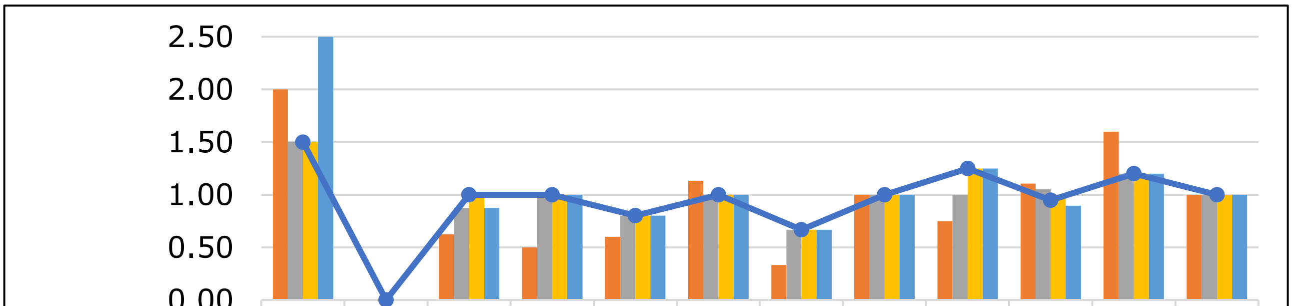
The Ai/Pi for four-wheelers for the 12 different zones, the observed ratio is same in the all zones and calculated is higher in zone – 7 and 12 and lower in zone – 6 and 10 with comparison of all other three iterations.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	1.00	0.50	1.50	0.67	1.14	1.22	0.40	1.50	0.50	0.50
2	1.00	1.00	1.00	1.00	0.86	0.92	1.05	1.00	0.80	1.10	0.83	1.00
3	1.00	1.00	1.00	1.00	1.17	1.00	1.05	1.00	0.80	1.00	0.83	1.00
4	1.00	1.00	1.00	1.00	1.17	1.08	1.00	1.00	0.80	1.00	0.83	1.00
Observed	1.00	1.00	1.00	1.00	1.17	1.08	1.00	1.00	0.80	1.00	0.83	1.00

FIGURE 5:5 AI/PI RATIO FOR AUTO

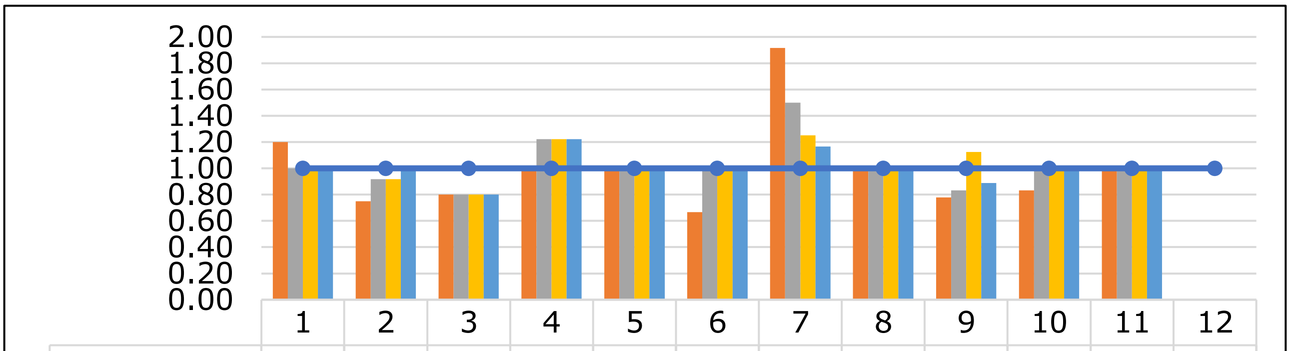
The Ai/Pi for Auto for the 12 different zones, the observed ratio is high in zone 5 and calculated is higher in zone – 5 and lower in zone – 9 with comparison of all other three iterations. Here observed and 4th iteration calculation are same.



	1	2	3	4	5	6	7	8	9	10	11	12
1	2.00	0.00	0.63	0.50	0.60	1.13	0.33	1.00	0.75	1.11	1.60	1.00
2	1.50	0.00	0.88	1.00	0.80	1.00	0.67	1.00	1.00	1.05	1.20	1.00
3	1.50	0.00	1.00	1.00	0.80	1.00	0.67	1.00	1.25	1.00	1.20	1.00
4	2.50	0.00	0.88	1.00	0.80	1.00	0.67	1.00	1.25	0.89	1.20	1.00
Observed	1.50	0.00	1.00	1.00	0.80	1.00	0.67	1.00	1.25	0.95	1.20	1.00

FIGURE 5:6 AI/PI RATIO FOR BUS

The Ai/Pi for Bus for the 12 different zones, the observed ratio is high in zone 1 and calculated is higher in zone – 1 and lower in zone – 2 with comparison of all other three iterations. Here observed and 4th iteration calculation are same.

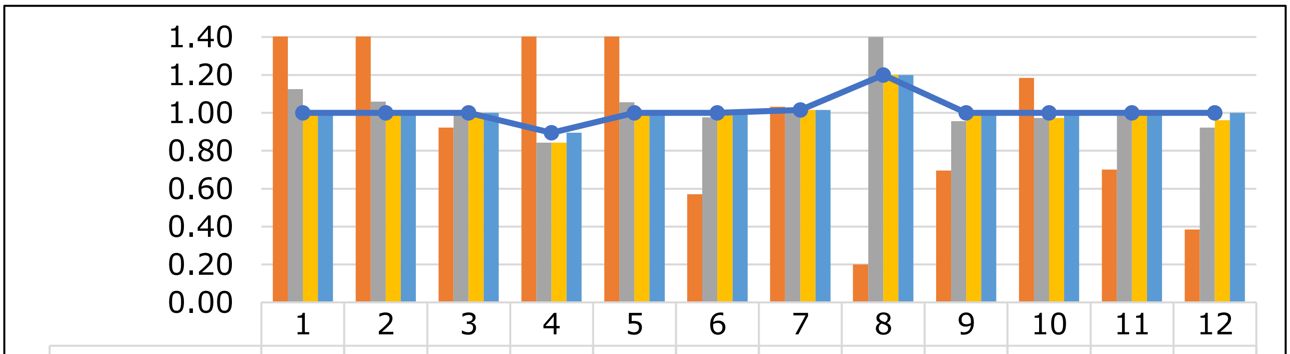


	1	2	3	4	5	6	7	8	9	10	11	12
1	1.20	0.75	0.80	1.00	1.00	0.67	1.92	1.00	0.78	0.83	1.00	0.00
2	1.00	0.92	0.80	1.22	1.00	1.00	1.50	1.00	0.83	1.00	1.00	0.00
3	1.00	0.92	0.80	1.22	1.00	1.00	1.25	1.00	1.13	1.00	1.00	0.00
4	1.00	1.00	0.80	1.22	1.00	1.00	1.17	1.00	0.89	1.00	1.00	0.00
Observed	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

FIGURE 5:7 AI/PI RATIO FOR WALKING

The Ai/Pi for walking for the 12 different zones, the observed ratio is same 1 in the all zones and calculated is higher in zone – 4 and lower in zone – 3 with comparison of all other three iterations.

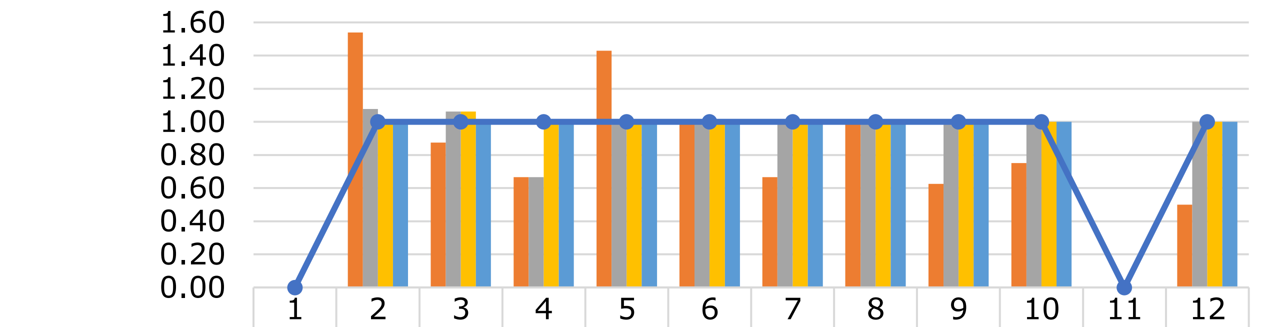
5.6.2 OBSERVED AND GRAVITY MODEL OUTPUT FOR EDUCATION PURPOSE



	1	2	3	4	5	6	7	8	9	10	11	12
1	1.44	1.41	0.92	1.47	1.46	0.57	1.03	0.20	0.70	1.18	0.70	0.38
2	1.13	1.06	1.00	0.84	1.06	0.98	1.02	1.40	0.96	0.97	1.00	0.92
3	1.00	1.00	1.00	0.84	1.01	1.00	1.02	1.20	1.00	0.97	1.00	0.96
4	1.00	1.00	1.00	0.89	1.00	1.00	1.02	1.20	1.00	1.00	1.00	1.00
Observed	1.00	1.00	1.00	0.89	1.00	1.00	1.02	1.20	1.00	1.00	1.00	1.00

FIGURE 5:8 AI/PI RATIO FOR TWO-WHEELERS

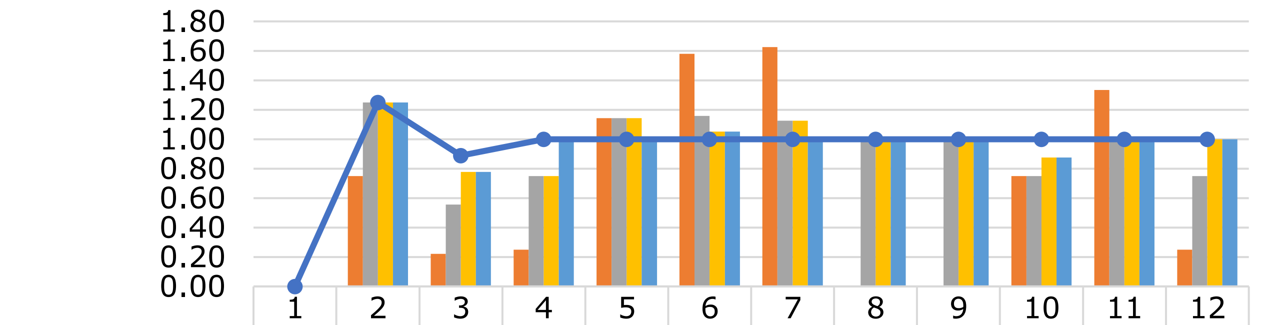
The Ai/Pi for two-wheelers for the 12 different zones, the observed ratio is high in zone - 8 and calculated is higher in zone – 8 and lower in zone – 4 with comparison of all other three iterations. For other zones the ratio will be same.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	1.54	0.88	0.67	1.43	1.00	0.67	1.00	0.63	0.75	0.00	0.50
2	0.00	1.08	1.06	0.67	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
3	0.00	1.00	1.06	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
4	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Observed	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00

FIGURE 5:9 AI/PI RATIO FOR AUTO

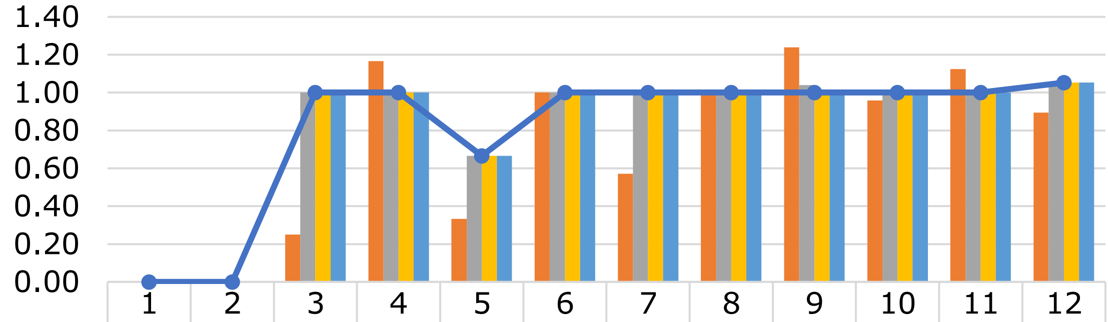
The Ai/Pi for Auto for the 12 different zones, the observed ratio and calculated is same for all the zones. Only zone 1 and 11 have 0 value, it means these zones do not produced and attracted any trips.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.75	0.22	0.25	1.14	1.58	1.63	0.00	0.00	0.75	1.33	0.25
2	0.00	1.25	0.56	0.75	1.14	1.16	1.13	1.00	1.00	0.75	1.00	0.75
3	0.00	1.25	0.78	0.75	1.14	1.05	1.13	1.00	1.00	0.88	1.00	1.00
4	0.00	1.25	0.78	1.00	1.00	1.05	1.00	1.00	1.00	0.88	1.00	1.00
Observed	0.00	1.25	0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

