ASSESSING THE FACTORS WHICH INFLUENCE THE USAGE OF PUBLIC TRANSPORT UNDER DIFFERENT URBAN CHARACTERISTICS - CASE STUDY OF VIJAYAWADA

A thesis submitted

in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF PLANNING

Submitted By

Bolla Sravani

2190200268

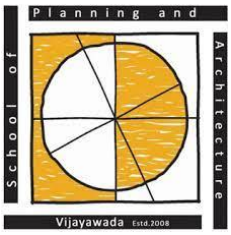
2019-2023

Thesis Supervisor

Ms. Naina Gupta

Assistant professor

Department of planning



DEPARTMENT OF PLANNING

SCHOOL OF PLANNING AND ARCHITECTURE

Vijayawada, Andhra Pradesh

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UNDERTAKING

I, **Ms. Bolla Sravani** hereby declare that the thesis titled **"Assessing the factors which influence the usage of public transport under different urban characteristics – Case Study of Vijayawada"** is a record of original research work undertaken by me towards partial fulfilment of the requirements for the award of the Bachelor of planning in the Department of Planning, School of Planning and Architecture, Vijayawada. The work has not been submitted to any other organization/ institution for the award of any Degree. I hereby confirm the originality of the work and that there is no plagiarism in any part of the Thesis.

Name**: Bolla Sravani**
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2019-23

Date: 10-05-2023

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School of Planning and Architecture, Vijayawada
An Institute of National Importance, Ministry of Education Gov. of India

CERTIFICATE

This is to certify that the thesis tilted "**Assessing the factors which influence the usage of public transport under different urban characteristics – Case Study of Vijayawada**", has been submitted by **Ms. Bolla Sravani** (Reg.No.2190200268, Batch of 2019-23) at the department of planning, towards partial fulfilment of the requirements for the award of Bachelor of Planning. This is a bonafide work of the student

RECOMMENDED

_____

Signature of the supervisor
Ms. Naina Gupta
(Assistant professor)

ACCEPTED

_____

Signature of the Head,
Department of planning
Prof. Dr. Adinarayanane. R

DISCLAIMER

The content produced in the thesis report is an original piece of work and takes due acknowledgement of referred content, wherever applicable. The thoughts expressed herein remain the responsibility of the undersigned author and have no bearing on or does not represent those of School of Planning and Architecture, Vijayawada.

Name**: Bolla Sravani**
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Abstract

As the city of Vijayawada is growing very rapidly in terms of development population and economy the city needs a specific care in its growing development pattern. Existing share of public transport is 21% from development plan but desired share of public transport as per population according to NTUP is 50% which needs to improve and desired mode of transport is non-motorized vehicles, motorized IPT, high-capacity bus system, rail-based public transport so it requires high-capacity bus system based public transport. In the present city bus service, the main bus route ply through Bandar Road, Eluru road, Ibrahimpatnam route, Prakasam road, milk factory route and nunna route. All other roads in the city have no bus services or poor service frequency. Each bus route has completely different frequency level leading to high waiting time in some area. Buses are accessible to 70% of Vijayawada residents, however only 30% use them. Bus terminal in Vijayawada receives 3 lakh passengers each day and experiences an annual loss of roughly 90 lakh rupees. and has a population of 14.76 lakh people and is one of the densely populated cities, with about 31,200 people per square. Due to the high cost of land and the populace's reluctance to part with their lands, the city has a limited public transportation system. Thus, the city of Vijayawada needs to improve public transport with respective to population and development. By promoting public transportation, we can reduce the influence on traffic, pollution, and other environmental factors. This study looks at the indicators of public transportation in various urban characteristics that limit reliance on public transportation and to increase ridership by improving those indicators.

Keywords: Public transport, urban characteristic, weighted mean method, mode choice model scenario analysis.

Table of contents

List of figures

List of tables

Chapter 1. Introduction

All vehicle services intended to convey people along local and regional routes are considered public transit. Rail and organized bus-based systems will be the only public transportation options. The BRTS project, the municipal bus system, and public transportation infrastructure such bus stations, terminals, transit systems, and control centers are all part of the road-based transportation system. Fixed origins, fixed destinations, set timetables, fixed stop places, and fixed charges are characteristics of public transportation networks. When transportation systems are effective, they offer economic and social opportunities and benefits that have a positive multiplier effect and lead to better market accessibility, employment opportunities, and additional investments. Benefits of public transportation include increased fuel efficiency, decreased air pollution, reduced traffic congestion, cost savings, and good alternatives for tourists. Frequency of service, speed of service, passenger load, dependability, bus delays, real-time bus availability, safety level, vehicle comfort level, and accessibility are all factors that affect public transportation. Approximately 25-75% of all trips are made using public and non-motorized modes of transportation. In India, the transport sector's greenhouse gas emissions are mostly caused by the road system, accounting for 90% of emissions. The primary source of greenhouse gas emissions from this industry was the usage of on-road vehicles to consume fossil fuels. Vehicle emissions are responsible for 72% of Delhi's air pollution. According to a 2015 analysis of urban mobility in India, public transport accounts for 90% of GHG emissions. Indian government initiatives to enhance public transport include The National Urban Transport Policy's objective is to ensure that the growing number of city residents have access to jobs, education, recreation, and other needs within the cities in a safe, affordable, quick, comfortable, reliable, and sustainable manner. JnNURM seeks to create "economically productive, efficient, equitable, and responsive Cities" through a strategy of upgrading urban social and economic infrastructure, to achieve a major improvement in road safety, implement the National Road Safety Policy. Raise Awareness of Road Safety Issues, National Electric Mobility Mission Plan is a culmination of a Comprehensive Collaborative Planning for Promotion of Hybrid and Electric Mobility in India, Schemes to Strengthen Public Transport is to Provide Latest Technologies such as GPS/GSM based Vehicle Tracking System, Covering Inter-City

and Mofussil Areas Computerised Reservation System, Electronic Ticket Vending Machines, Passenger Information System, etc. for Serious Issues, Including: Serious Road Safety Issues.

The Days and years passed, and city buses developed just like anything else. People were scared to travel a city bus due to several problems, including unpredictable operations, poor bus maintenance, and frequent accidents. The RTC then came on the program. The then-expanding STU provided city bus service to every city in the state. In the cities of Hyderabad, Warangal, Visakhapatnam, Vijayawada, Guntur, and Tirupati, the APSRTC City Buses provide first-rate service. The number of individuals using RTC city services increased along with the threat posed by private city buses. The RTC and the private operators used to argue about the operations. To put a stop to this chaos, the RTC Workers requested the Andhra Pradesh government to nationalize Vijayawada City Buses. In Vijayawada, the City Bus Operations first started in the 1970s. Private individuals and organizations used to drive city buses with Route Permits. The network, which started with 3 routes and has since grown to 65 routes and about 100 routes, After Visakhapatnam and Hyderabad, Vijayawada is the third city in the Andhra Pradesh state to have its city bus system nationalized. The visionaries who brought about the incredible miracle of nationalization also foresaw the risks associated with municipal transit (vijayawada-city-transport-division-apsrtc, 2019). The choice to establish a separate division particularly for Vijayawada City Buses led to the creation of the Vijayawada City Transport Division (VCTD) - APSRTC. Following the Medaram Festival that year, the city received its first shipment of brand-new city buses. The growth and alteration of the City Bus System were advantageous to the RTC when it was nationalized. The VCTD optimized bus routes in various cities, eliminated some, and created new ones where necessary. Suburban lines were originally introduced in the city; today, the whole network inside these boundaries is referred to as the City Zone, and City Bus Passes are accepted there. The many types of city bus services are City Ordinary, Metro Express, Metro Deluxe, and Metro Luxury A/C services. APSRTC also received many plaudits for the Vijayawada City Transport concept, the most. Nevertheless, despite this, it continues to lose about 90 lakh rupees annually as a result of certain supply and demand factors that lessen the reliance on public transport. The city also has a limited public transport system

as a result of the high cost of land and the population's unwillingness to part with their holdings. In this study, we examine how different metropolitan characteristics affect public transportation demand and supply. By reducing reliance on public transportation and increasing supply, we can increase ridership on public transportation.

1.1 Research question

What are the different factors which influence the mode choice behavior of the public transport user?

Chapter 2. Literature study

2.1 Public transport supply indicators

Respondent questionary include name, gender, age, last education, occupation, monthly income, the purpose and purpose of the respondent's trip, the quality of public transportation services in Jember Regency, and factors influencing the selection of criteria for public transportation services in Jember Regency (Kriswardhana, 2022). Background information of the respondents like age, sex, destination, frequency of trips and service. In previous literature, the most relevant features of the transportation system regarding the user satisfaction were found to be: trip duration. reliability, fare. network connectivity information, comfort, safety, accessibility, and staff's behavior (Peungnumsai, 2020). The first step in developing new TPI indicators is to identify public transport supply-demand gaps and their equity. This analysis of public transport supply distribution through accessibility, availability, and capacity, as well as public transport demand distribution estimated by travel demand model, was integrated. (Enoch F. Sam, 2014).

2.2 Public transport demand indicators

Urban transport details like ridership, modal share, fleet of electric buses etc. and indicators of sustainable urban transport index like Traffic fatalities, public transport quality and reliability, Operational costs of the public transport system, Air quality,

Greenhouse gas emissions from transport, intermodal facilities and infrastructure for active modes and Modal share of active and public transport in commuting etc. number of fleets operating based on routes and vehicle codes (Burinskiene, 2012). Operator survey questions like Reliability of bus/ service provider, Quality of in-vehicle experience, Service availability, Perceived safety of bus/ accident record, Comfort/ vehicle quality, Fare affordability (secretariat, 2018).

2.3 Mode choice modelling

Choice Set Formation - considers resource limits and personalized travel costs and times when modelling mode choice.

Statistical modeling - The practice of using statistical models and presumptions to produce sample data and make predictions about the real world is known as statistical modelling. It aids data scientists in strategically interpreting datasets and visualizing the connections between random variables.

Soft compute basicing - soft computing is the use of approximations to generate erroneous but workable answers to challenging computer issues. The method allows solutions for issues that would be impossible or just take too long to tackle with the gear we now have. Computational intelligence is a term occasionally used to describe soft computing. (Ibrahim, 2016).

Analytical hierarchy process - The Analytic Hierarchy Process (AHP) is a decision-making method that was developed by Thomas L. Saaty in the 1970s. It is a structured approach to decision-making that helps individuals and teams to prioritize options and make informed choices. The AHP process involves breaking down a decision into a hierarchy of criteria and sub-criteria, and then assigning numerical values to each criterion based on its relative importance. These values are then used to calculate a weighted score for each option, allowing the decision-maker to identify the best choice based on their priorities.

Statistical product for solution service model – Numerous modelling techniques drawn from statistics, artificial intelligence, and machine learning are available in SPSS Modeler. You can create predictive models and extrapolate new knowledge from your

data using the tools offered by the Modelling palette. Each approach has advantages and works well for types of issues.

Linear rescaling - One way of rescaling the ratings on k-step primary rating scales to make the findings similar when utilizing primary scales with varying numbers (k) of ratings is linear scale transformation.

Mode choice model - Models of mode choice is used to examine and forecast the decisions that individuals or groups of individuals make when deciding which modes of transport to employ for different kinds of journeys. Predicting the proportion or total number of trips taken by each mode is often the objective. Predicting the fraction of trips drawn to public transport is a key goal in mode choice modelling. (Juremalani, 2017).

Fuzzy logic – Fuzzy logic is a method of processing variables that enables the processing of several potential truth values through a single variable. Fuzzy logic makes an effort to resolve issues using an open, imperfect spectrum of facts and heuristics that enables the production of a variety of exact conclusions.

Discrete Choice Model - In a discrete choice model, the probability that a person would select a specific option is expressed as a function of factors that are related to both the alternatives and the individual making the choice. (Shlomo Bekhor, 2009).

2.4 Survey approaches

Preference survey - A particular research technique used to gather information about people's preferences for various possibilities is the preference survey. It is a survey that typically asks respondents to rate their preferences for each choice or rank them in order of preference after presenting them with a list of possibilities. Numerous applications for preference surveys exist, such as market research, political polling, and analysis of public policy. They can assist organisations make more informed decisions regarding product development, marketing efforts, and policy initiatives by offering useful insights on consumer or voter behaviour.