FIGURE 5:10 AI/PI RATIO FOR BUS

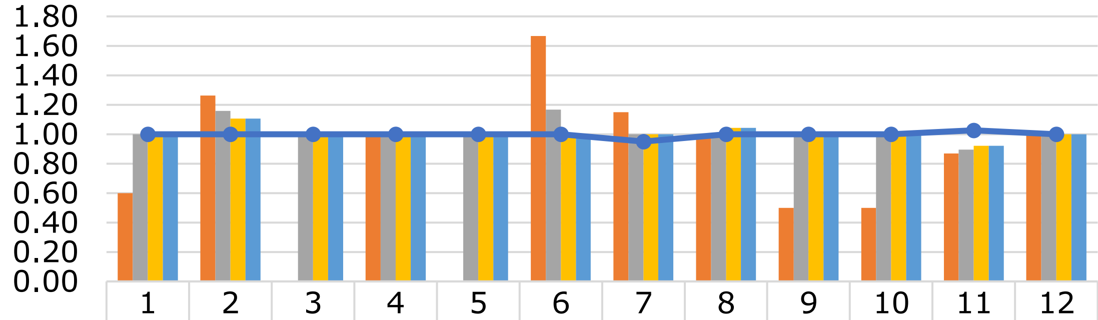
The Ai/Pi for bus for the 12 different zones, the observed ratio is high in zone - 2 and calculated is higher in zone – 2 and lower in zone – 3 with comparison of all other three iterations. The zone 1 has zero value means it has not trip attraction and trip production.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.00	0.25	1.17	0.33	1.00	0.57	1.00	1.24	0.96	1.13	0.89
2	0.00	0.00	1.00	1.00	0.67	1.00	1.00	1.00	1.04	1.00	1.00	1.05
3	0.00	0.00	1.00	1.00	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.05
4	0.00	0.00	1.00	1.00	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.05
Observed	0.00	0.00	1.00	1.00	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.05

FIGURE 5:11 AI/PI RATIO FOR BICYCLE

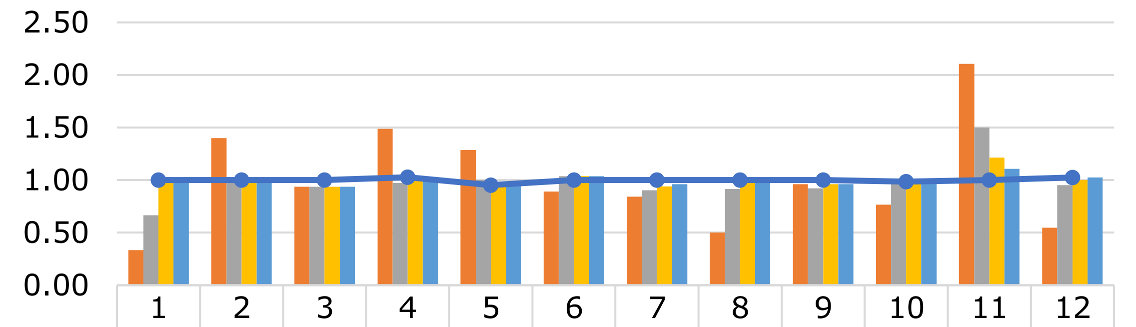
The Ai/Pi for Bicycle for the 12 different zones, the observed ratio and calculated is same for all the zones. Only zone 1 and 2 have 0 value, it means these zones do not produced and attracted any trips.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.60	1.26	0.00	1.00	0.00	1.67	1.15	1.00	0.50	0.50	0.87	1.00
2	1.00	1.16	1.00	1.00	1.00	1.17	1.00	1.00	1.00	1.00	0.89	1.00
3	1.00	1.11	1.00	1.00	1.00	1.00	1.00	1.04	1.00	1.00	0.92	1.00
4	1.00	1.11	1.00	1.00	1.00	1.00	1.00	1.04	1.00	1.00	0.92	1.00
Observed	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.00	1.03	1.00

FIGURE 5:12 AI/PI RATIO FOR WALKING

The Ai/Pi for walking for the 12 different zones, the observed ratio is high in zone - 11 and calculated is higher in zone – 2 and lower in zone – 11 with comparison of all other three iterations. For other zones the ratio will be same.

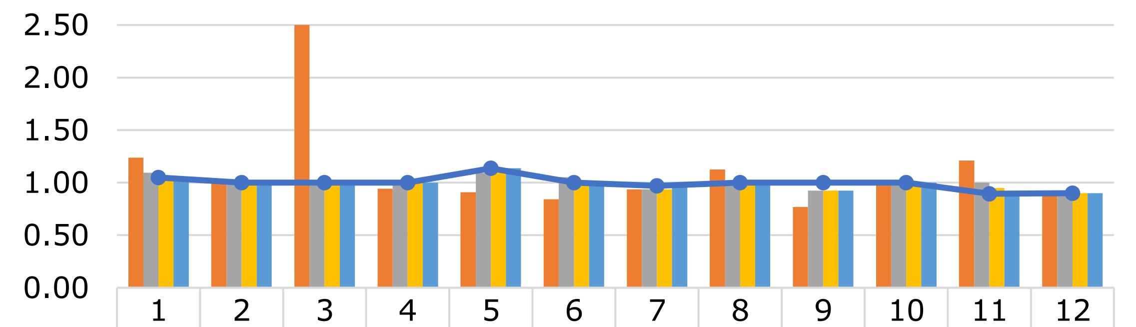


	1	2	3	4	5	6	7	8	9	10	11	12
1	0.33	1.40	0.94	1.49	1.29	0.89	0.84	0.50	0.96	0.77	2.11	0.55
2	0.67	1.00	0.94	0.97	1.00	1.04	0.90	0.92	0.92	0.97	1.50	0.95
3	1.00	1.00	0.94	1.00	0.95	1.04	0.94	1.00	0.96	0.98	1.21	1.00
4	1.00	1.00	0.94	1.03	0.95	1.04	0.96	1.00	0.96	0.98	1.11	1.02
Observed	1.00	1.00	1.00	1.03	0.95	1.00	1.00	1.00	1.00	0.98	1.00	1.02

FIGURE 5:13 AI/PI RATIO FOR VANPOOL

The Ai/Pi for vanpool for the 12 different zones, the observed ratio is high in zone - 4 and calculated is higher in zone – 11 and lower in zone – 7 and 9 with comparison of all other three iterations.

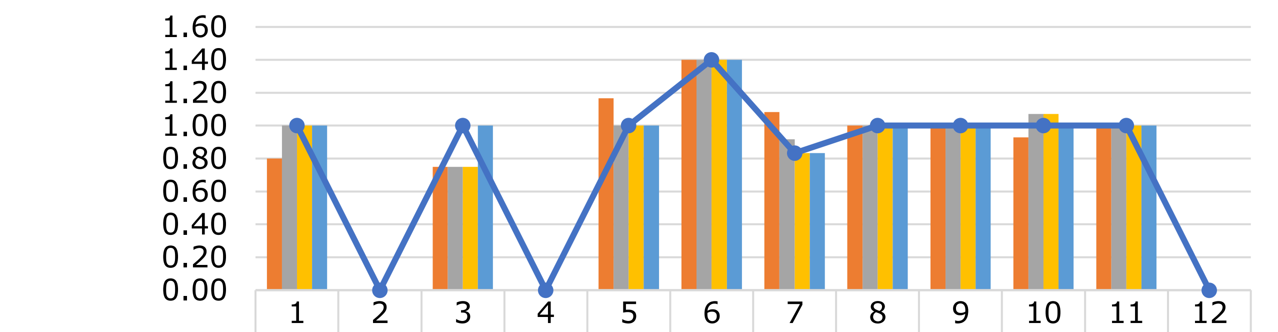
5.6.3 OBSERVED AND GRAVITY MODEL OUTPUT FOR SHOPPING PURPOSE



	1	2	3	4	5	6	7	8	9	10	11	12
1	1.24	1.00	2.50	0.94	0.91	0.84	0.94	1.13	0.77	1.00	1.21	0.90
2	1.10	1.00	1.00	1.00	1.09	1.05	0.94	1.00	0.92	1.00	1.00	0.90
3	1.05	1.00	1.00	1.00	1.14	1.00	0.94	1.00	0.92	1.00	0.95	0.90
4	1.05	1.00	1.00	1.00	1.14	1.00	0.97	1.00	0.92	1.00	0.89	0.90
Observed	1.05	1.00	1.00	1.00	1.14	1.00	0.97	1.00	1.00	1.00	0.89	0.90

FIGURE 5:14 AI/PI RATIO FOR TWO-WHEELERS

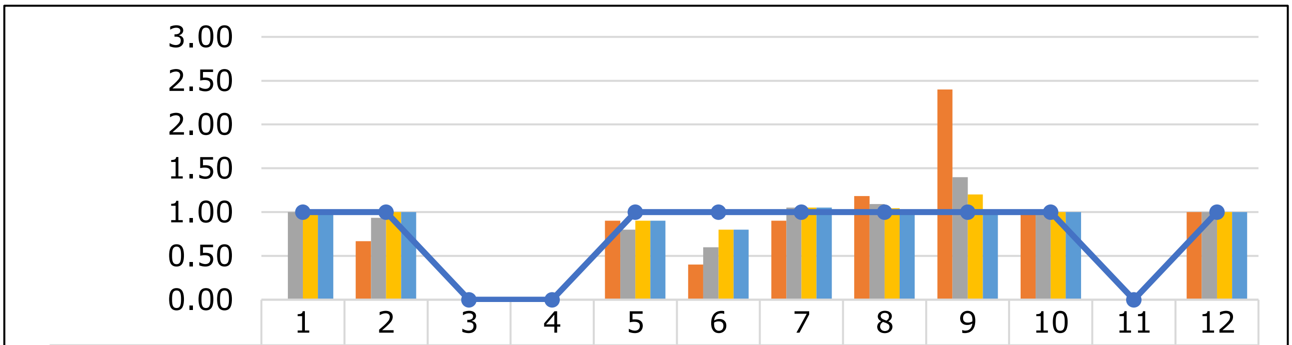
The Ai/Pi for Two-wheeler for the 12 different zones, the observed ratio and calculated is same for all the zones. The highest ratio is in zone – 5 and lowest in zone – 11.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.80	0.00	0.75	0.00	1.17	1.40	1.08	1.00	1.00	0.93	1.00	0.00
2	1.00	0.00	0.75	0.00	1.00	1.40	0.92	1.00	1.00	1.07	1.00	0.00
3	1.00	0.00	0.75	0.00	1.00	1.40	0.83	1.00	1.00	1.07	1.00	0.00
4	1.00	0.00	1.00	0.00	1.00	1.40	0.83	1.00	1.00	1.00	1.00	0.00
Observed	1.00	0.00	1.00	0.00	1.00	1.40	0.83	1.00	1.00	1.00	1.00	0.00

FIGURE 5:15 AI/PI RATIO FOR AUTO

The Ai/Pi for auto for the 12 different zones, the observed ratio and calculated is same for all the zones. The highest in zone – 6 and lowest in 7. Only zone 2 and 12 have 0 value.

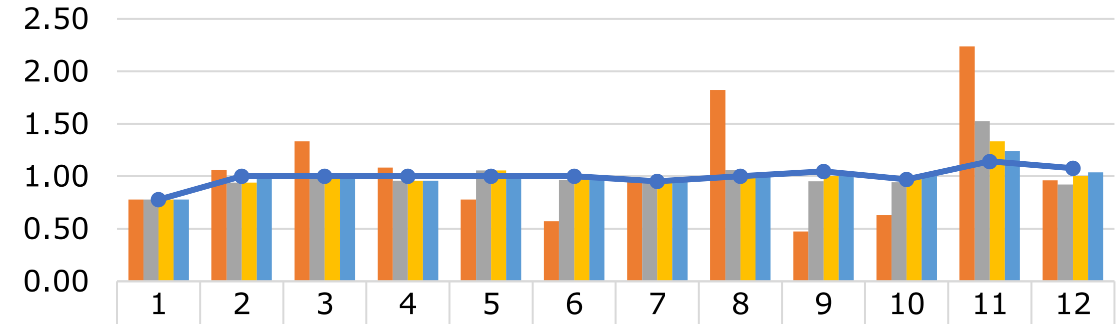


	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.67	0.00	0.00	0.90	0.40	0.90	1.18	2.40	1.00	0.00	1.00
2	1.00	0.93	0.00	0.00	0.80	0.60	1.05	1.09	1.40	1.00	0.00	1.00
3	1.00	1.00	0.00	0.00	0.90	0.80	1.05	1.05	1.20	1.00	0.00	1.00
4	1.00	1.00	0.00	0.00	0.90	0.80	1.05	1.00	1.00	1.00	0.00	1.00
Observed	1.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00

FIGURE 5:16 AI/PI RATIO FOR WALKING

The Ai/Pi for walking for the 12 different zones, the observed ratio value is same for all the zones. Calculated is higher in zone – 7 and lower in zone – 6 with comparison of all other three iterations. The zone 3, 4 and 11 has zero value means it has not trip attraction and trip production.

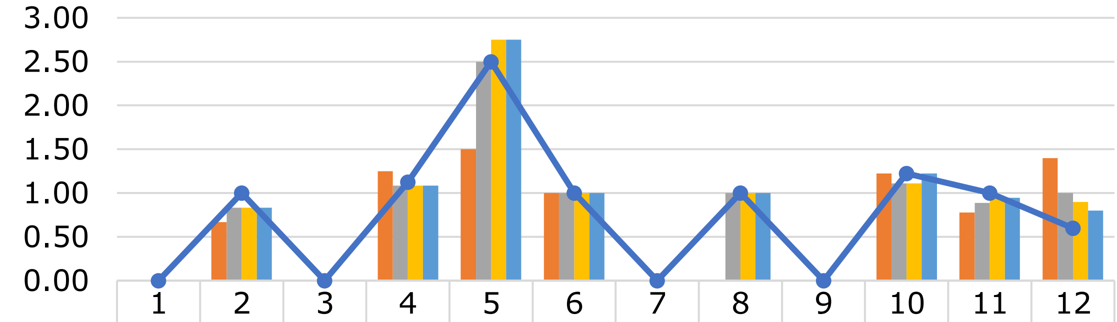
5.6.4 OBSERVED AND GRAVITY MODEL OUTPUT FOR OTHER PURPOSE



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.78	1.06	1.33	1.08	0.78	0.57	0.97	1.82	0.48	0.63	2.24	0.96
2	0.78	0.94	1.00	0.96	1.06	0.96	0.97	1.06	0.95	0.94	1.52	0.92
3	0.78	0.94	1.00	0.96	1.06	1.00	0.95	1.00	1.00	1.00	1.33	1.00
4	0.78	1.00	1.00	0.96	1.00	1.00	0.95	1.00	1.00	1.00	1.24	1.04
Observed	0.78	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.05	0.97	1.14	1.08

FIGURE 5:17 AI/PI RATIO FOR TWO-WHEELERS

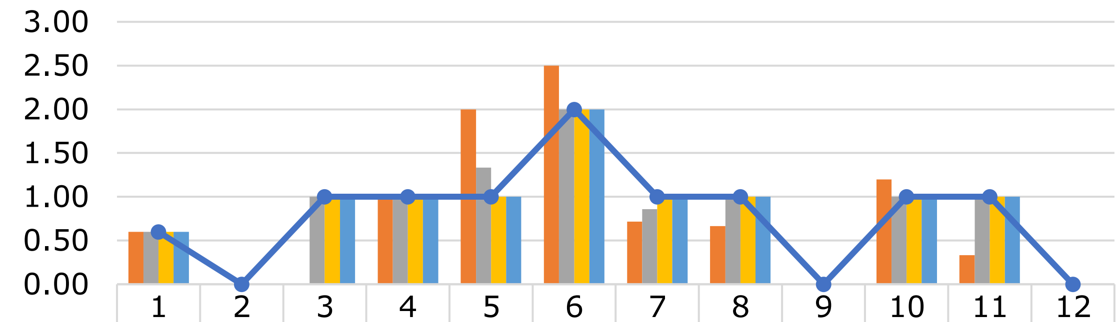
The Ai/Pi for two-wheelers for the 12 different zones, calculated is higher in zone – 11 and lower in zone – 1 with comparison of all other three iterations.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	0.67	0.00	1.25	1.50	1.00	0.00	0.00	0.00	1.22	0.78	1.40
2	0.00	0.83	0.00	1.08	2.50	1.00	0.00	1.00	0.00	1.11	0.89	1.00
3	0.00	0.83	0.00	1.08	2.75	1.00	0.00	1.00	0.00	1.11	0.94	0.90
4	0.00	0.83	0.00	1.08	2.75	1.00	0.00	1.00	0.00	1.22	0.94	0.80
Observed	0.00	1.00	0.00	1.13	2.50	1.00	0.00	1.00	0.00	1.22	1.00	0.60

FIGURE 5:18 AI/PI RATIO FOR FOUR-WHEELERS

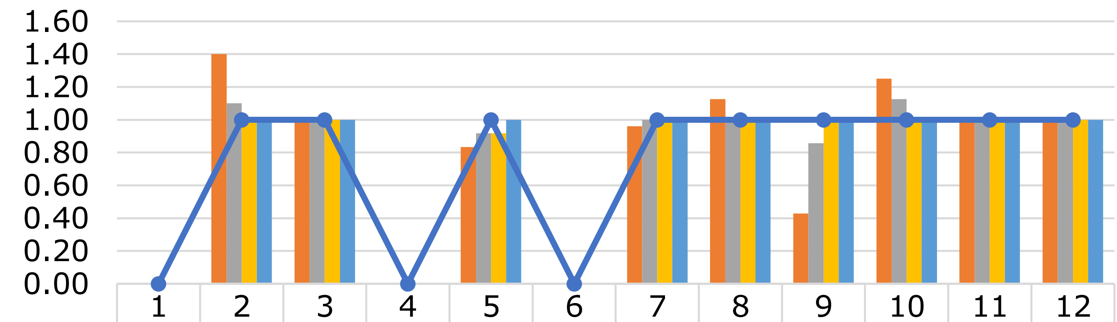
The Ai/Pi for four-wheelers for the 12 different zones, the observed ratio is high in zone - 5 and calculated is higher in zone – 5 and lower in zone – 12 with comparison of all other three iterations. The zone 1, 3, 7 and 9 has zero value means it has not trip attraction and trip production.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.60	0.00	0.00	1.00	2.00	2.50	0.71	0.67	0.00	1.20	0.33	0.00
2	0.60	0.00	1.00	1.00	1.33	2.00	0.86	1.00	0.00	1.00	1.00	0.00
3	0.60	0.00	1.00	1.00	1.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00
4	0.60	0.00	1.00	1.00	1.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00
Observed	0.60	0.00	1.00	1.00	1.00	2.00	1.00	1.00	0.00	1.00	1.00	0.00

FIGURE 5:19 AI/PI RATIO FOR AUTO

The Ai/Pi for auto, the observed and calculated ratio value is same for all the zones. The Ratio is higher in zone – 6 and lower in zone – 1. The zone 2, 9 and 12 has zero value means it has not trip attraction and trip production.



	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00	1.40	1.00	0.00	0.83	0.00	0.96	1.13	0.43	1.25	1.00	1.00
2	0.00	1.10	1.00	0.00	0.92	0.00	1.00	1.00	0.86	1.13	1.00	1.00
3	0.00	1.00	1.00	0.00	0.92	0.00	1.00	1.00	1.00	1.00	1.00	1.00
4	0.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Observed	0.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00

FIGURE 5:20 AI/PI RATIO FOR WALKING

The Ai/Pi for walking for the 12 different zones, the observed and calculated ratio value is same for all the zones. All the zones have same value for observed trips and 3rd and 4th iteration is 1. The zone 1, 4 and 6 has zero value means it has not trip attraction and trip production. It means there is no more difference between actual and predicted trips.

5.6.5 TRIP LENGTH FREQUENCEY DISTRIBUTION

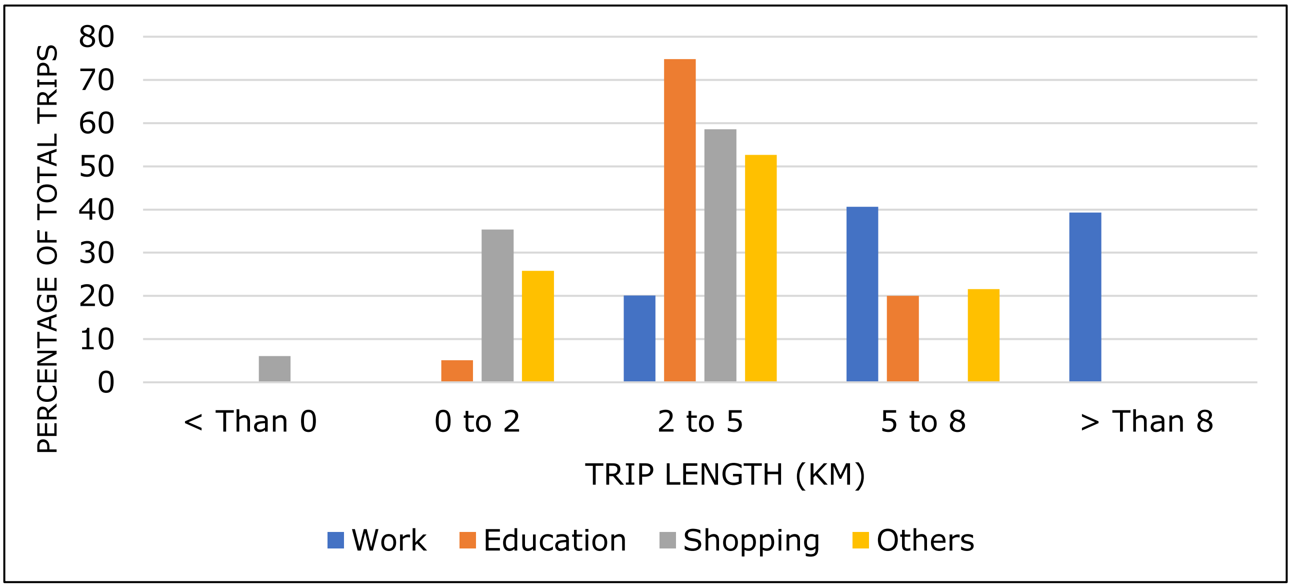


FIGURE 5:21 TRIP LENGTH DISTRIBUTION FOR TWO-WHEELER

The figure shows that the trip length frequency distribution for two wheelers. Most of the long trips are occurred for the work purpose. For work purpose there is not shortest trips are generated. For 2 to 5 km travels, 50% trips are generated by the different travel purpose.

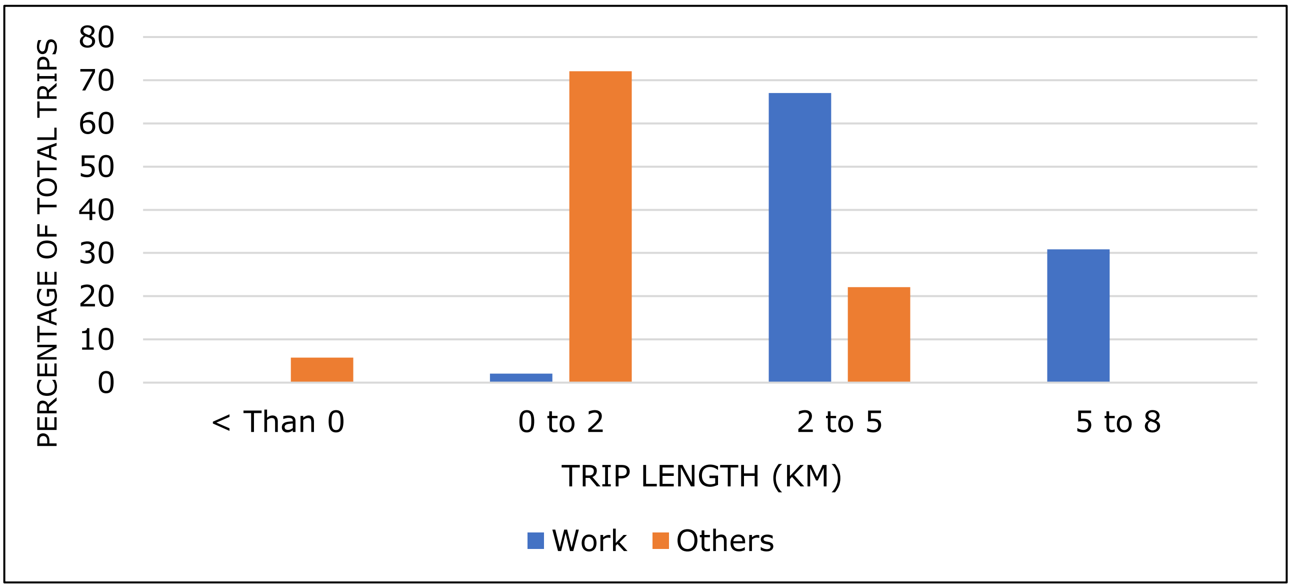


FIGURE 5:22 TRIP LENGTH DISTRIBUTION FOR FOUR-WHEELER

For using the four-wheeler vehicle only work and other purpose trip distribution occurred. These trips are in medium length with the frequency of 1 to 5 km travel pattern. The long work trips are generated using the four wheeler.it means the four-wheeler vehicle ownership and its trips are not impact much more.