Stated preference survey - A survey type known as a "stated preference survey" asks respondents to rank their choices for potential outcomes or alternatives. A stated

preference survey aims to discover how people value various product or service features and how these attributes affect their decision-making. In market research, transportation planning, and environmental policy analysis, stated preference surveys are frequently utilised. One way to learn how commuters value various trip time, cost, and comfort features of public transport options is to conduct an expressed preference poll, for instance.

Survey planning sampling - Any successful survey research project must include survey planning and sample. Planning entails establishing the study's goals, creating the survey's questions, identifying the intended audience, and calculating the sample size. Sampling is the process of choosing a portion of the intended audience to take part in the survey.

Individual in-depth survey - Comprehensive interview with just one subject. Gaining a deeper knowledge of the participant's views, opinions, and experiences in relation to a specific topic or issue is the goal of an individual in-depth survey. Market research, social science research, and public policy analysis frequently use individual in-depth surveys. They can offer rich, comprehensive data that would be challenging to find using other research techniques.

Longitudinal surveys - In order to track changes in a group of people's views, actions, or other characteristics over time, longitudinal surveys follow participants over a prolonged period. Researchers can investigate how things change over time and spot patterns and trends via longitudinal surveys as opposed to cross-sectional surveys, which collect data from a single point in time. A variety of subjects, such as health and wellbeing, education, employment, and social and economic trends, can be studied using longitudinal surveys. They allow researchers to monitor changes in participants' behaviours or outcomes before and after an intervention is adopted, making them especially helpful for examining the long-term consequences of treatments or policies.

Chapter 3. Research formulation

The act of creating a research topic or hypothesis and specifying the parameters and goals of an investigation is known as research formulation. It entails locating an issue or knowledge gap,

formulating a research question that addresses the issue, and selecting the best methodology for pursuing the question.

3.1 Hypothesis

Improving public transportation supply which enhance the public transportation ridership.

3.2 Aim

To analysis the supply and demand indicators of public transport in different urban characteristics which hinders the public transportation dependency and improving supply of public transport which enhance public transportation ridership.

3.3 Objectives

The study is expected to

- Assessing the existing public transportation characteristics.
- To delineate zones with low, moderate, and high public transport supply and understand the influence of urban characteristics of public transport usage.
- Analysis the existing patterns of public transport under urban characteristics.
- To model the influence of urban characteristics on mode choice behavior.
- Recommending strategies for improving the ridership of public transport.

Urban characteristics in general definition means Population, Site, Function, land use, hierarchy of settlement, growth process, Heterogeneity, Politics, Work, Segmentation of personality, Regimentation, Social distance, Formality of relations, Anonymity, Mobility and transiency, Urban Facilities, Formal Social Interaction, Social Institutions and Social Organizations, economic mobility, High Standard of Living etc.

Urban characteristics according to our objective – Population density, Bus shelters density, land value and distance from CBD. Using these urban characteristics, we delineate the wards

3.4 Methodology

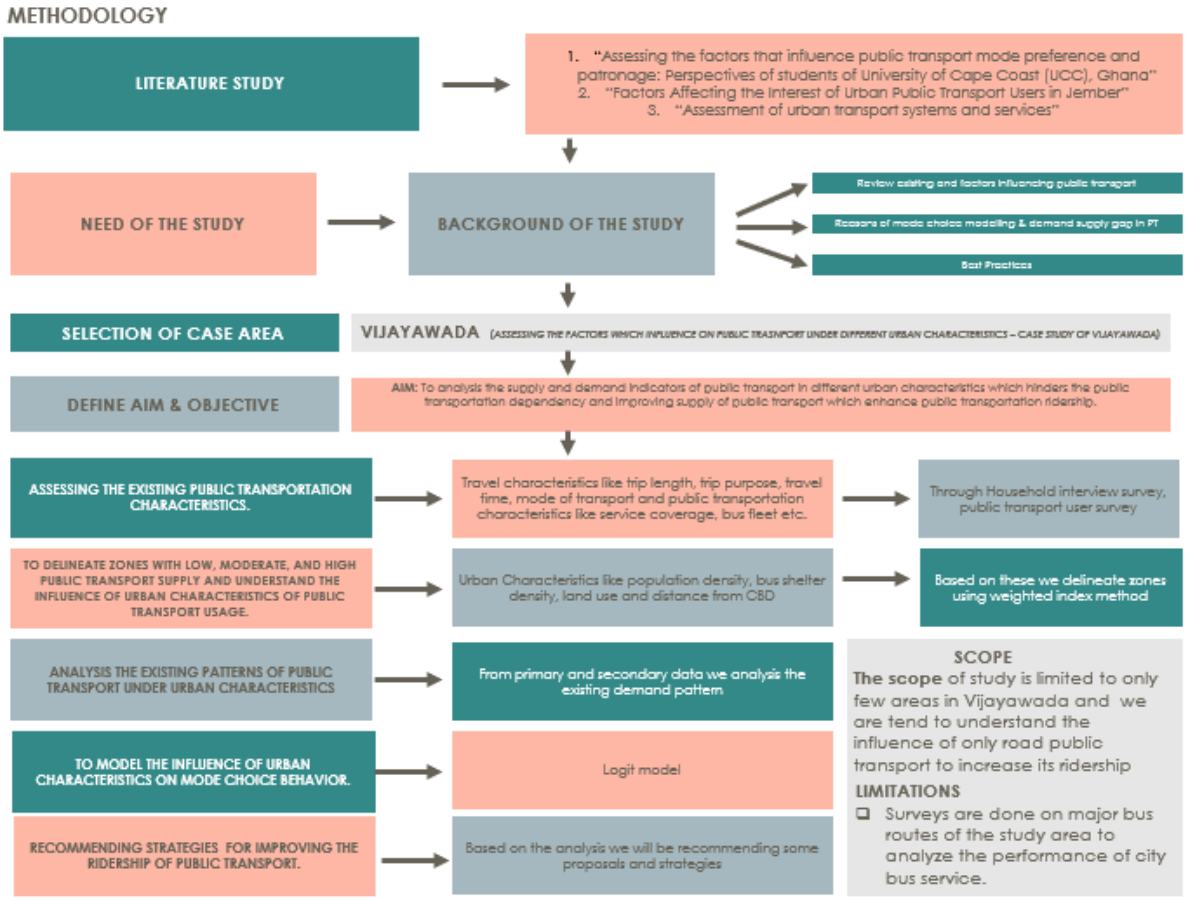


Fig. No. 1 Methodology

First we should know the need of the study and background of the study like reviewing of existing public transport profile, factors influencing public transport demand, reasons of mode choice modelling, demand and supply gap in public transport and best practices and then selection of case area and then define aim and objectives with analyzing existing public transport characteristics with supply and demand indicators and compare the public transport pattern demand in the study area with respect to suppliers and delineate different traffic analysis zones for the study area. To model the influence of urban characteristics as mode choice behavior and propose strategies to improve quality of service with in public transport facilities and user friendliness

3.5 Scope

The scope of study is limited to only few areas in Vijayawada and we are tending to understand the influence of only road public transport to increase its ridership.

3.6 Limitations

Surveys are done on major bus routes of the study area to analyze the performance of city bus service. Study is done only by focusing few major urban characteristics.

Chapter 4. Study area

The Andhra Pradesh Capital Regional Development Authority oversees the administration of the Vijayawada City, also referred to as "Bezwada," which is a city in the state of Andhra Pradesh. It is located at 16°29' to 16°40' N Latitude and 80°28' to 80°46' E Longitude on the banks of the Holy River "Krishna" (APCRDA). With nearly 31,200 people per square kilometer, Vijayawada, one of the most crowded cities, has a population of 14.76 lakh. The city takes approximately 160 square kilometres of land. Vijayawada, a thriving town with 78 wards and a VMC size of 61.88 sq. km, is in the NTR District of coastal Andhra Pradesh. It is the 34th largest city overall and the second largest in the state of Andhra Pradesh. Indrakeeladri Hills, part of the Eastern Ghats, surround it as it sits along the banks of the Krishna River in Krishna District. The designated Vijayawada Metropolitan Area encompasses 104.8 square kilometres. The city falls into the Tier-I and Metropolitan city categories. The Andhra Pradesh Capital Regional Development Authority oversees the administration of the Vijayawada City, also referred to as "Bezwada," which is a city in the state of Andhra Pradesh. With nearly 31,200 people per square kilometer, Vijayawada, one of the most crowded cities, has a population of 14.76 lakh. The city occupies an area of 160 square kilometers.