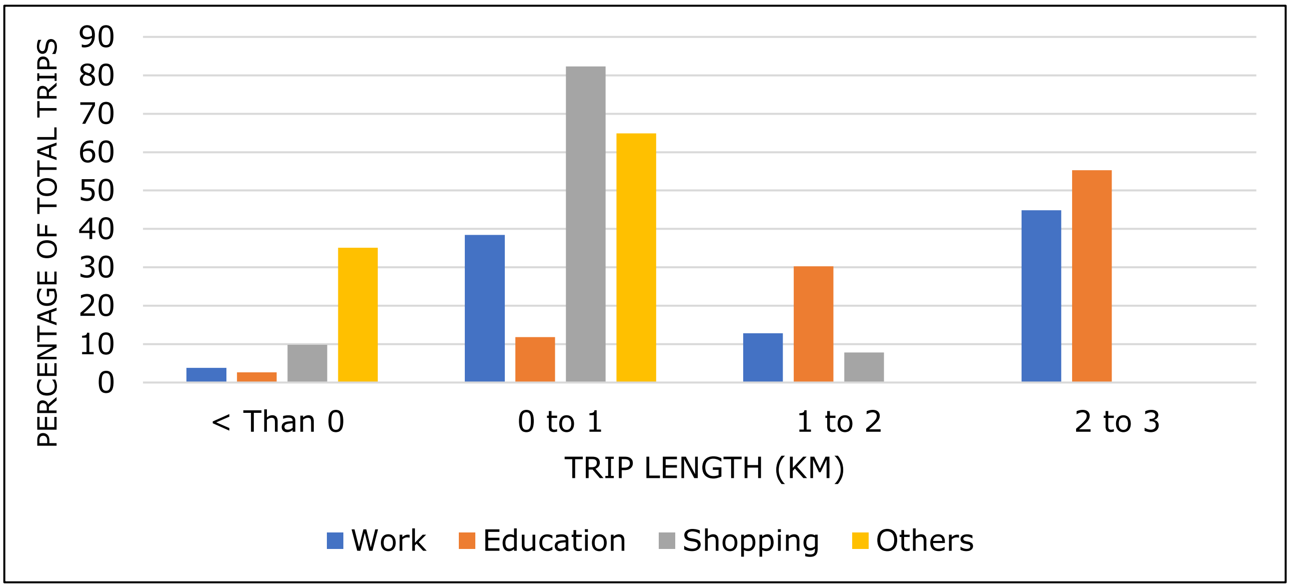


FIGURE 5:23 TRIP LENGTH DISTRIBUTION FOR AUTO

Work, Education, Shopping and other trips are mostly using by Auto vehicle. Most of the trips by using the Auto are occurred for the Work and education purpose and for its frequency is 0 to 1 km. for higher the distance the trips are going decrease for this travel mode.

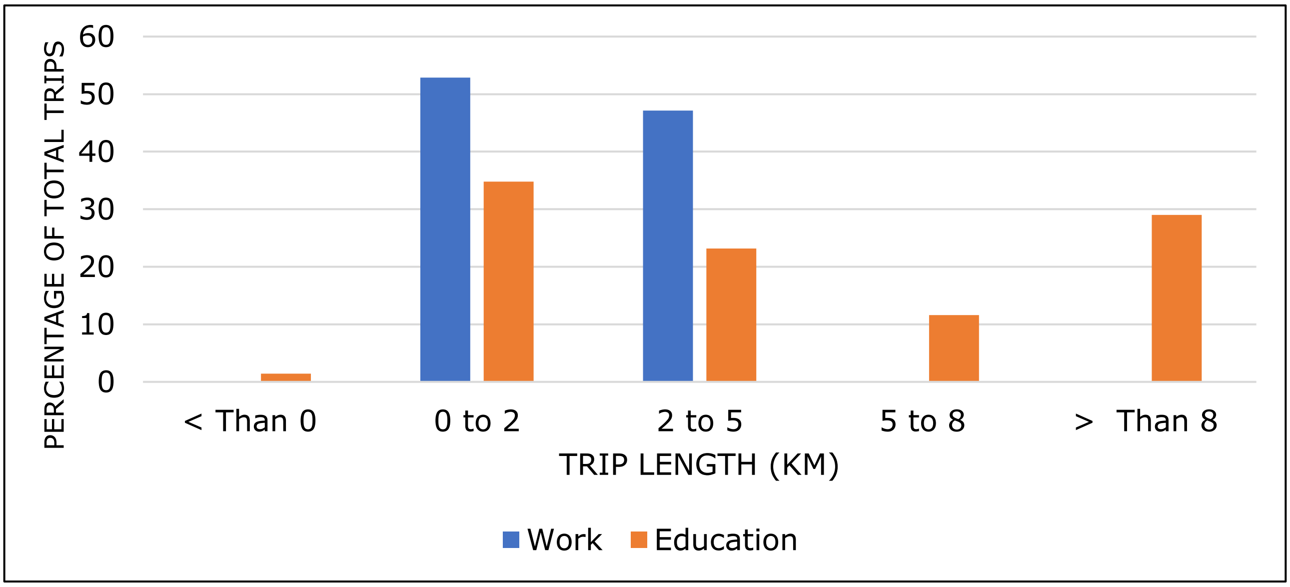


FIGURE 5:24 TRIP LENGTH DISTRIBUTION FOR BUS

For using the Bus only work and education purpose trip distribution occurred. These trips are in medium length with the frequency of 1 to 5 km travel pattern. The long educational trips are generated using the bus. It means people prefer more public transport for the long distances.

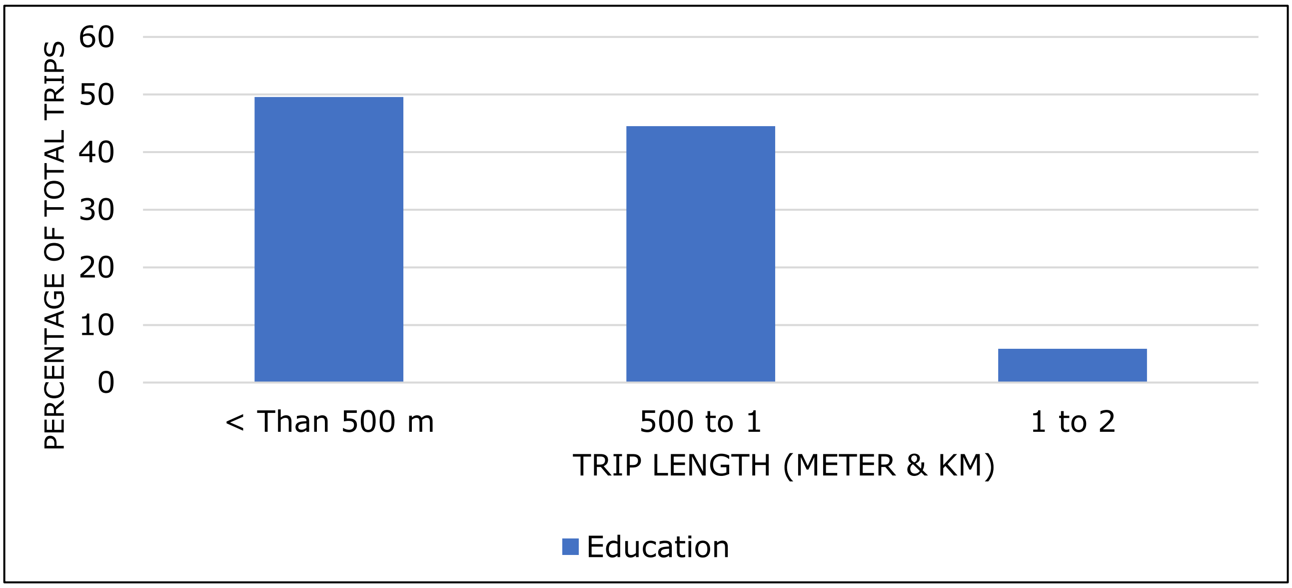


FIGURE 5:25 TRIP LENGTH DISTRIBUTION FOR BICYCLE

For using the Bicycle only education purpose trip is occurred in the Vadodara city. And bicycle used by most of the students who live near their educational facilities and its 1 km surrounding radius. For long distances the trips frequency is decreased.

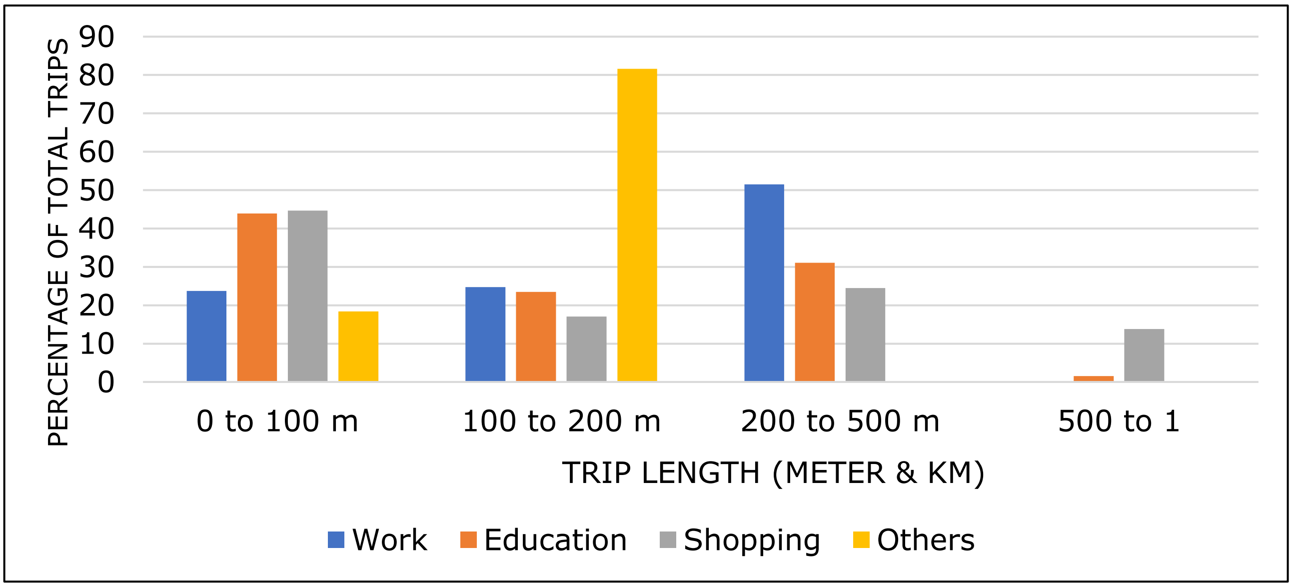


FIGURE 5:26 TRIP LENGTH DISTRIBUTION FOR WALKING

The figure shows that the trip length frequency distribution for Walking. For walking purpose people travel not more than 1 km in the city. The nearest trips from the households for the Education and shopping purpose. Most of the long trips are occurred for the education purpose. For work purpose there is not longest trips are generated. For 100m to 200m travels, 35% trips are generated by the different travel purpose.