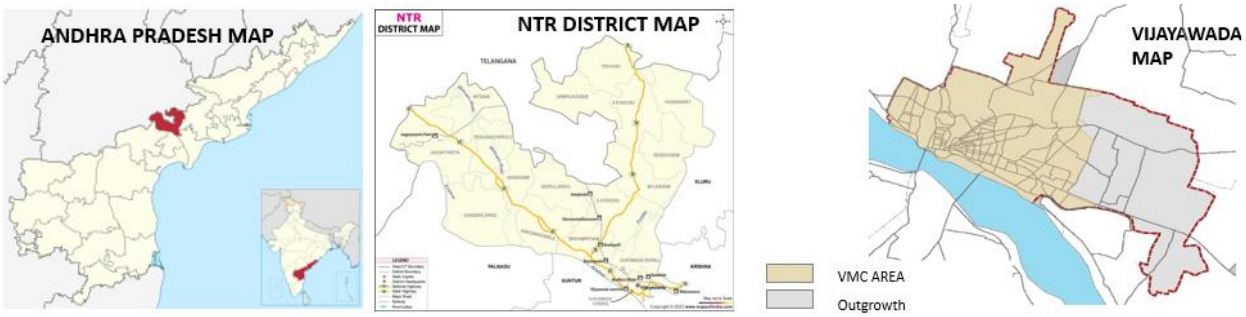


Fig. No. 2 Location map

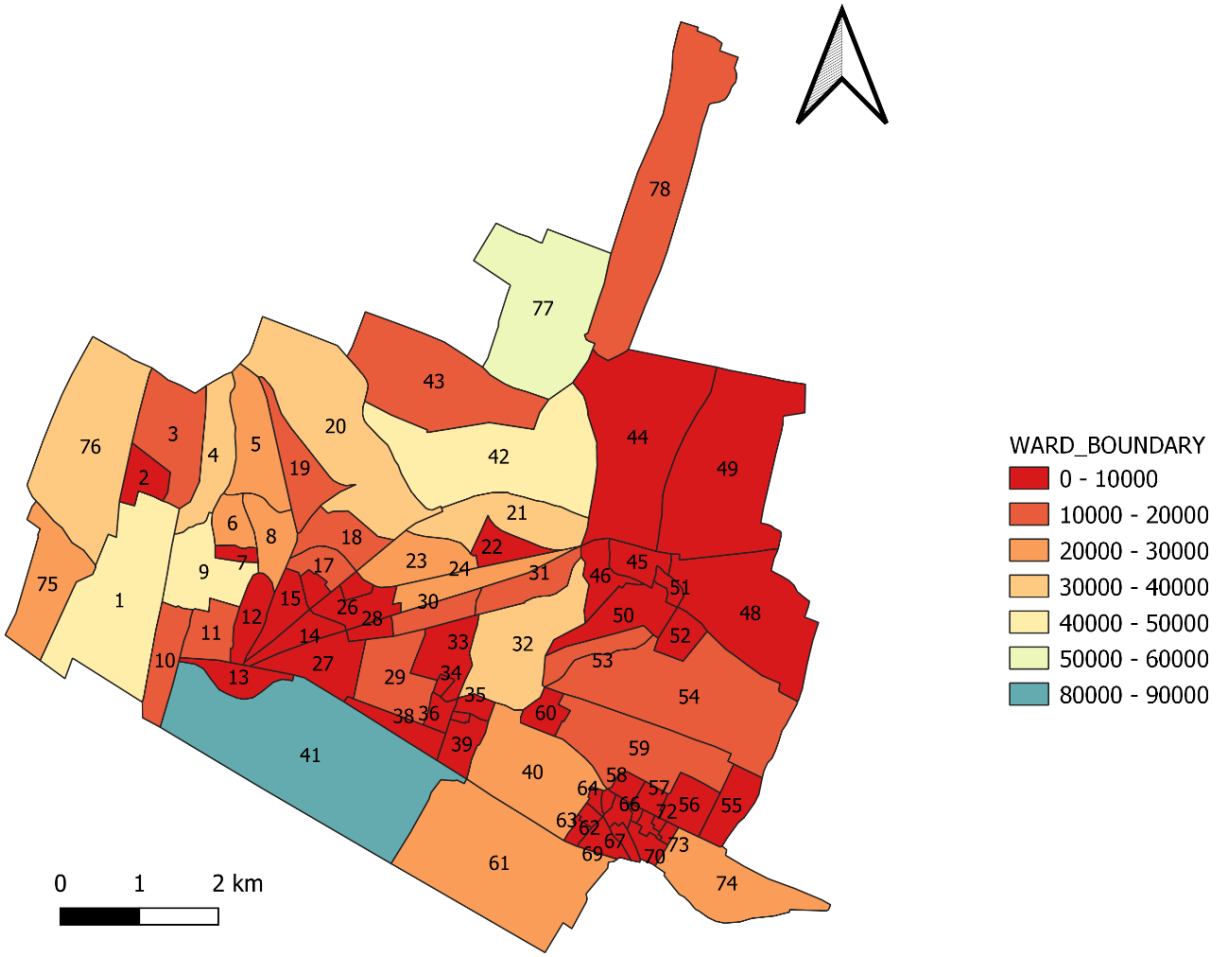


Fig. No. 3 Population map

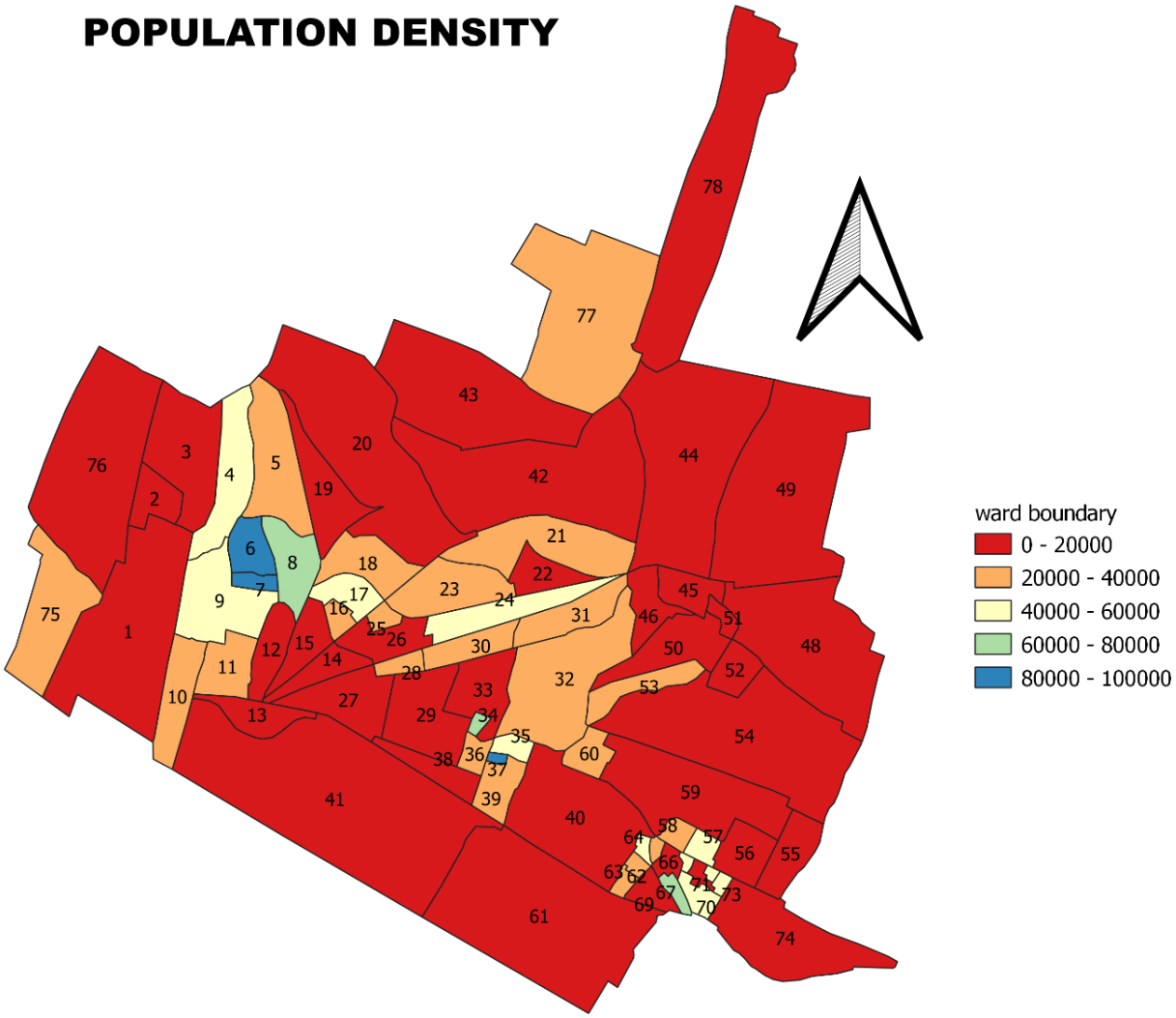


Fig. No. 4 Population density map

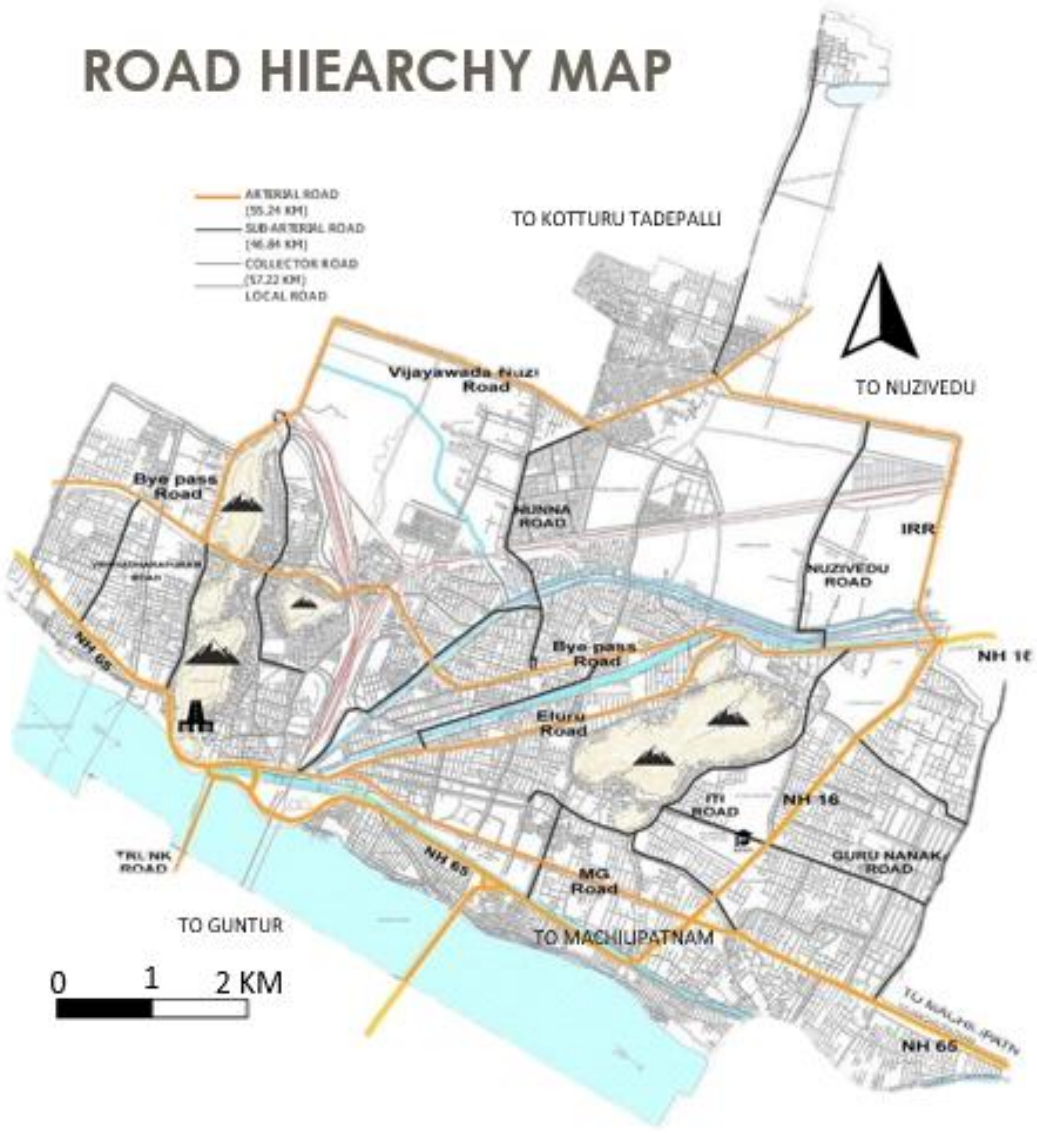


Fig. No. 5 Road hierarchy map

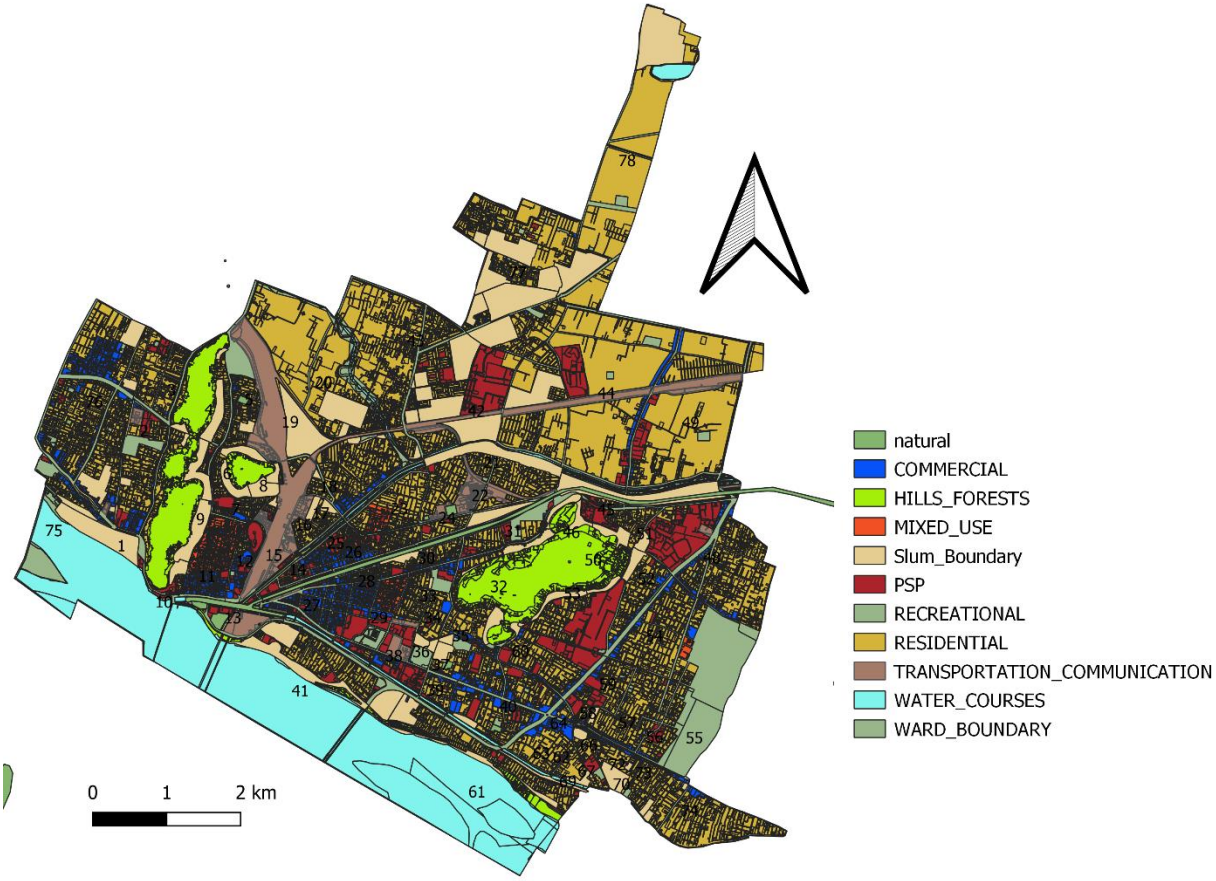


Fig. No. 6 Land use map

4.1 Site selection criteria

As One of the biggest cities in the Andhra Pradesh state is Vijayawada. It is one of the state's principal economic and cultural hubs. The city is expanding quickly as a national multifunctional metropolis. The population of Vijayawada is close to 2 million. Consequently, a high-capacity bus infrastructure is needed. One of Asia's largest and busiest bus terminals, it is both. It is impossible to identify traffic and travel patterns due to the accessibility, availability, and greater familiarity of the city with surveying and obtaining precise data as soon as two days after the survey.

4.2 Vijayawada public transport

500 city buses are being run by the Vijayawada City Transport Division on 130 regular routes that pass through all the major areas of the city and its surroundings. There are eight bus depots that operate these. The STU transports 3 million passengers every day while losing over 90 lakh rupees a year. Regular city buses run to Kaza (KRISHNA DISTRICT) in the east, Hanuman Junction in the north-east, Vissannapeta in the north, Jamalapuram (Telangana) in the north-west, Kodada (Telangana) in the west, Amaravati Temple in the south-west, and Chinakakani Y Junction in the south. The various types of city bus routes include urban, suburban, rural, and mofussil. The many types of city bus services are City Ordinary, Metro Express, Metro Deluxe, and Metro Luxury A/C services. All bus ticket costs are rounded to the next multiple of 5 to avoid disputes over change. 70% of Vijayawada inhabitants have access to RTC City Buses, yet only 30% use them. Additionally, 28% of city buses operate on the Metro Express and 70% on the City Ordinary. The most recent accolade APSRTC received in connection with the Vijayawada City Transport concept was for Best Mileage. Vijayawada has been the main hub for city buses travelling to Amaravati, the capital city, since 2015. In addition to the 26 regular city buses, it also runs roughly 24 special routes to the High Court and the Secretariat. Among these distinctive services are buses like City Ordinary and Metro Express. The seating capacity is 56, with 60 passengers during peak hours and only 15 during off-peak hours. There are 500 buses in all. There are now 141 bus stations and 8 bus depots. The

city's bus route network is 65 km long, with 130 bus routes and 568 daily trips.