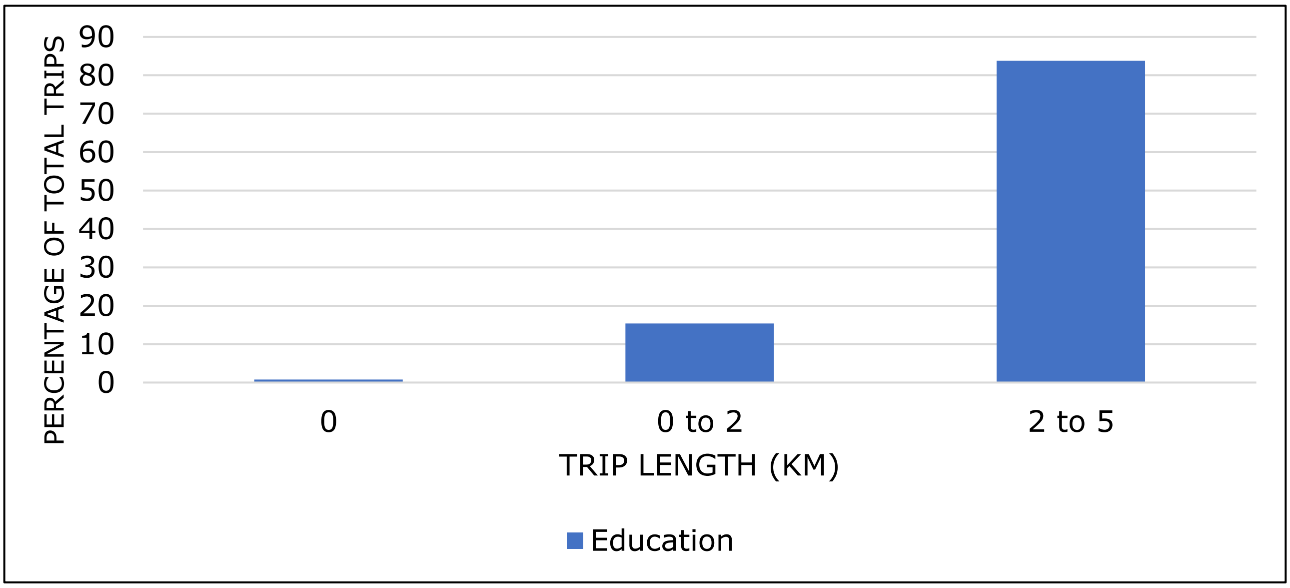


FIGURE 5:27 TRIP LENGTH DISTRIBUTION FOR VANPOOL

For using the vanpool only education purpose trip is occurred in the Vadodara city. Because parents have no time to pick and drop services for their children, so they higher this type of facilities. And it is beneficiary for the long-distance travel for the students. For long distances the trips frequency is increased.

5.7 MODEL APPLICATION FOR WHOLE STUDY AREA

All the three gravity models developed above are based on the sample data which is obtained from the survey data. Using the expansion ratio, the trip interchanges obtained from the survey data are projected for whole population. The table 5-88 shows the multiplication factor for each zone.

TABLE 5:88 ZONE WISE MULTIPLICATION FACTOR

ZONE	TOTAL POPULATION	SAMPLE POPULATION	MULTIPLICATION FACTOR
1	43555	107	407.06
2	122741	270	454.60
3	141314	191	739.86
4	160969	364	442.22
5	88349	247	357.69
6	130715	251	520.78
7	182568	371	492.10
8	98723	217	454.94
9	236097	488	483.81
10	177287	461	384.57
11	122645	242	506.80
12	139349	336	414.73

Now this multiplication factor is applied to observed O/D matrix of each vehicle ownership categories. The table 5-88 shows that the total population of each zone and sample population which is used for the primary survey. After getting this data the total population divided by the sample population. Getting the multiplication factor. The highest survey carried out in the zone – 9 and lowest in zone – 1. The highest multiplication factor is shown higher in zone – 6 and lowest in zone – 5.

5.7.1 WORK PURPOSE TRIP DISTRIBUTION FOR WHOLE STUDY AREA

TABLE 5:89 TRIP INTERCHANGE MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	2492	117	849	407	3280	1326	1042	15137	1124	1227	331	348	**27680**	**1.06**
2	119	4615	1644	546	837	2057	7690	2018	12734	4018	556	898	**37732**	**1.05**
3	1336	2534	12947	214	1645	1847	2083	2011	16734	2557	0	4922	**48831**	**0.72**
4	410	539	137	22701	913	1805	1111	526	1083	2157	715	10800	**42895**	**0.98**
5	2747	688	740	759	7186	8404	4787	6877	3647	4482	1317	2720	**44354**	**1.25**
6	1996	2455	1569	2182	10892	7564	12236	8773	5701	14132	12479	11157	**91137**	**0.87**
7	1145	8280	446	1211	6835	11390	30088	2405	6520	11604	1848	2378	**84149**	**0.97**
8	16019	2094	1353	552	8787	7420	2317	736	2296	1523	563	1379	**45039**	**0.97**
9	1203	13355	11080	1150	5635	6006	6352	2322	17035	1717	1546	3718	**71120**	**1.03**
10	1063	3414	1409	1855	4569	9689	9393	1247	1269	26184	8959	3633	**72684**	**1.18**
11	387	638	0	831	1841	11992	2303	622	1691	12101	9151	0	**41558**	**0.90**
12	375	798	2837	9718	2945	9943	1963	1182	3151	3825	0	17593	**54330**	**1.10**
Ai	**29293**	**39526**	**35011**	**42125**	**55365**	**79442**	**81364**	**43856**	**72986**	**85527**	**37465**	**59547**	**661507**	

It is calculated for the total population of the 12 zones of the city. The 5-89 table shows the trip interchange matrix for two-wheelers. The total predicted and futured trips can be 6,61,507 for the 12 zones. The highest trips produced in zone - 6 and attracted in zone – 10. The zone – 1 has lowest production and attracted trips in the future.

TABLE 5:90 TRIP INTERCHANGE MATRIX FOR FOUR-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	1221	0	0	0	0	0	0	0	0	0	**1221**	**1.15**
2	0	3981	594	549	890	0	2104	689	1036	1068	0	0	**10910**	**1.03**
3	521	1260	0	1099	1252	2028	0	0	0	1239	0	0	**7399**	**0.58**
4	0	518	488	2534	1727	1681	1535	98	260	568	300	5326	**15035**	**1.02**
5	0	687	456	1415	3738	1851	1064	0	0	1446	419	1443	**12519**	**1.23**
6	0	0	1029	1918	2578	4472	4325	131	0	7528	991	2547	**25518**	**0.86**
7	0	2160	0	1672	1415	4131	5498	987	2178	4256	1325	0	**23621**	**0.95**
8	0	668	0	101	0	118	932	0	0	0	0	0	**1820**	**1.05**
9	0	1067	0	284	0	0	2185	0	69	531	93	609	**4838**	**0.95**
10	884	906	496	511	1588	4755	3501	0	437	5128	3189	2064	**23459**	**1.19**
11	0	0	0	346	590	1002	1404	0	99	4091	657	934	**9122**	**0.85**
12	0	0	0	4868	1611	1957	0	0	509	2097	740	5222	**17004**	**1.07**
Ai	**1404**	**11246**	**4283**	**15297**	**15389**	**21995**	**22546**	**1905**	**4588**	**27954**	**7713**	**18145**	**152467**	

It is calculated for the total population of the 12 zones of the city. The 5-90 table shows the trip interchange matrix for four-wheelers. The total predicted and futured trips can be 1,52,467 for the 12 zones. The highest trips produced in zone - 6 and attracted in zone – 10. The zone – 1 has lowest production and attracted trips in the future.

TABLE 5:91 TRIP INTERCHANGE MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	407	0	0	0	0	0	0	**407**	**1.27**
2	0	0	0	0	0	455	0	0	0	0	0	0	**455**	**1.14**
3	0	0	1480	0	0	0	0	0	0	0	0	0	**1480**	**1.00**
4	0	0	0	0	0	0	360	0	0	0	0	525	**884**	**1.01**
5	0	0	0	0	0	1402	0	482	188	74	0	0	**2146**	**1.62**
6	519	519	0	0	2189	1187	0	0	0	1119	717	0	**6249**	**0.87**
7	0	0	0	400	0	0	3989	2397	1008	2632	0	399	**10826**	**0.93**
8	0	0	0	0	869	0	2028	459	0	391	348	0	**4094**	**1.01**
9	0	0	0	0	294	0	1414	0	710	0	0	0	**2419**	**0.79**
10	0	0	0	0	118	905	1970	346	0	187	321	0	**3846**	**1.28**
11	0	0	0	0	0	1073	0	451	0	509	1008	0	**3041**	**0.79**
12	0	0	0	493	0	0	337	0	0	0	0	0	**829**	**1.11**
Ai	**519**	**519**	**1480**	**893**	**3470**	**5428**	**10098**	**4135**	**1907**	**4912**	**2394**	**923**	**36677**	

It is calculated for the total population of the 12 zones of the city. The 5-91 table shows the trip interchange matrix for auto. The total predicted and futured trips can be 36,677 for the 12 zones. The highest trips produced and attracted in zone – 7. The zone – 1 & 2 has lowest production and attracted trips in the future.

TABLE 5:92 TRIP INTERCHANGE MATRIX FOR BUS

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	578	0	0	0	56	180	0	0	0	0	**814**	**4.08**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	2157	0	2163	0	0	1328	0	271	0	0	0	0	**5919**	**0.71**
4	0	0	0	0	0	0	0	0	0	0	165	720	**884**	**0.90**
5	0	0	0	0	0	602	0	0	1017	0	170	0	**1788**	**1.12**
6	0	0	1318	0	855	2358	0	0	563	1999	719	0	**7812**	**0.92**
7	450	0	0	0	0	0	0	0	0	1026	0	0	**1476**	**0.54**
8	712	0	138	0	0	0	0	0	0	515	0	0	**1365**	**0.94**
9	0	0	0	0	907	682	0	0	0	0	0	346	**1935**	**1.01**
10	0	0	0	0	0	1479	734	831	0	2784	1480	0	**7307**	**1.06**
11	0	0	0	118	247	736	0	0	0	1433	0	0	**2534**	**1.00**
12	0	0	0	677	0	0	0	0	384	0	0	598	**1659**	**1.00**
Ai	**3320**	**0**	**4196**	**795**	**2009**	**7185**	**790**	**1282**	**1964**	**7756**	**2533**	**1664**	**33494**	

It is calculated for the total population of the 12 zones of the city. The 5-92 table shows the trip interchange matrix for bus. The total predicted and futured trips can be 33,494 for the 12 zones. The highest trips produced in zone - 6 and attracted in zone – 10. The zone – 2 has lowest production and attracted trips in the future.

TABLE 5:93 TRIP INTERCHANGE MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	452	0	0	0	0	0	0	1584	0	0	0	0	**2035**	**1.09**
2	0	1678	0	0	0	0	2331	0	1447	0	0	0	**5455**	**1.01**
3	0	0	2054	0	0	0	0	0	1645	0	0	0	**3699**	**0.75**
4	0	0	0	925	0	0	3055	0	0	0	0	0	**3980**	**1.32**
5	0	0	0	0	733	0	0	1413	0	0	0	0	**2146**	**1.18**
6	0	0	0	0	0	681	0	881	0	0	0	0	**1562**	**0.93**
7	0	694	0	4321	0	0	793	0	0	98	0	0	**5905**	**1.07**
8	1771	0	0	0	1798	768	0	2942	0	0	0	0	**7279**	**0.94**
9	0	2697	717	0	0	0	0	0	5294	0	0	0	**8709**	**0.96**
10	0	0	0	0	0	0	118	0	0	2189	0	0	**2307**	**0.99**
11	0	0	0	0	0	0	0	0	0	0	4054	0	**4054**	**1.00**
12	0	415	0	0	0	0	0	0	0	0	0	0	**415**	**0.00**
Ai	**2222**	**5484**	**2771**	**5245**	**2532**	**1449**	**6297**	**6820**	**8386**	**2287**	**4054**	**0**	**47548**	

It is calculated for the total population of the 12 zones of the city. The 5-93 table shows the trip interchange matrix for walking. The total predicted and futured trips can be 47,548 for the 12 zones. The highest trips produced and attracted in zone – 9. The zone – 12 has lowest production and attracted trips in the future.

TABLE 5:94 TRIP INTERCHANGE MATRIX FOR WORK PURPOSE

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	2944	117	2649	407	3280	1733	1098	16901	1124	1227	331	348	**32158**	**1.14**
2	119	10274	2238	1095	1727	2511	12124	2708	15216	5086	556	898	**54552**	**1.04**
3	4014	3794	18644	1312	2897	5204	2083	2282	18379	3796	0	4922	**67327**	**0.71**
4	410	1057	625	26159	2640	3486	6061	624	1343	2725	1180	17370	**63680**	**1.01**
5	2747	1375	1195	2174	11658	12259	5850	8772	4852	6002	1905	4164	**62953**	**1.25**
6	2515	2974	3915	4100	16514	16262	16561	9785	6264	24777	14906	13704	**132278**	**0.87**
7	1595	11133	446	7604	8250	15521	40368	5789	9706	19616	3173	2777	**125978**	**0.96**
8	18502	2762	1491	653	11455	8306	5277	4137	2296	2428	911	1379	**59597**	**0.97**
9	1203	17119	11797	1434	6837	6688	9951	2322	23109	2249	1639	4673	**89021**	**1.01**
10	1947	4319	1904	2367	6275	16827	15716	2424	1707	36472	13949	5697	**109602**	**1.17**
11	387	638	0	1295	2677	14803	3706	1074	1790	18135	14870	934	**60309**	**0.90**
12	375	1213	2837	15756	4555	11900	2300	1182	4044	5922	740	23413	**74237**	**1.08**
Ai	**36758**	**56775**	**47741**	**64355**	**78765**	**115499**	**121096**	**57998**	**89830**	**128436**	**54159**	**80279**	**931692**	

It is calculated for the total population of the 12 zones of the city. The 5-94 table shows the trip interchange matrix for work purpose. The total predicted and futured trips can be 9,31,692 for the 12 zones. The highest trips produced in zone - 6 and attracted in zone – 10. The zone – 1 has lowest production and attracted trips in the future.

5.7.2 EDUCATION PURPOSE TRIP DISTRIBUTION FOR WHOLE STUDY AREA

TABLE 5:95 TRIP INTERCHANGE MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	2304	0	1172	0	1824	0	908	0	0	0	0	304	**6513**	**1.15**
2	0	1019	3605	33	218	561	1488	491	314	0	0	0	**7728**	**1.34**
3	2075	6232	5466	211	1269	1695	0	0	2289	0	0	0	**19236**	**0.73**
4	0	39	144	2431	1551	1108	277	0	0	112	0	2740	**8402**	**0.88**
5	1655	178	650	673	15288	5127	4343	1430	794	622	850	584	**32192**	**1.20**
6	0	698	1219	1165	7193	7853	13356	0	4250	3820	3273	1961	**44787**	**0.90**
7	1095	1752	0	234	5771	12591	5742	0	1065	1756	996	0	**31002**	**0.96**
8	0	64	0	0	1695	70	0	446	0	0	0	0	**2275**	**1.04**
9	0	408	1717	0	1139	3237	1350	0	3076	0	200	0	**11128**	**1.08**
10	0	0	0	89	658	2882	1399	0	0	6645	2940	0	**14614**	**1.15**
11	0	0	0	0	1183	3248	1044	0	190	3867	604	0	**10136**	**0.87**
12	339	0	0	2522	717	1718	0	0	0	0	0	5487	**10783**	**1.03**
Ai	**7467**	**10389**	**13974**	**7357**	**38506**	**40090**	**29908**	**2366**	**11979**	**16822**	**8863**	**11076**	**198796**	

It is calculated for the total population of the 12 zones of the city. The 5-95 table shows the trip interchange matrix for two-wheelers. The total predicted and futured trips can be 1,98,796 for the 12 zones. The highest trips produced and attracted in zone – 6. The zone – 8 has lowest production and attracted trips in the future.

TABLE 5:96 TRIP INTERCHANGE MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	2372	2384	0	91	0	275	53	735	0	0	0	**5910**	**1.29**
3	0	3856	3771	0	0	557	0	0	3653	0	0	0	**11838**	**0.77**
4	0	0	0	0	476	0	0	0	0	0	0	851	**1327**	**0.80**
5	0	111	0	229	0	1430	523	0	0	212	0	0	**2504**	**1.33**
6	0	0	530	0	1816	763	1571	979	589	0	0	0	**6249**	**0.87**
7	0	393	0	0	616	1459	1712	0	249	0	0	0	**4429**	**0.96**
8	0	70	0	0	0	840	0	0	0	0	0	0	**910**	**1.13**
9	0	801	2462	0	0	417	190	0	0	0	0	0	**3870**	**1.35**
10	0	0	0	0	330	0	0	0	0	1209	0	0	**1538**	**0.92**
11	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
12	0	0	0	829	0	0	0	0	0	0	0	0	**829**	**1.03**
Ai	**0**	**7602**	**9147**	**1058**	**3330**	**5467**	**4271**	**1032**	**5226**	**1420**	**0**	**851**	**39404**	

It is calculated for the total population of the 12 zones of the city. The 5-96 table shows the trip interchange matrix for auto. The total predicted and futured trips can be 39,404 for the 12 zones. The highest trips produced and attracted in zone – 3. The zone – 1 & 11 has lowest production and attracted trips in the future.

TABLE 5:97 TRIP INTERCHANGE MATRIX FOR BUS

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	1168	479	0	0	0	171	0	**1818**	**1.87**
3	0	2430	0	0	1860	2369	0	0	0	0	0	0	**6659**	**0.51**
4	0	0	0	0	772	508	489	0	0	0	0	0	**1769**	**0.95**
5	0	0	1150	557	0	0	133	0	0	313	0	350	**2504**	**1.56**
6	0	575	2219	556	0	4359	56	0	1024	0	0	1106	**9895**	**1.05**
7	0	253	0	574	217	60	1963	505	0	0	0	365	**3937**	**0.98**
8	0	0	0	0	0	0	455	0	0	0	0	0	**455**	**1.11**
9	0	0	0	0	0	968	0	0	0	0	0	0	**968**	**1.06**
10	0	0	0	0	609	0	0	0	0	1486	982	0	**3077**	**1.03**
11	0	151	0	0	0	0	0	0	0	1369	0	0	**1520**	**0.76**
12	0	0	0	0	445	929	285	0	0	0	0	0	**1659**	**1.10**
Ai	**0**	**3409**	**3369**	**1687**	**3903**	**10360**	**3861**	**505**	**1024**	**3168**	**1153**	**1821**	**34260**	

It is calculated for the total population of the 12 zones of the city. The 5-97 table shows the trip interchange matrix for bus. The total predicted and futured trips can be 34,260 for the 12 zones. The highest trips produced and attracted in zone – 6. The zone – 1 has lowest production and attracted trips in the future.

TABLE 5:98 TRIP INTERCHANGE MATRIX FOR BICYCLE

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	0	0	0	0	0	0	0	0	2959	0	0	0	**2959**	**0.66**
4	0	0	0	5336	723	0	0	0	0	0	0	4554	**10613**	**0.95**
5	0	0	0	848	0	0	226	0	0	0	0	0	**1073**	**0.84**
6	0	0	0	0	0	578	0	984	0	0	0	0	**1562**	**0.90**
7	0	0	0	0	176	0	1534	57	1679	0	0	0	**3445**	**0.97**
8	0	0	0	0	0	833	77	0	0	0	0	0	**910**	**1.14**
9	0	0	1955	0	0	0	1512	0	8629	0	0	0	**12095**	**1.10**
10	0	0	0	0	0	0	0	0	0	6721	2509	0	**9230**	**1.09**
11	0	0	0	0	0	0	0	0	0	3306	748	0	**4054**	**0.80**
12	0	0	0	3907	0	0	0	0	0	0	0	3973	**7880**	**1.08**
Ai	**0**	**0**	**1955**	**10090**	**899**	**1411**	**3348**	**1041**	**13267**	**10027**	**3257**	**8527**	**53822**	

It is calculated for the total population of the 12 zones of the city. The 5-98 table shows the trip interchange matrix for bicycle. The total predicted and futured trips can be 53,822 for the 12 zones. The highest trips produced in zone - 9 and attracted in zone – 4. The zone – 1 & 2 has lowest production and attracted trips in the future.

TABLE 5:99 TRIP INTERCHANGE MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	320	0	0	0	0	0	0	1715	0	0	0	0	**2035**	**1.13**
2	0	2595	487	0	0	0	3607	0	1949	0	0	0	**8637**	**1.18**
3	0	740	0	0	0	0	0	0	0	0	0	0	**740**	**0.66**
4	0	0	0	884	0	0	0	0	0	0	0	0	**884**	**1.00**
5	0	0	0	0	0	0	715	0	0	0	0	0	**715**	**1.50**
6	0	0	0	0	0	0	901	2224	0	0	0	0	**3125**	**0.96**
7	0	4923	0	0	1072	1439	2407	0	0	0	0	0	**9842**	**0.94**
8	1987	0	0	0	0	1556	0	6921	0	0	0	0	**10464**	**1.04**
9	0	1935	0	0	0	0	0	0	0	0	0	0	**1935**	**1.01**
10	0	0	0	0	0	0	0	0	0	0	769	0	**769**	**1.19**
11	0	0	0	0	0	0	1594	0	0	912	16753	0	**19258**	**0.91**
12	0	0	0	0	0	0	0	0	0	0	0	4147	**4147**	**1.00**
Ai	**2307**	**10193**	**487**	**884**	**1072**	**2995**	**9224**	**10859**	**1949**	**912**	**17522**	**4147**	**62553**	

It is calculated for the total population of the 12 zones of the city. The 5-99 table shows the trip interchange matrix for walking. The total predicted and futured trips can be 62,553 for the 12 zones. The highest trips produced and attracted in zone – 11. The zone – 5 has lowest production and attracted in zone - 4 trips in the future.

TABLE 5:100 TRIP INTERCHANGE MATRIX FOR VANPOOL

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	1221	0	0	0	0	0	0	0	0	0	**1221**	**1.69**
2	0	221	0	0	0	0	746	801	83	2405	0	290	**4546**	**0.96**
3	2065	0	1334	0	0	0	6296	0	2142	0	0	0	**11838**	**0.64**
4	0	0	0	3509	1013	1296	0	199	801	2946	0	6598	**16362**	**0.97**
5	0	0	0	1046	3110	973	1071	853	0	423	36	0	**7511**	**1.11**
6	0	0	0	1383	1175	3077	0	0	761	5606	13907	2734	**28643**	**0.91**
7	0	1623	3800	0	1568	0	9673	1811	2628	3994	0	0	**25097**	**0.99**
8	0	1371	0	202	982	0	1424	795	0	596	0	89	**5459**	**0.94**
9	0	176	1267	1015	0	904	2576	0	4420	1737	0	0	**12095**	**1.01**
10	0	982	0	2858	464	5097	2996	569	1330	9729	588	0	**24612**	**1.14**
11	0	0	0	0	39	12340	0	0	0	574	1237	0	**14190**	**1.11**
12	0	0	0	5934	0	2304	0	78	0	0	0	9102	**17419**	**1.08**
Ai	**2065**	**4373**	**7622**	**15947**	**8351**	**25992**	**24782**	**5107**	**12166**	**28010**	**15768**	**18813**	**168995**	

It is calculated for the total population of the 12 zones of the city. The 5-100 table shows the trip interchange matrix for vanpool. The total predicted and futured trips can be 1,68,995 for the 12 zones. The highest trips produced and attracted in zone – 6. The zone – 1 has lowest production and attracted trips in the future.

TABLE 5:101 TRIP INTERCHANGE MATRIX FOR EDUCATION PURPOSE

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	2625	0	2393	0	1824	0	908	1715	0	0	0	304	**9769**	**1.21**
2	0	6207	6476	33	309	1730	6594	1345	3080	2405	171	290	**28640**	**1.26**
3	4140	13258	10571	211	3129	4621	6296	0	11044	0	0	0	**53270**	**0.69**
4	0	39	144	12160	4535	2912	766	199	801	3058	0	14743	**39358**	**0.94**
5	1655	289	1800	3352	18398	7529	7011	2283	794	1569	886	934	**46500**	**1.21**
6	0	1273	3967	3103	10184	16630	15884	4187	6624	9426	17180	5802	**94261**	**0.92**
7	1095	8944	3800	808	9420	15549	23033	2372	5620	5750	996	365	**77752**	**0.97**
8	1987	1505	0	202	2677	3299	1956	8161	0	596	0	89	**20472**	**1.02**
9	0	3320	7402	1015	1139	5526	5627	0	16125	1737	200	0	**42091**	**1.08**
10	0	982	0	2947	2061	7979	4395	569	1330	25789	7788	0	**53840**	**1.12**
11	0	151	0	0	1222	15588	2637	0	190	10028	19342	0	**49160**	**0.95**
12	339	0	0	13193	1162	4951	285	78	0	0	0	22709	**42717**	**1.06**
Ai	**11840**	**35967**	**36554**	**37024**	**56060**	**86316**	**75393**	**20910**	**45609**	**60359**	**46563**	**45235**	**557830**	

It is calculated for the total population of the 12 zones of the city. The 5-101 table shows the trip interchange matrix for education purpose. The total predicted and futured trips can be 5,57,830 for the 12 zones. The highest trips produced and attracted in zone – 6. The zone – 1 has lowest production and attracted trips in the future.