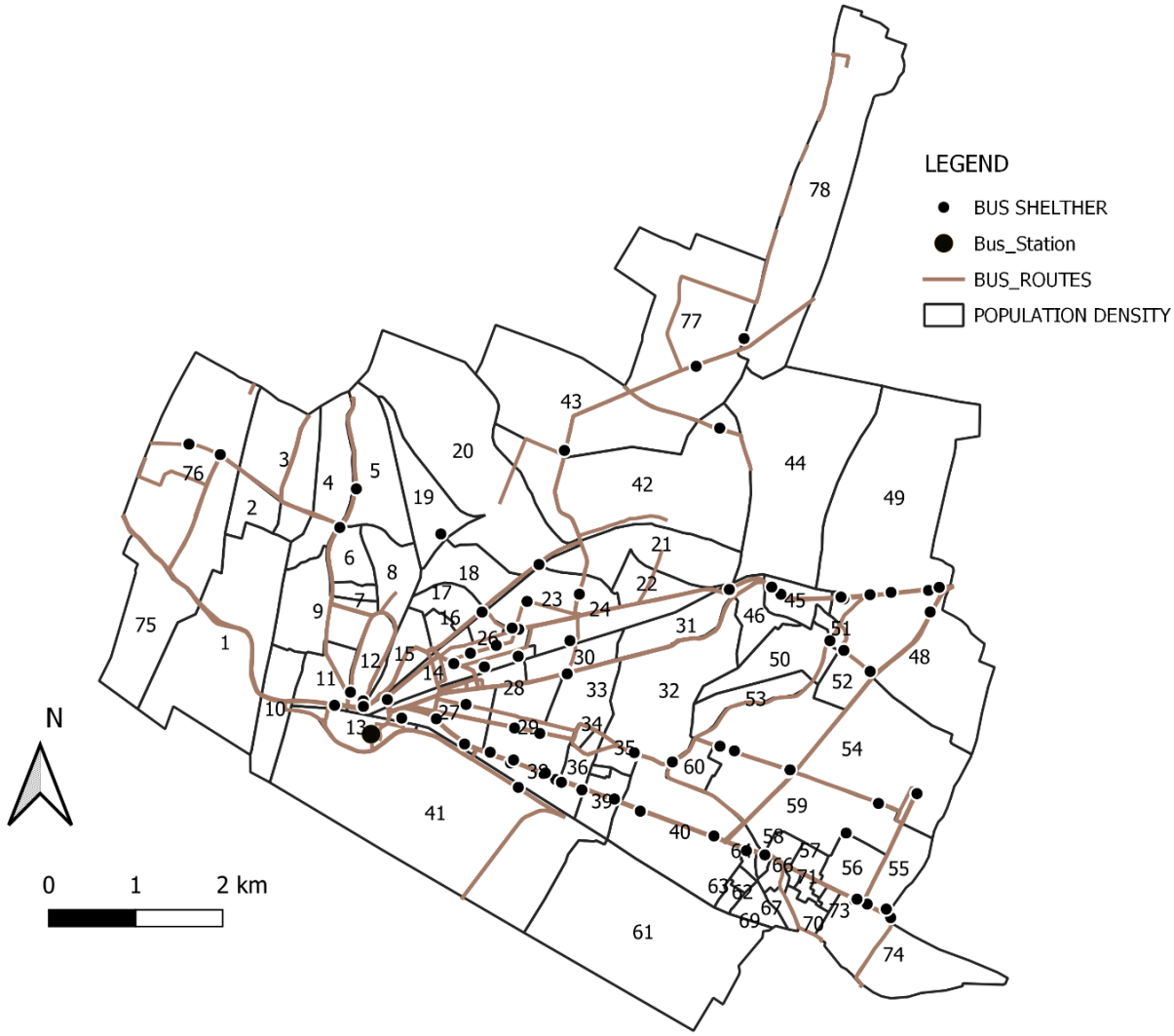


Fig. No. 7 Bus routes and bus shelter

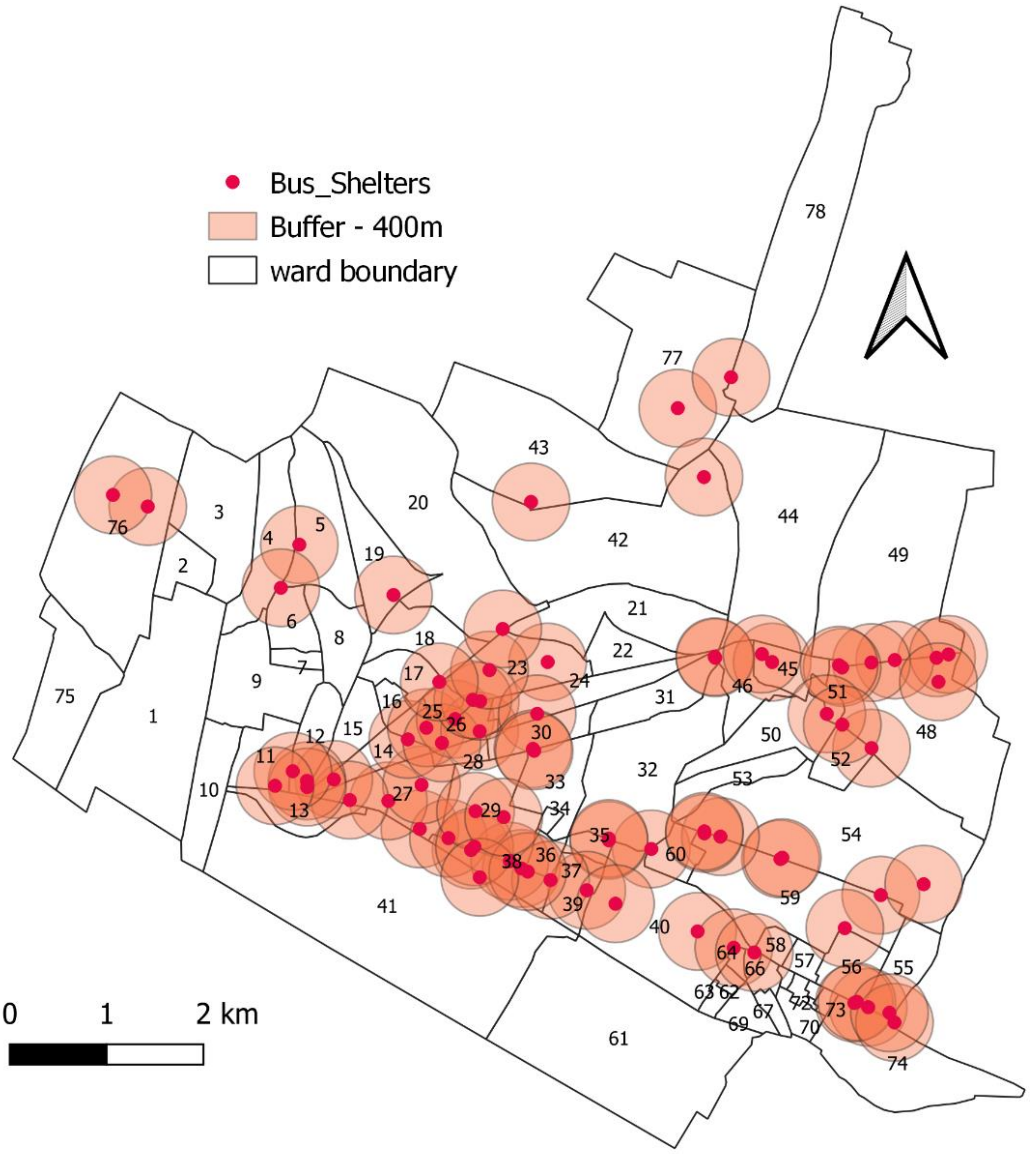


Fig. No. 8 Bus shelters with 400m buffer

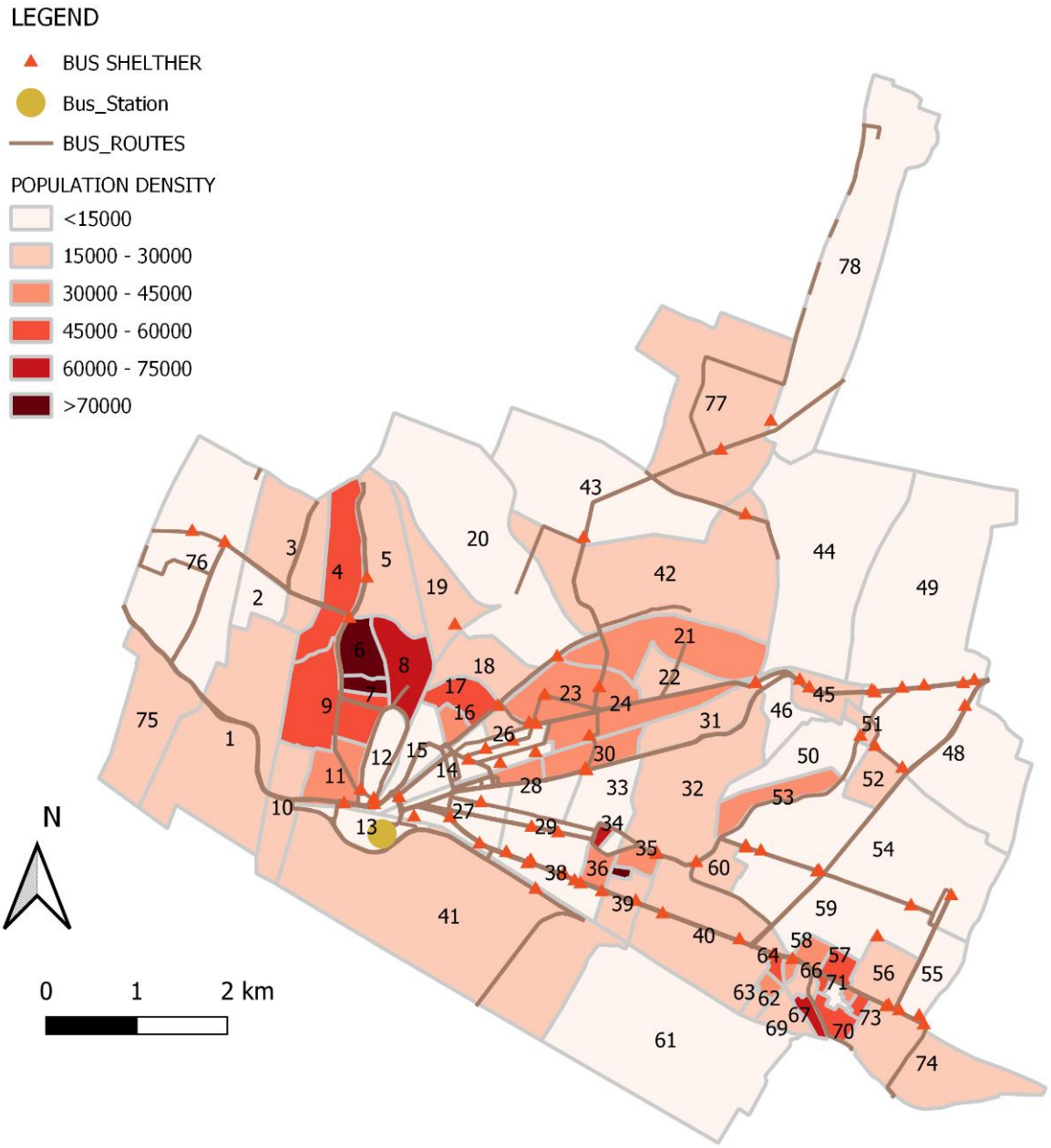


Fig. No. 9 Bus routes and shelters map overlay with population density

Fig. No. 10 Bus routes and shelter map overlay with street lights

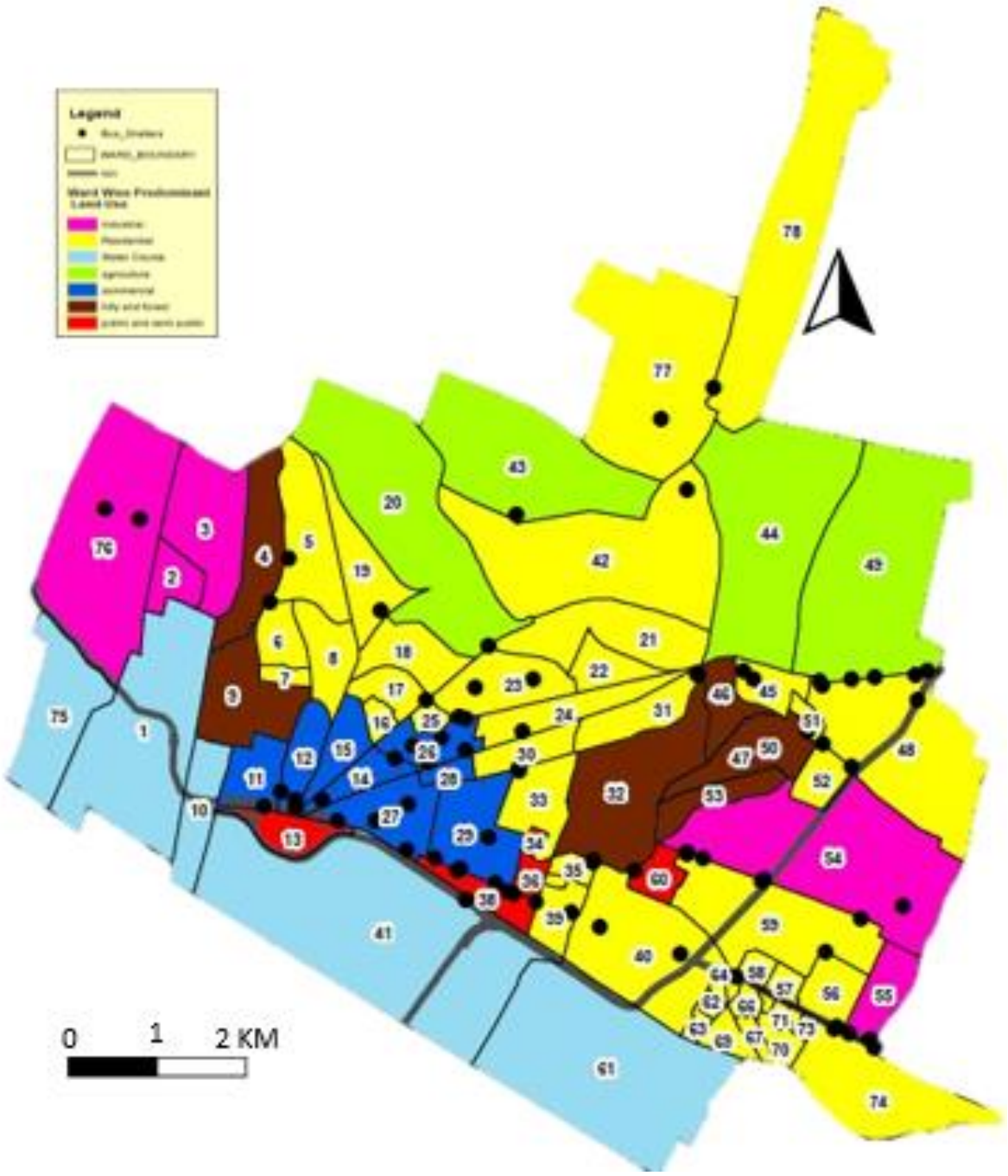


Fig. No. 11 Bus shelter map overlay with ward wise land use map

Bus routes and bus shelter maps are overlayed with population density, street lights, and land use map to known the coverage. Around 76 Bus Shelters are observed in the VMC study area across 78 wards of VMC Area. Standard buffer distance of 400 meters is

considered for the assessment of coverage. Most of the area is not under bus stop coverage that to mostly are core areas.

4.3 Delineation of the study area

As it is difficult to study the complete area, we delineated the study area using weighted mean method. Weighted mean method have been used for delineation of the study area because of data constraints in other method. Weighted Mean is an average computed by giving different weights to some of the individual values. The weighted mean is a type of mean that is calculated by multiplying the weight (or probability) associated with a particular event or outcome with its associated quantitative outcome and then summing all the products together.

The process of delineation is first we need to set the criteria to delineate the study area and then find the data regarding that criteria's and give scaling using k-mean clustering in SPSS software. Now normalize the data to scaling and then normalize them into weights by multiplying with the weights and summarize all weighted values and save the excel in csv format. Now join the csv file+ with the shapefiles in GIS and understand the required delineate area for study purpose.

Here I have chosen the criteria for delineating study area are population density, bus shelter density, land value and distance from CBD area.

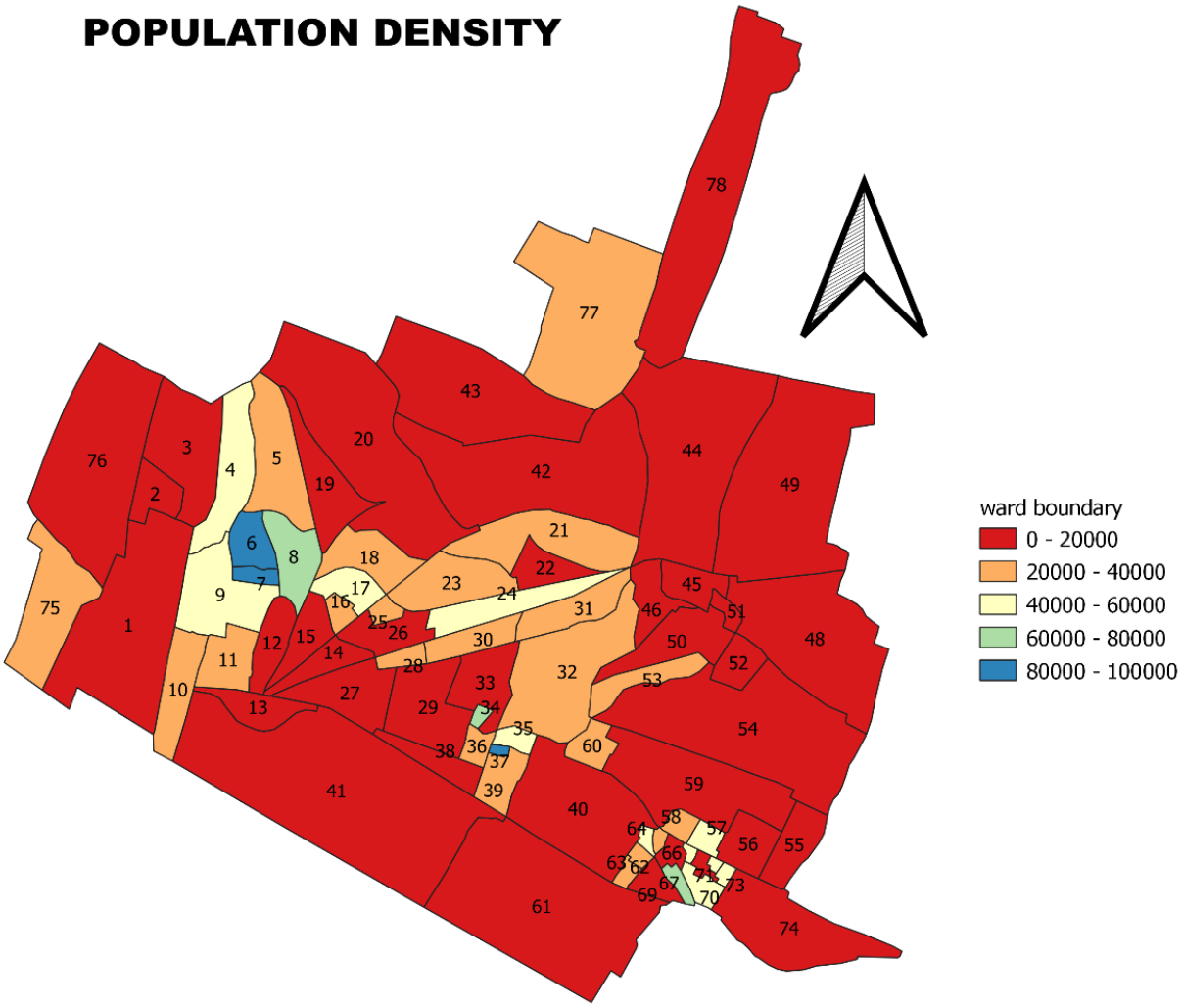


Fig. No. 12 Population density map

From population density map most of the population density is of range 20000 only few wards like31,32,35 which are between core area and periphery areas and ward 6, 7 and 37 have high population density of 80000-100000.

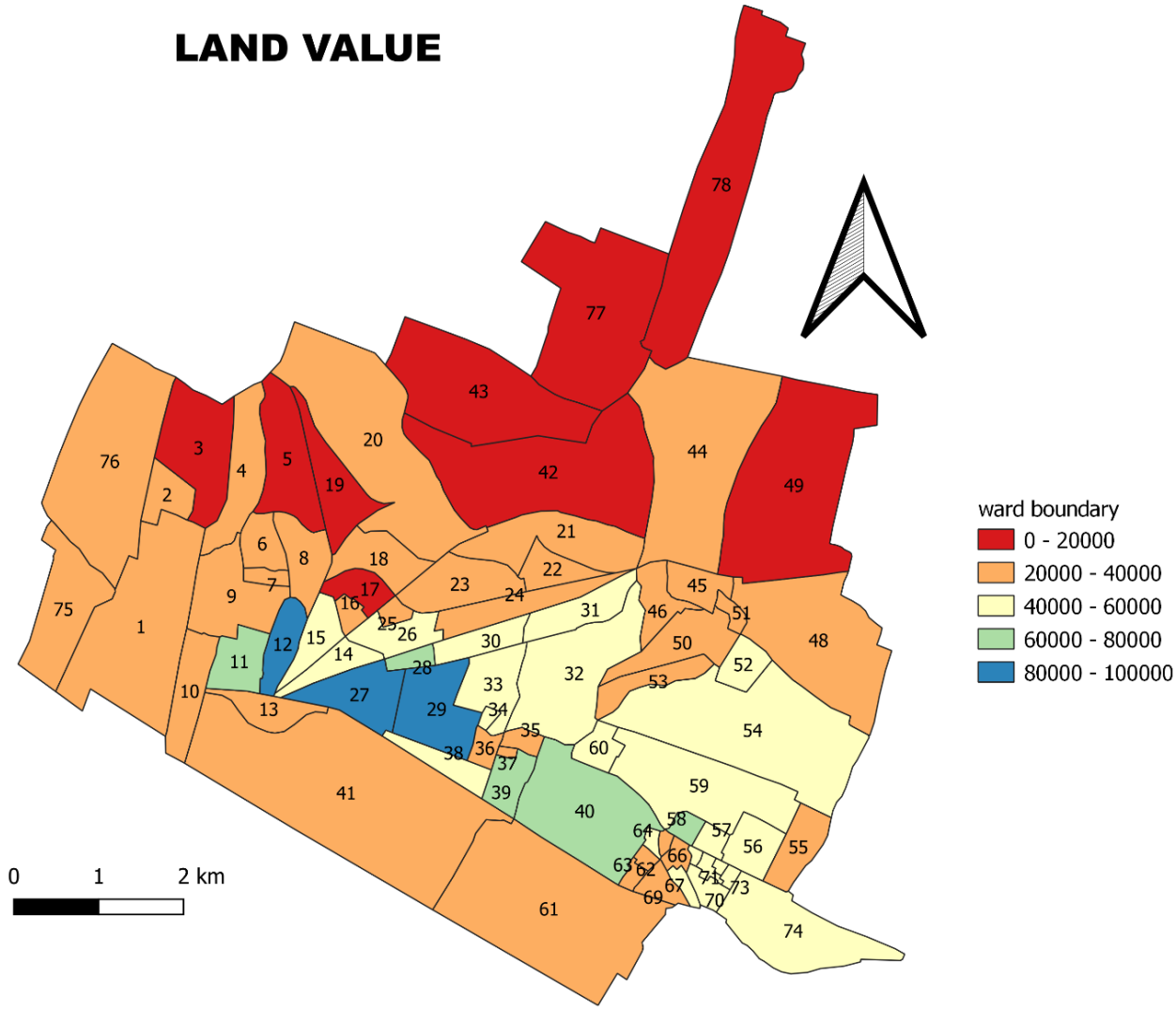


Fig. No. 13 Land value map

Land which are near to CBD area that is near ward 13 have high cost that is 8000-100000 which are peripheral area have less cost that is 20000 and areas between core and peripheral have cost range of 40000-60000

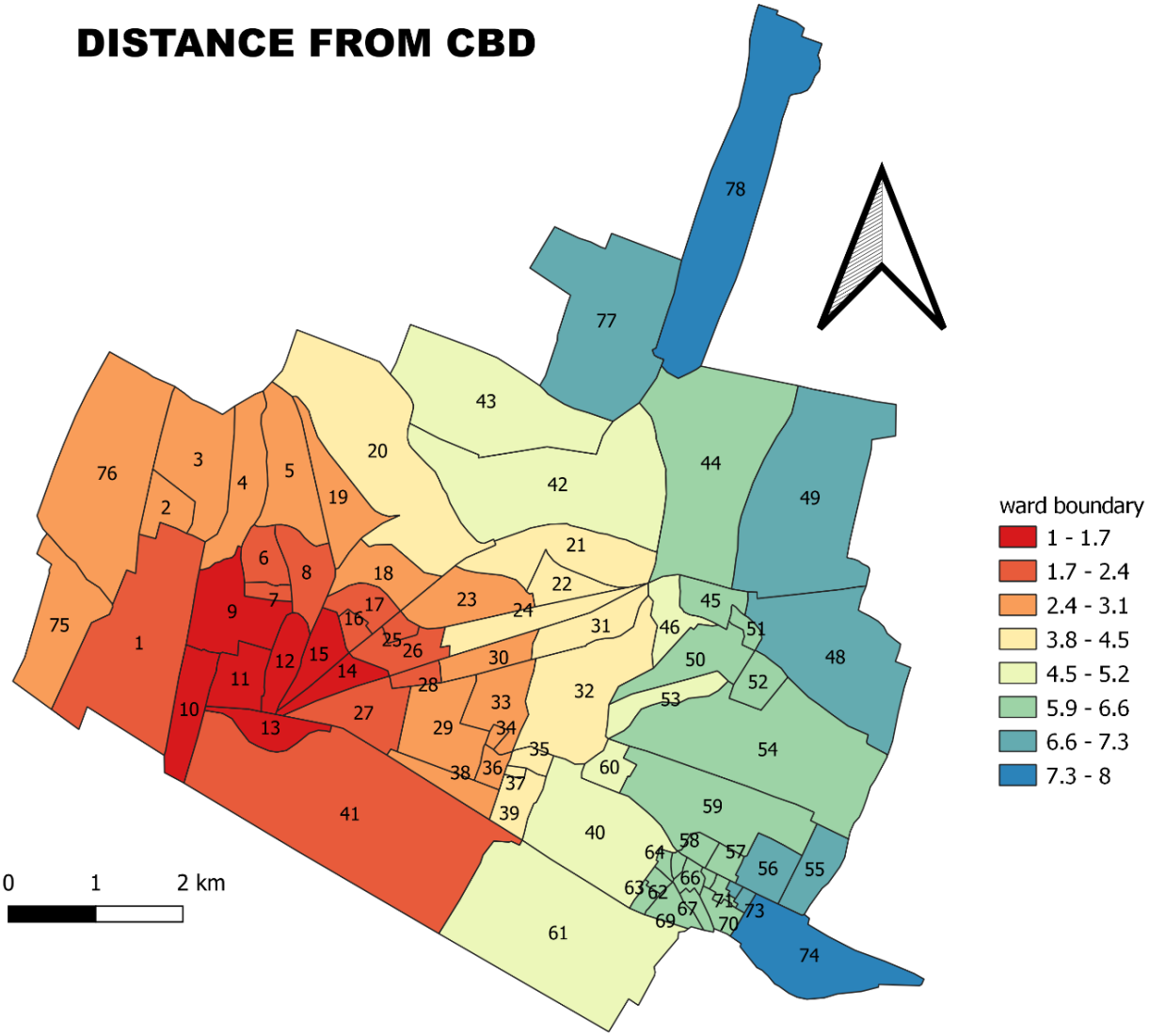


Fig. No. 14 Distance from CBD map

Ward 13 is the CBD area. Map has been plotted based on buffer distance from CBD area. Total Vijayawada is covered in 8km form the CBD area.

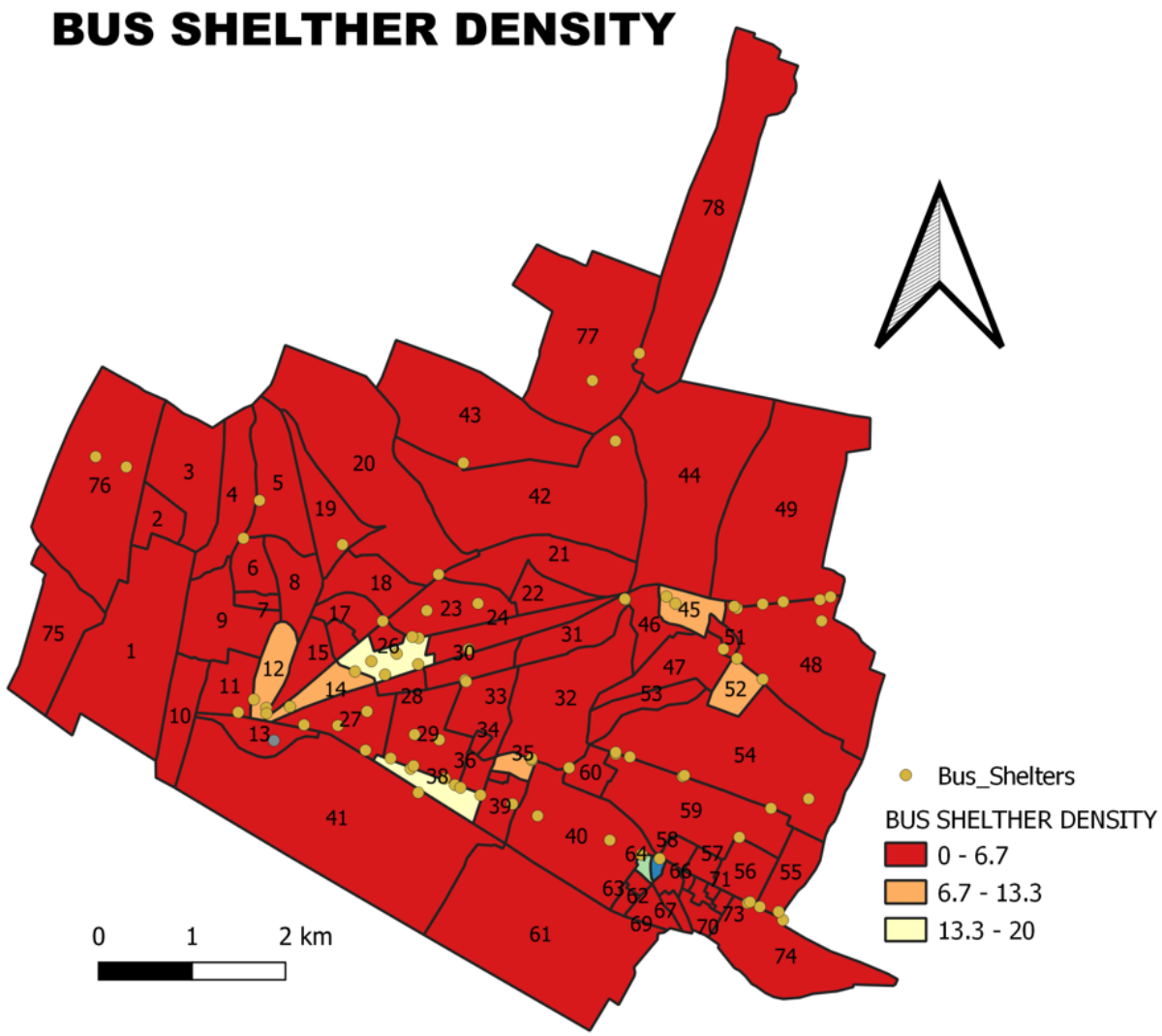


Fig. No. 15 Bus shelter density map

Bus shelter density is calculated as number of bus shelter in wards divided by area of ward. Most of the wards have less bus shelter density few wards near to core area has better bus shelther density.

CRITERIAS	SCALING		
	1	2	3
Population density	0 to 33,333	33,333 to 66,666	66,666 to 99,999

Bus shelter density	0 to 15.15	15.15 to 30.30	30.30 to 45.45
Land value	0 to 33,333	33,333 to 66,666	66,666 to 99,999
Distance from CBD	5.4 TO 8.1	2.7 to 5.4	0 to 2.7
Weightage		0.25 (equal weightages)	

This is the scaling table for the criteria. Using these table, we all scale down all the criteria values and normalize the values and calculate the total score (detail table in annexure 1).