5.7.3 SHOPPING PURPOSE TRIP DISTRIBUTION FOR WHOLE STUDY AREA

TABLE 5:102 TRIP INTERCHANGE MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	4112	0	779	273	2124	806	0	0	340	0	0	113	**8548**	**1.16**
2	0	4546	0	0	0	0	0	0	0	0	0	0	**4546**	**1.00**
3	1430	0	0	0	0	0	0	0	50	0	0	0	**1480**	**0.56**
4	430	0	0	3731	528	355	1666	0	0	0	98	709	**7518**	**1.01**
5	1639	0	0	259	4578	0	218	529	0	505	142	0	**7869**	**1.25**
6	1524	0	0	426	0	3716	0	1351	0	1447	1431	0	**9895**	**0.92**
7	0	0	0	1636	436	0	7375	1933	540	3562	264	0	**15747**	**0.90**
8	0	0	0	0	579	1154	1906	0	0	0	0	0	**3640**	**1.05**
9	595	0	48	0	0	0	611	0	5036	0	0	0	**6290**	**0.95**
10	0	0	0	0	1110	1299	1980	0	0	4881	634	95	**9999**	**1.14**
11	0	0	0	143	442	1741	393	0	0	860	6050	0	**9629**	**0.90**
12	153	0	0	1088	0	0	0	0	0	97	0	2810	**4147**	**0.90**
Ai	**9881**	**4546**	**827**	**7557**	**9797**	**9071**	**14149**	**3814**	**5967**	**11353**	**8618**	**3727**	**89307**	

It is calculated for the total population of the 12 zones of the city. The 5-102 table shows the trip interchange matrix for two-wheelers. The total predicted and futured trips can be 89,307 for the 12 zones. The highest trips produced and attracted in zone – 7. The zone – 3 has lowest production and attracted trips in the future.

TABLE 5:103 TRIP INTERCHANGE MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	367	0	1668	0	0	0	0	0	0	0	**2035**	**1.01**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	701	0	0	0	803	0	0	727	727	0	0	0	**2959**	**0.52**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
5	1351	0	241	0	0	554	0	0	0	0	0	0	**2146**	**1.34**
6	0	0	0	0	411	0	1254	0	0	633	306	0	**2604**	**1.18**
7	0	0	0	0	0	1495	2612	0	0	1798	0	0	**5905**	**0.82**
8	0	0	455	0	0	0	0	0	0	0	0	0	**455**	**1.60**
9	0	0	484	0	0	0	0	0	0	0	0	0	**484**	**1.50**
10	0	0	0	0	0	679	1004	0	0	3701	0	0	**5384**	**1.14**
11	0	0	0	0	0	340	0	0	0	0	1181	0	**1520**	**0.98**
12	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
Ai	**2052**	**0**	**1547**	**0**	**2883**	**3068**	**4871**	**727**	**727**	**6132**	**1487**	**0**	**23493**	

It is calculated for the total population of the 12 zones of the city. The 5-103 table shows the trip interchange matrix for auto. The total predicted and futured trips can be 23,493 for the 12 zones. The highest trips produced in zone - 7 and attracted in zone – 10. The zone – 2, 4 & 12 has lowest production and attracted trips in the future.

TABLE 5:104 TRIP INTERCHANGE MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	407	0	0	0	0	**407**	**1.13**
2	0	2919	0	0	0	0	0	3516	384	0	0	0	**6819**	**1.02**
3	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
5	0	0	0	0	1883	153	0	1541	0	0	0	0	**3577**	**1.07**
6	0	0	0	0	782	1822	0	0	0	0	0	0	**2604**	**0.76**
7	0	0	0	0	0	0	4624	3041	2177	0	0	0	**9842**	**1.01**
8	460	3705	0	0	1155	0	3236	1453	0	0	0	0	**10009**	**0.99**
9	0	359	0	0	0	0	2060	0	0	0	0	0	**2419**	**1.06**
10	0	0	0	0	0	0	0	0	0	5384	0	0	**5384**	**1.00**
11	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
12	0	0	0	0	0	0	0	0	0	0	0	829	**829**	**1.00**
Ai	**460**	**6983**	**0**	**0**	**3820**	**1975**	**9919**	**9958**	**2561**	**5384**	**0**	**829**	**41890**	

It is calculated for the total population of the 12 zones of the city. The 5-104 table shows the trip interchange matrix for walking. The total predicted and futured trips can be 41,890 for the 12 zones. The highest trips produced and attracted in zone – 8. The zone – 3, 4 & 11 has lowest production and attracted trips in the future.

TABLE 5:105 TRIP INTERCHANGE MATRIX FOR SHOPPING PURPOSE

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	4112	0	1147	273	3792	806	0	407	340	0	0	113	**10991**	**1.13**
2	0	7465	0	0	0	0	0	3516	384	0	0	0	**11365**	**1.01**
3	2131	0	0	0	803	0	0	727	777	0	0	0	**4439**	**0.53**
4	430	0	0	3731	528	355	1666	0	0	0	98	709	**7518**	**1.01**
5	2990	0	241	259	6461	707	218	2070	0	505	142	0	**13592**	**1.21**
6	1524	0	0	426	1193	5538	1254	1351	0	2080	1737	0	**15103**	**0.93**
7	0	0	0	1636	436	1495	14611	4975	2717	5360	264	0	**31494**	**0.92**
8	460	3705	455	0	1734	1154	5142	1453	0	0	0	0	**14103**	**1.03**
9	595	359	531	0	0	0	2671	0	5036	0	0	0	**9192**	**1.01**
10	0	0	0	0	1110	1978	2984	0	0	13966	634	95	**20767**	**1.10**
11	0	0	0	143	442	2081	393	0	0	860	7231	0	**11150**	**0.91**
12	153	0	0	1088	0	0	0	0	0	97	0	3639	**4977**	**0.92**
Ai	**12394**	**11529**	**2374**	**7557**	**16500**	**14114**	**28939**	**14499**	**9255**	**22868**	**10105**	**4557**	**154690**	

It is calculated for the total population of the 12 zones of the city. The 5-105 table shows the trip interchange matrix for shopping purpose. The total predicted and futured trips can be 1,54,690 for the 12 zones. The highest trips produced and attracted in zone – 7. The zone – 3 has lowest production and attracted trips in the future.

5.7.4 OTHER PURPOSE TRIP DISTRIBUTION FOR WHOLE STUDY AREA

TABLE 5:106 TRIP INTERCHANGE MATRIX FOR TWO-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	129	0	1373	637	363	0	0	0	1076	85	**3664**	**0.87**
2	0	1775	1262	0	0	0	2945	0	1746	0	0	0	**7728**	**1.12**
3	273	1982	0	0	0	0	0	0	1015	1169	0	0	**4439**	**0.59**
4	0	0	0	7073	420	443	478	0	0	0	0	2199	**10613**	**0.94**
5	1278	0	0	294	1775	0	1405	892	0	795	0	0	**6438**	**1.19**
6	609	0	0	318	0	6272	1276	85	1663	1551	1660	1148	**14582**	**0.92**
7	505	3030	0	500	2099	1858	11883	5288	1776	4341	277	430	**31987**	**0.89**
8	0	0	0	0	1188	110	4711	1423	0	262	39	0	**7734**	**1.02**
9	0	1898	702	0	0	765	1876	0	2033	0	0	2885	**10160**	**1.02**
10	0	0	526	0	817	1176	2985	203	0	6622	1132	0	**13460**	**1.14**
11	536	0	0	0	0	867	88	12	0	590	8549	0	**10643**	**1.20**
12	**0**	**0**	**0**	**1808**	**0**	**1313**	**338**	**0**	**2146**	**0**	**0**	**5177**	**10783**	**1.11**
Ai	**3201**	**8686**	**2619**	**9994**	**7672**	**13441**	**28349**	**7904**	**10379**	**15331**	**12733**	**11924**	**132231**	

It is calculated for the total population of the 12 zones of the city. The 5-106 table shows the trip interchange matrix for two-wheelers. The total predicted and futured trips can be 1,32,231 for the 12 zones. The highest trips produced and attracted in zone – 7. The zone – 1 has lowest production and attracted trips in the future.

TABLE 5:107 TRIP INTERCHANGE MATRIX FOR FOUR-WHEELER

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	0	0	0	0	2728	0	0	0	0	0	0	**2728**	**0.99**
3	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
4	0	0	0	7675	1495	450	0	433	0	0	560	0	**10613**	**1.08**
5	0	0	0	1393	14	0	0	0	0	0	0	24	**1431**	**3.17**
6	0	2703	0	942	0	0	0	0	0	0	0	0	**3645**	**0.87**
7	0	0	0	0	0	0	0	0	0	0	0	3445	**3445**	**0.00**
8	0	0	0	455	0	0	0	0	0	0	0	0	**455**	**0.95**
9	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
10	0	0	0	0	0	0	0	0	0	2343	1112	6	**3461**	**1.30**
11	0	0	0	1025	0	0	0	0	0	1570	6487	41	**9122**	**0.89**
12	0	0	0	0	3020	0	0	0	0	575	0	552	**4147**	**0.98**
Ai	**0**	**2703**	**0**	**11489**	**4529**	**3177**	**0**	**433**	**0**	**4488**	**8159**	**4069**	**39048**	

It is calculated for the total population of the 12 zones of the city. The 5-107 table shows the trip interchange matrix for four-wheelers. The total predicted and futured trips can be 39,048 for the 12 zones. The highest trips produced and attracted in zone – 4. The zone – 1, 3 & 9 has lowest production and attracted trips in the future.

TABLE 5:108 TRIP INTERCHANGE MATRIX FOR AUTO

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	447	395	703	491	0	0	0	0	0	0	**2035**	**0.76**
2	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
3	740	0	0	0	0	0	0	0	0	0	0	0	**740**	**0.60**
4	340	0	0	987	0	0	0	0	0	0	0	0	**1327**	**1.04**
5	459	0	0	0	119	0	0	495	0	0	0	0	**1073**	**1.27**
6	0	0	0	0	0	0	847	0	0	195	0	0	**1042**	**1.74**
7	0	0	0	0	0	1081	1644	0	0	720	0	0	**3445**	**0.92**
8	0	0	0	0	546	0	0	819	0	0	0	0	**1365**	**0.96**
9	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
10	0	0	0	0	0	235	681	0	0	1827	1103	0	**3846**	**1.11**
11	0	0	0	0	0	0	0	0	0	1520	0	0	**1520**	**0.73**
12	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
Ai	**1539**	**0**	**447**	**1382**	**1368**	**1807**	**3172**	**1314**	**0**	**4261**	**1103**	**0**	**16392**	

It is calculated for the total population of the 12 zones of the city. The 5-108 table shows the trip interchange matrix for auto. The total predicted and futured trips can be 16,392 for the 12 zones. The highest trips produced and attracted in zone – 10. The zone – 2, 9 & 12 has lowest production and attracted trips in the future.

TABLE 5:109 TRIP INTERCHANGE MATRIX FOR WALKING

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
2	0	536	0	0	0	0	1928	0	1249	0	834	0	**4546**	**1.09**
3	0	0	1480	0	0	0	0	0	0	0	0	0	**1480**	**1.00**
4	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
5	0	0	0	0	2675	0	0	1617	0	0	0	0	**4292**	**1.06**
6	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.00**
7	0	2110	0	0	0	0	5305	1255	0	3633	0	0	**12303**	**0.93**
8	0	0	0	0	1878	0	1403	358	0	0	0	0	**3640**	**0.89**
9	0	1357	0	0	0	0	0	0	2030	0	0	0	**3387**	**0.97**
10	0	0	0	0	0	0	2767	0	0	248	62	0	**3077**	**1.29**
11	0	931	0	0	0	0	0	0	0	82	0	0	**1014**	**0.88**
12	0	0	0	0	0	0	0	0	0	0	0	829	**829**	**1.00**
Ai	**0**	**4933**	**1480**	**0**	**4553**	**0**	**11403**	**3230**	**3279**	**3963**	**896**	**829**	**34566**	

It is calculated for the total population of the 12 zones of the city. The 5-109 table shows the trip interchange matrix for walking. The total predicted and futured trips can be 34,566 for the 12 zones. The highest trips produced and attracted in zone – 7. The zone – 1, 4 & 6 has lowest production and attracted trips in the future.