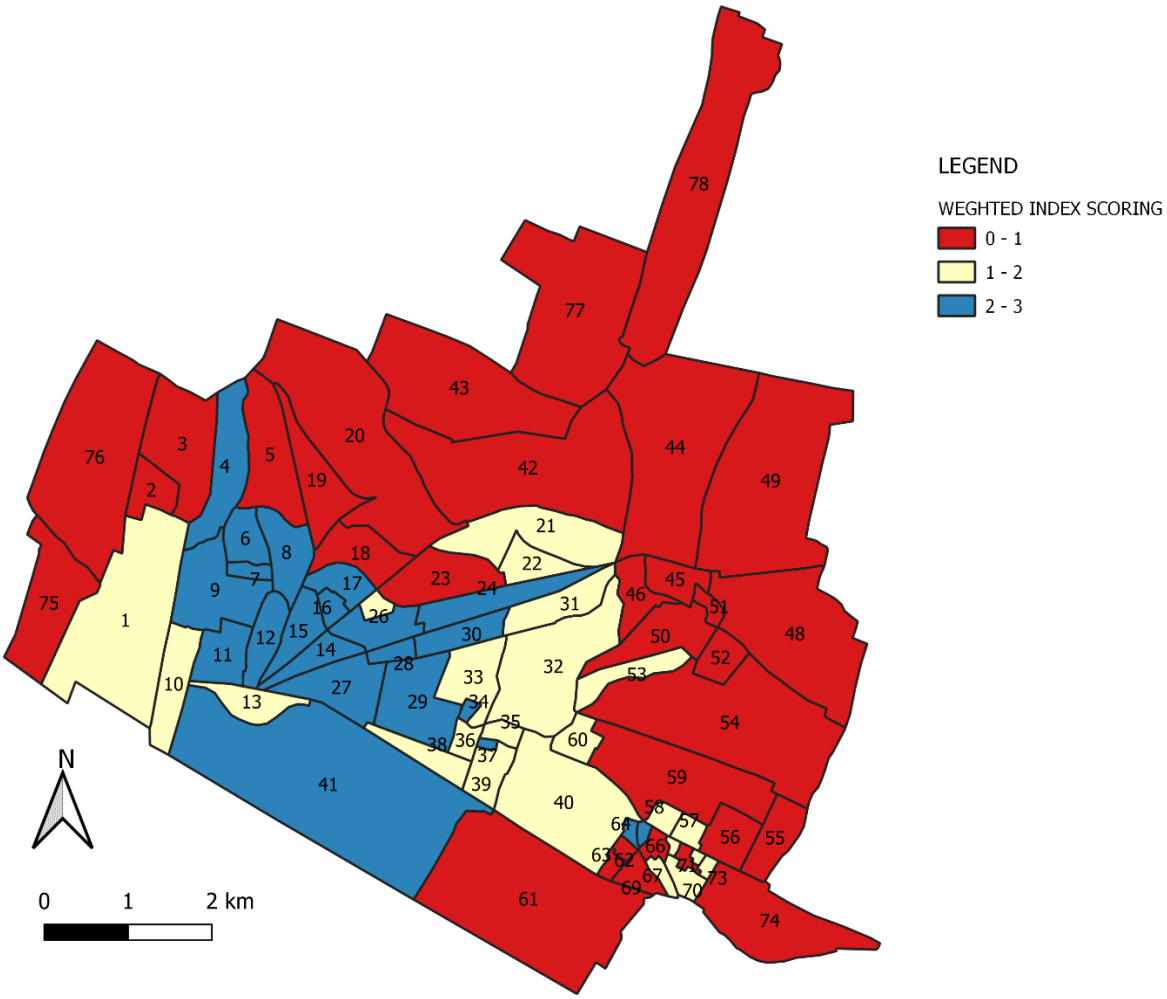


Fig. No. 16 Weighted index scoring map

We have delineated the wards based on weighted mean method. Now we divided the wards according to scoring and based on high residential area we have selected one ward form each score (detail table in annexure 2). To study all the aspects like ward with high, low public transport supply and wards that are in core area, periphery area and between core & periphery areas etc. Therefore wards 78 where is low public transport supply, 40 with medium public transport and 41 with high public transport supply.

4.3.1 Ward 41

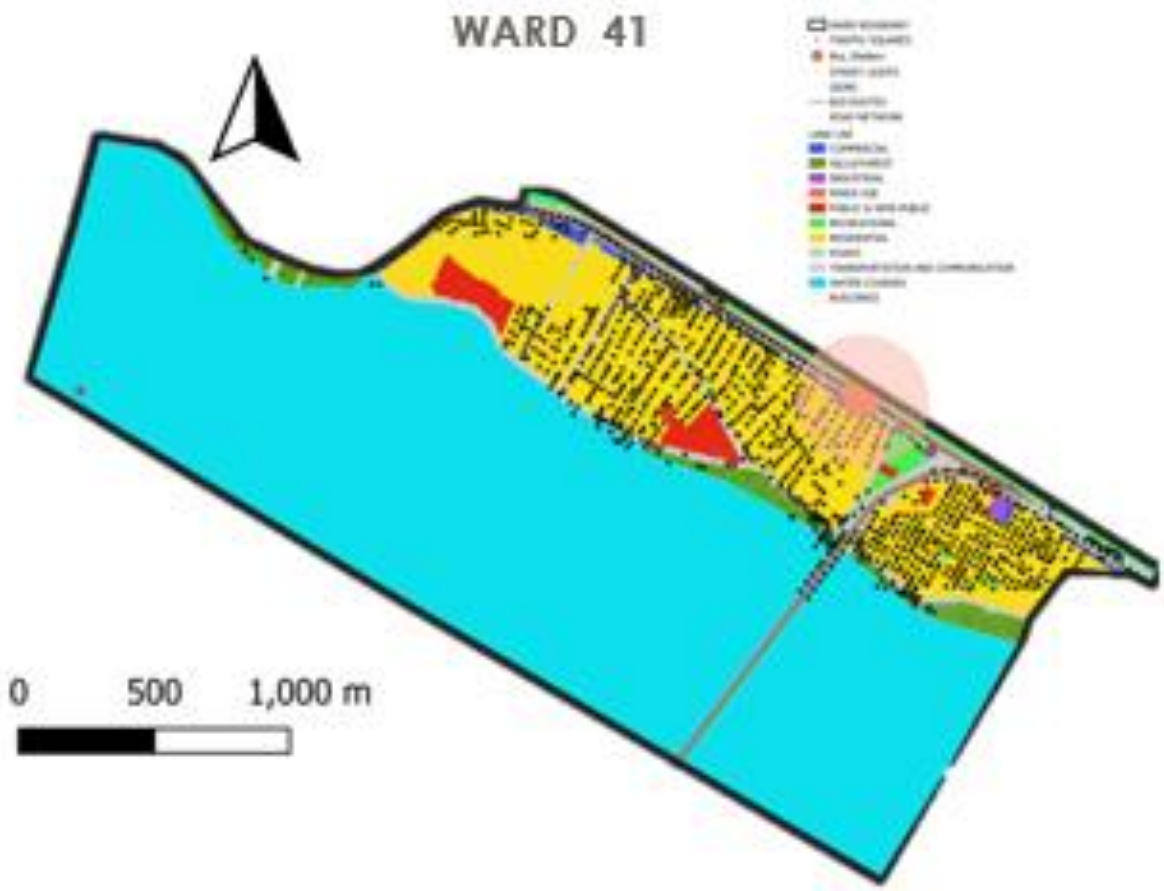


Fig. No. 17 Ward 41

Ward 41 is in the core area which is 2km away from CBD area, in which there is more public transport facilities. And major bus terminal is near to this ward which is 3km far from ward bus shelter. Ward 41 has population of 85990 according to 2011 census of an area 4.48 sqkm. Population density is 19194. Land value of this ward is 40000 as its area between core area but land value is less because of its potential. There is one bus

shelters in this ward of bus shelter density 0.22. Survey is done in this ward through random sampling in which both public transport user and non-public transport users include.

4.3.2 Ward 40

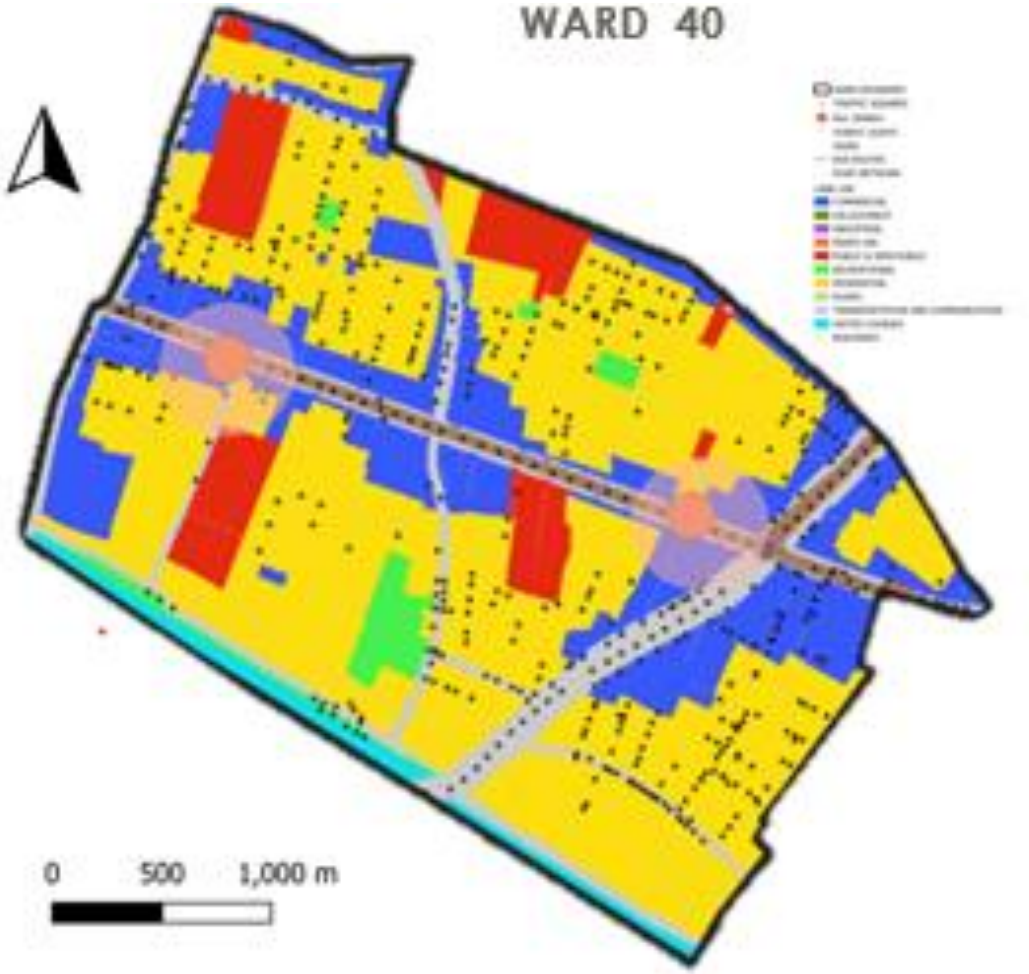


Fig. No. 18 Ward 40

Ward 40 is the area between core area and periphery area where it is 5km away from CBD area, in which there is limited public transport facilities. Ward 40 has population of 25953 according to 2011 census of an area 1.6 sqkm. Population density is 16220. Land value of this ward is 61000 as its area between core area and periphery area. There are 2 bus shelters in this ward of bus shelter density 1.25. Survey is done in this ward through random sampling in which both public transport user and non-public transport users include.