TABLE 5:110 TRIP INTERCHANGE MATRIX FOR OTHER PURPOSE

	1	2	3	4	5	6	7	8	9	10	11	12	Pi	Ai/Pi
1	0	0	576	395	2076	1128	363	0	0	0	1076	85	**5699**	**0.83**
2	0	2311	1262	0	0	2728	4873	0	2995	0	834	0	**15002**	**1.09**
3	1013	1982	1480	0	0	0	0	0	1015	1169	0	0	**6659**	**0.68**
4	340	0	0	15735	1915	893	478	433	0	0	560	2199	**22553**	**1.01**
5	1737	0	0	1687	4582	0	1405	3005	0	795	0	24	**13235**	**1.37**
6	609	2703	0	1261	0	6272	2123	85	1663	1745	1660	1148	**19269**	**0.96**
7	505	5139	0	500	2099	2939	18832	6543	1776	8694	277	3875	**51178**	**0.84**
8	0	0	0	455	3612	110	6114	2600	0	262	39	0	**13193**	**0.98**
9	0	3255	702	0	0	765	1876	0	4063	0	0	2885	**13547**	**1.01**
10	0	0	526	0	817	1411	6433	203	0	11039	3408	6	**23843**	**1.18**
11	536	931	0	1025	0	867	88	12	0	3763	15036	41	**22299**	**1.03**
12	0	0	0	1808	3020	1313	338	0	2146	575	0	6559	**15760**	**1.07**
Ai	**4740**	**16323**	**4546**	**22865**	**18121**	**18425**	**42923**	**12881**	**13657**	**28043**	**22891**	**16822**	**222237**	

It is calculated for the total population of the 12 zones of the city. The 5-110 table shows the trip interchange matrix for other purpose. The total predicted and futured trips can be 2,22,237 for the 12 zones. The highest trips produced and attracted in zone – 7. The zone – 1 has lowest production and attracted in zone - 3 trips in the future.

TABLE 5:111 FINAL O-D MATRIX FOR ALL TRAVEL PURPOSE AND TRAVEL MODES OF VADODARA CITY

	1	2	3	4	5	6	7	8	9	10	11	12
1	9680	117	6764	1075	10973	3667	2370	19022	1464	1227	1407	851
2	119	26257	9975	1127	2037	6968	23591	7569	21675	7492	1561	1188
3	11298	19034	30695	1524	6829	9825	8379	3010	31215	4965	0	4922
4	1179	1095	770	57785	9619	7646	8971	1256	2144	5783	1838	35021
5	9129	1664	3237	7472	41099	20495	14484	16130	5646	8871	2933	5122
6	4647	6951	7883	8890	27891	44702	35823	15409	14551	38028	35482	20653
7	3194	25217	4246	10548	20205	35504	96843	19679	19820	39420	4710	7016
8	20949	7971	1946	1310	19478	12869	18489	16351	2296	3287	950	1468
9	1797	24054	20433	2449	7976	12979	20125	2322	48333	3986	1839	7558
10	1947	5301	2431	5313	10263	28195	29528	3195	3036	87266	25779	5798
11	924	1720	0	2463	4342	33340	6825	1086	1980	32786	56479	975
12	867	1213	2837	31845	8737	18164	2923	1260	6190	6595	740	56320
Ai	**65731**	**120593**	**91215**	**131801**	**169447**	**234354**	**268351**	**106288**	**158352**	**239705**	**133718**	**146893**
Pi	**58617**	**109559**	**131695**	**133108**	**136280**	**260911**	**286402**	**107366**	**153852**	**208052**	**142918**	**137690**
Ai/Pi	**1.12**	**1.10**	**0.69**	**0.99**	**1.24**	**0.90**	**0.94**	**0.99**	**1.03**	**1.15**	**0.94**	**1.07**

It is calculated for the total population of the 12 zones of the city. The 5-111 table shows the trip interchange matrix for all purposes and all travel mode. The total predicted and futured trips can be 18,66,449 for the 12 zones. The highest trips produced and attracted in zone – 7. The zone – 1 has lowest production and attracted trips in the future.

6. CONCLUSION

Travel demand estimation is one of the most important and difficult tasks in transportation planning process. Trip making process involves human decision making, where in uncertainty prevails. Trip distribution from residence as origin and activity centre as destination is affected significantly by the land use, income level and vehicle ownership. The present research is attempts to brief the application of Gravity trip distribution modelling for predicting trip distribution for study area. In this study of Vadodara city is taken as study area. For this analysis 898 households were surveyed by home interviewed survey and the following are the main outcomes of the survey.

6.1 HOUSEHOLD AND SOCIO-ECONOMIC CHARACTERISTICS

- The average household size found out 3.92 in the study area consisting 1.39 working members and 0.90 student members in each house. The average number of non-working members per household is 1.44.
- There is average car ownership is 0.45 and two-wheeler ownership is 1.62. This reveals the households in the study area may belong to medium income and study area is highly population density.
- In the micro level analysis, that is zone wise, it is found that Average household size is high in Zone – 2 and low in Zone 3.
- Working members vary from 1.11 to 1.67 in different zones. More number of working members is observed in Zone - 7. Student members vary from 0.58 to 1.23 in a family. Highest observed are in Zone – 11 and lowest is for Zone - 8. Average number of non-working members vary from 0.91 to 1.97.

6.2 TRIP CHARACTERISTICS

6.2.1 TRIP RATES

- It is observed that out of all the trips 49% are work trips. 30% are educational trips. Discretionary trips including social, shopping and recreation together constitutes 21%.
- The average trip rate is 1.21.
- Highest trip rate is in zone – 7 (1.68) and lowest trip rate is in zone – 12 (0.99).

6.2.2 INTER - INTRA ZONAL TRIPS

- There is an average 88% of the work trips are inside the study area this is due to mix land use, as the study area consist major market places of city, city general hospitals and many government offices. There is an average 12% work trips going outside the study area. This may be because of better opportunity for the employment.
- There is an average 87% of the education trips are inside the study area this is due to the availability of schools and colleges. There is an average 13% education trips going outside the study area.
- There is an average 96% of the shopping trips are inside the study area this is due to the availability of markets and malls.
- There is an average 90% of the others trips are inside the study area.
- Average intra zonal trips are observed in the study area are of 91%, 82%, 93%, 71%, 100%, 98%, and 87% for households owning two-wheeler, four-wheeler, auto, bus, bicycle, walking and vanpool respectively.

6.2.3 VEHICLE OWNERSHIP IMPACT ON ACCESSIBILITY

- Impact of Vehicle ownership is analysed by accessibility vs. distance graph. It is observed that Accessibility of two-wheeler is low compared to four-wheeler, auto, bus and walking, as low-income people desire shorter trips and resist more with trip length.
- Average trip length of Walking and Bicycle is quite lower compared to average trip length of Two-wheeler and Four-Wheeler.
- When family income is low the trips generated are significantly low and as the size increases the trips being generated by the family also increases.
- As the household size increases the trips generated by the family also increases significantly. As when household size is 1 the trip being generated is 2 and when household size is 8 trips generated are 4.
- When employed person in Household is low the trips generated are significantly low and as the person increases the trips being generated by the employed people also increases. But at the Stage, where the Household have more than 5 to 6 employed people the trips generated per day also decreasing.
- A fair relationship between trips and the number of vehicles owned by the family i.e., increase in the number of vehicles corresponds to higher number of trips made by family.
- People with higher income make more trips than people with a lower income. The most common mode of trip is 2W, this is because commuters will decide to ride on 2W than join Public Transportation since there is lot of traffic congestion.
- A fair relationship between trips generated and Journey Time. As the Journey Time increases the trips generated by the family also increases significantly. When the Journey time reach at more than 30 mins, the also trips per day are increasing, which means the more people are more traveling for the Work purpose.

6.3 PROPOSED TRIP DISTRIBUTION MODELS

Trip distribution Gravity model is developed here for analysing the trip distribution of the study area.

6.3.1 CONVENTIONAL GRAVITY TRIP DISTRIBUTION MODEL (SG-UTDM)

- Zonal generation and attraction rates and zonal separation distances are the main input of the model.
- The model calibration was based on estimating for different purposes with travel mode. The calibration was monitored through comparing the trip length distributions and average trip lengths for different purposes. The most important findings of this research are average trip lengths for different purposes. The overall average trip length (for all purposes combined) proves to be proportional to the small size of a dense city such as Vadodara.
- Realizing the influence of vehicle ownership on trip distribution, four different models using trip purpose have been developed for vehicle ownerships as households have two-wheeler, four-wheeler, auto, bus, walking, vanpool and bicycle are calibrated as 1.7, 1.5, 1.1, 1.1, 1.3, 2 and 1.2 respectively.
- For vehicle ownership having walking and auto α Value is very less this shows accessibility is high but the samples belonging to this category is very less so this α Value cannot describe very well or they might use public transport.
- α Value for household have bus and auto are coming same that means this households are having same trip making behaviour.
- Households owning Bicycle have higher accessibility with another zone compare to house hold owning two-wheeler and four-wheeler.
- From trip length frequency distribution of observed trips and simulated/modelled trips, it is concluded that the modelled trips are close to observed trips and the difference between observed and simulated trips is not more than 2 %.

The model proves to be sensitive and able to reflect different sensitivities to trip lengths for different trip purposes with longer work trips and shorter shopping trips with variable trip lengths for other purposes. Moreover, the share of the mandatory trips combined is slightly less than 67% which is less than the well-known 60–70% of the developing country. This is a good indicator of a shift toward more leisure trips in the city.

By using this model, the trip distribution prediction can be done for whole city.

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APPENDICES

THE M. S. UNIVERSITY OF BARODA Department of Architecture Research Project: Trip Distribution & Trip assignment in Baroda City Researcher: Pushpak Patel	Sample No.______	Home/Area: ______________
	Date: __________	Time:_________

1	Family Structure:	Joint Family ☐	Nuclear Family ☐

2. How many Vehicles do your household own?

Car		Two-Wheeler		Bicycle		Other	

3. Income (Per Month)

Rs. (Thousands)	< 10 ☐	10 – 15 ☐	15 – 25 ☐	25 – 45 ☐	45-60 ☐	> 60 ☐

4.

Member	Age	Gender	Primary Transport Mode	Trip Purpose	Destination Zone	Approx. Trip Length (KM)	No. of Trips: Daily	No. of Trips: Weekly	No. of Trips: Monthly	Departure Time**	Return Time**
1. ________ **Occupation** Govt. ☐ Semi Govt ☐ Professional ☐ Business ☐ Education ☐ Home Maker ☐		Male ☐ Female ☐	Car ☐ Two-Wheeler ☐ Public Transport ☐ Bicycle ☐ Others: (Specify)__________	Work							
				Shopping							
				Recreation							
				Social							
				Education							
2. ________ **Occupation** Govt. ☐ Semi Govt ☐ Professional ☐ Business ☐ Education ☐ Home Maker ☐		Male ☐ Female ☐	Car ☐ Two-Wheeler ☐ Public Transport ☐ Bicycle ☐ Others: (Specify)__________	Work							
				Shopping							
				Recreation							
				Social							
				Education							

Member	Age	Gender	Primary Transport Mode	Trip Purpose	Destination Zone	Approx. Trip Length (KM)	No. of Trips			Departure Time**	Return Time**
							Daily	Weekly	Monthly		
3. ___________ **Occupation** Govt. Semi Govt Professional Business Education Home Maker		Male Female	Car Two-Wheeler Public Transport Bicycle Others: (Specify)___________	Work							
				Shopping							
				Recreation							
				Social							
				Education							
4. ___________ **Occupation** Govt. Semi Govt Professional Business Education Home Maker		Male Female	Car Two-Wheeler Public Transport Bicycle Others: (Specify)___________	Work							
				Shopping							
				Recreation							
				Social							
				Education							
5. ___________ **Occupation** Govt. Semi Govt Professional Business Education Home Maker		Male Female	Car Two-Wheeler Public Transport Bicycle Others: (Specify)___________	Work							
				Shopping							
				Recreation							
				Social							
				Education							
6. ___________ **Occupation** Govt. Semi Govt Professional Business Education Home Maker		Male Female	Car Two-Wheeler Public Transport Bicycle Others: (Specify)___________	Work							
				Shopping							
				Recreation							
				Social							
				Education							