4.3.3 Ward 78

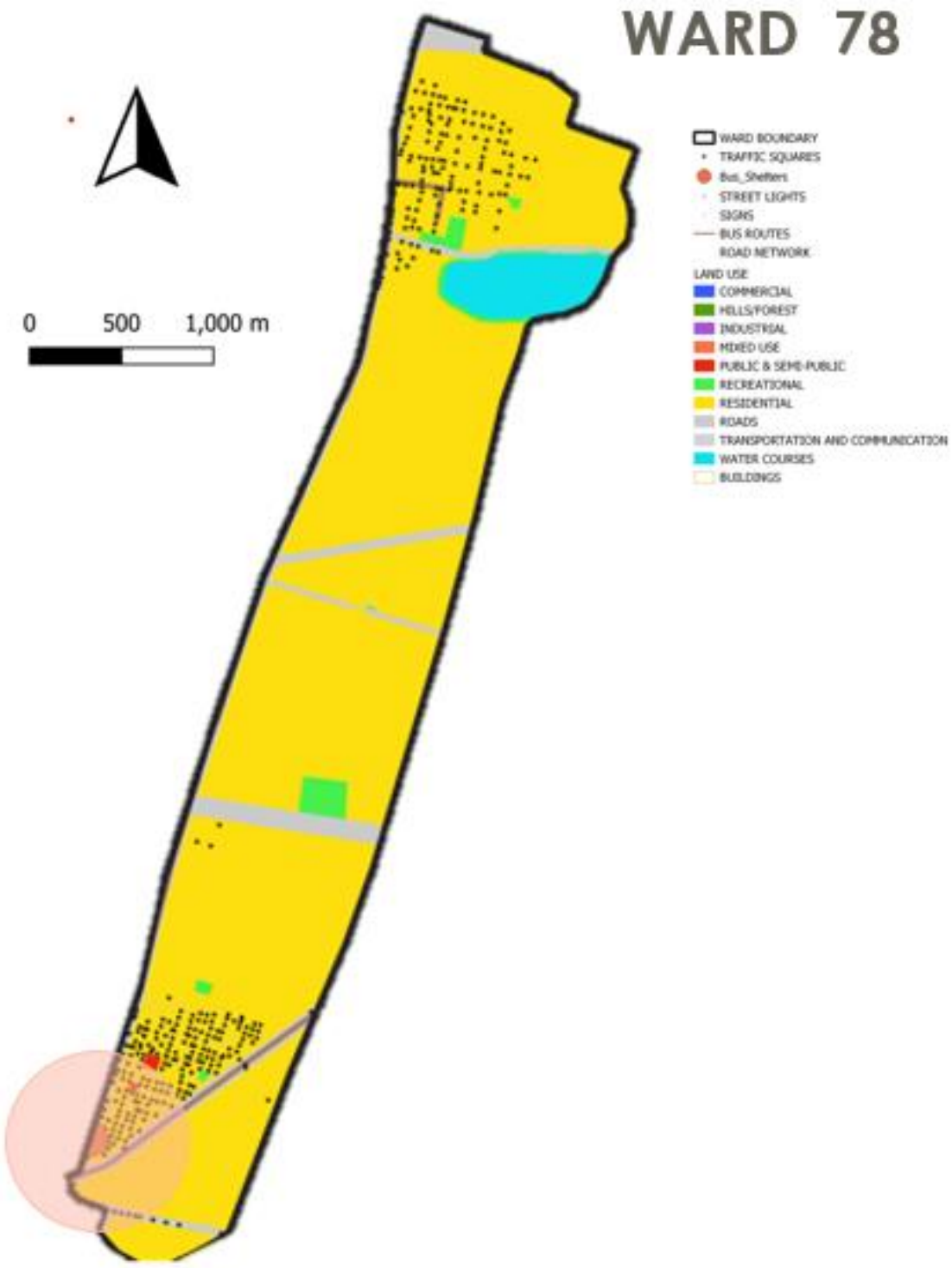


Fig. No. 19 Ward 78

Ward 78 is the periphery area where it is 8km away from CBD area, in which there is very less public transport facilities. Ward 78 has population of 12552 according to 2011 census of an area 2.68 sqkm. Population density is 4683. Land value of this ward is 9500 as its periphery area. There is one bus shelters in this ward of bus shelter density 0.37. Survey is done in this ward through random sampling in which both public transport user and non-public transport users include.

Chapter 5. Data required and collected

Data required and collected is of 3types travel characteristics, public transport characteristics and urban characteristics. Travel characteristics include trip length, trip length frequency, mode of transport etc. Whereas public transport characteristics include passenger footfall, service reliability, security etc. And urban characteristics include land use, population density, distance from CBD etc. (detail table in annexure 3). Household and public transport user is done in delineated wards (survey form in annexure 4). Offices visited to collect data are Vijayawada municipal corporation, APCRDA, APSRTC City bus stand, RTA Vijayawada.

Public transport survey and household survey is done at the delineated wards. Public transport survey is done to get the data people using public transport and to get data like their comfort level with respective to public transport and their mode of travel etc. and household level survey is done to get the data people not using to known the reasons not using public transport. Sampling is done through random sampling technique using stated preference and preference survey approaches so that people who are near to bus stop and far from bus stop in that ward should be covered. From survey analysis we got the data like socio-economic details like sex, income, occupation, education etc. And trip details like trip length, mode of transport, purpose, distance, waiting time etc. Survey is done is on week days and weekends. Sample size is 20-25 per wards.

Chapter 6. Analysis

First, we will analysis the existing public transport characteristics of the study area like number of bus shelter, bus routes, bus coverage etc. Then we will delineate the study

area using weighted mean method. Here I have chosen criteria for delineating study area are population density, bus shelter density, land value and distance from CBD area by equal weights. The wards that we got after delineation are ward 41, ward 40 and ward 78. Therefore wards 78 where is low public transport supply, 40 with medium public transport and 41 with high public transport supply. To study all the aspects like ward with high, low public transport supply and wards that are in core area, periphery area and between core & periphery areas etc. Then in these three wards we have done public transport survey to get data of people using public transport and household survey to get data people who are not using public transport. Sampling is done through random sampling method so that people who are near to bus stop and far from bus stop in that ward should be covered.

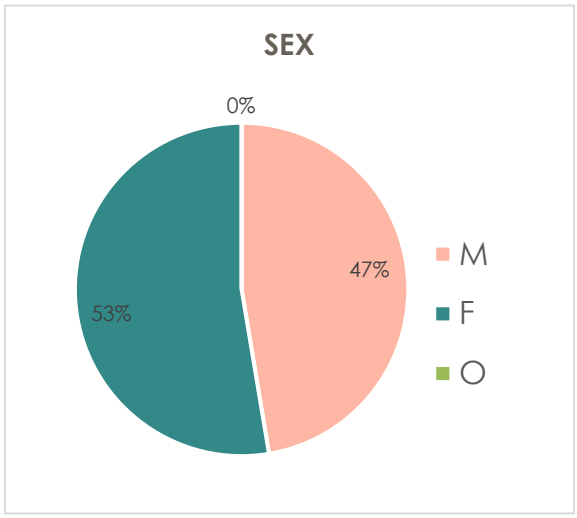
From survey analysis we got the data like socio-economic details like sex, income, occupation, education etc. And trip details like trip length, mode of transport, purpose, distance, waiting time etc. and we done cross classification analysis for the ward wise survey data that is for mode vs distance, mode vs cost, mode vs purpose, mode vs frequency, and mode vs travel time also with the income vs expenditure on transport monthly and income vs mode. Then with the survey data we have done the mode choice modelling for that first we have done outliers test to get idea about the data. Then we done correlation analysis using pearl son, the factors that is having highest and negative correlation have taken that factors and used for multinominal logit model and factors that we got are occupation, income, distance, cost, waiting time and comfort. In multinominal logit model we used these factors as covariate and mode choice as dependent variable and run the model then we get the model accuracy percentage we got is 89% and bus ridership that we got is 21%. So, this can be used for future predicted scenario analysis.

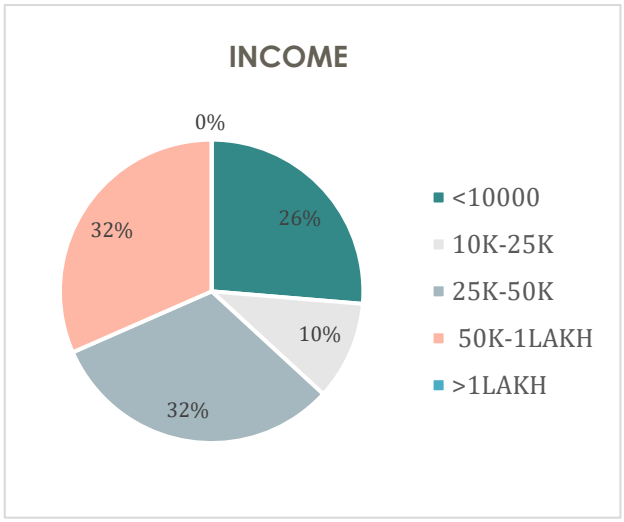
By referring some literature, we have developed 3 scenarios with the trip factors which have highest correlation. Scenario 1 where cost will be increased, comfort remains same, time reduces for some distance. In scenario 2 cost will be increased same as scenario 1, comfort level also increases, time also reduces more than scenario 1 and for same distance. And in scenario 3 the cost increase more than scenario 1 and 2, comfort is same as scenario 2, time will be reduced little than scenario for same distance. We changed the survey data according to these 3 scenarios and run the model

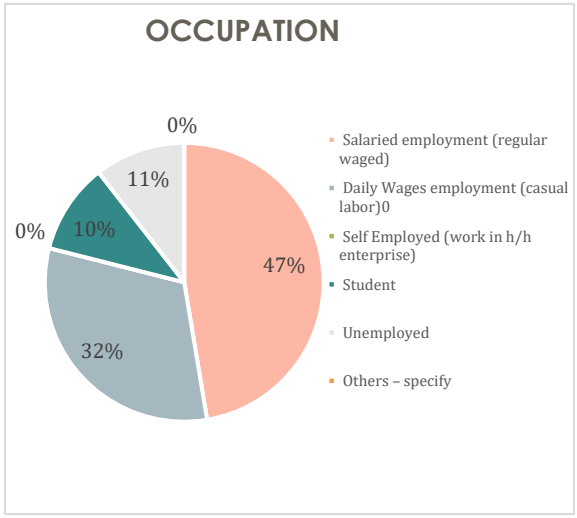
6.1 Preliminary Analysis

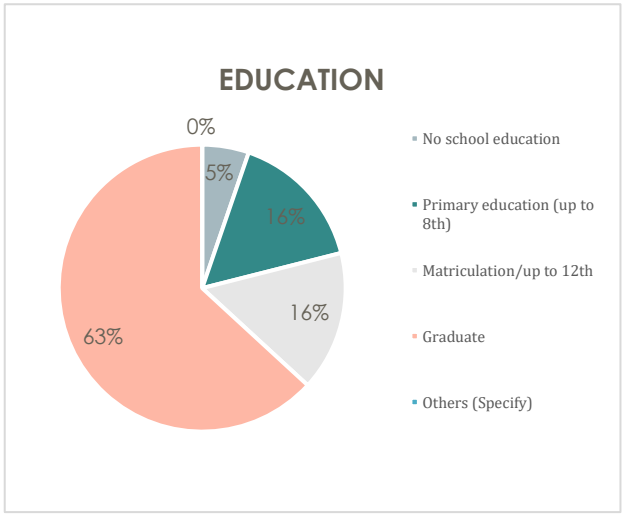
Household and public transport survey is done in delineated wards i.e., ward no. 41,40 and 78. In this survey we have collected data like socio-economic details like sex, income, occupation, education etc. And trip details like trip length, mode of transport, purpose, distance, waiting time etc.

6.1.1 Ward 41









In ward 41 the socio-economic details are 53% are female and 47% are male. Income priority is of range 25k to one lakh and major occupation is salaried employment and Education qualification is of graduates.

MODE	DISTANCE			
	0 - 4 km	4 - 8 km	8 - 12km	> 12 km
Walk				
2-wheeler	1	9	2	1
Car	8	2		
Bus		4		
Auto		8		

Table. No. 1 WARD 41 - Mode vs distance

MODE	COST				
	0-10k	10-20k	20-30k	30-40k	>40k
Walk	4				
2-wheeler	18	6	3		
Car	4	4		2	
Bus		2	2		
Auto			8		

Table. No. 2 WARD 41 - Mode vs income

MODE	PURPOSE					
	Work	Education	Shopping	Recreational/Social	Others (Medical etc)	Return Home-Ret.
Walk				2		2

2-wheeler	11		2	2	2	10
Car	4		1	1		4
Bus	1	2				1
Auto	1	1	1		1	4

Table. No. 3 WARD 41 - Mode vs purpose

MODE	**FREQUENCY**				
	Daily	Weekly	Few days a week	Monthly	Rarely
Walk	4				
2-wheeler	21	5	1		
Car	7		1	2	
Bus	4				
Auto	4	2			2

Table. No. 4 WARD 41 - Mode vs frequency

MODE	**TRAVEL TIME**				
	0-5 min	5- 10 min	10-15 min	15- 20 min	>20 min
Walk		2	2		
2-wheeler	9	9	6		3
Car	3	4	1	2	
Bus				2	2

Auto				6	2

Table. No. 5 WARD 41 - Mode vs Travel time

Here we are analysis the different parameters like distance, cost, purpose, frequency, and travel time with respective to mode of transport that is walk, 2-wheeler, car, bus and auto.

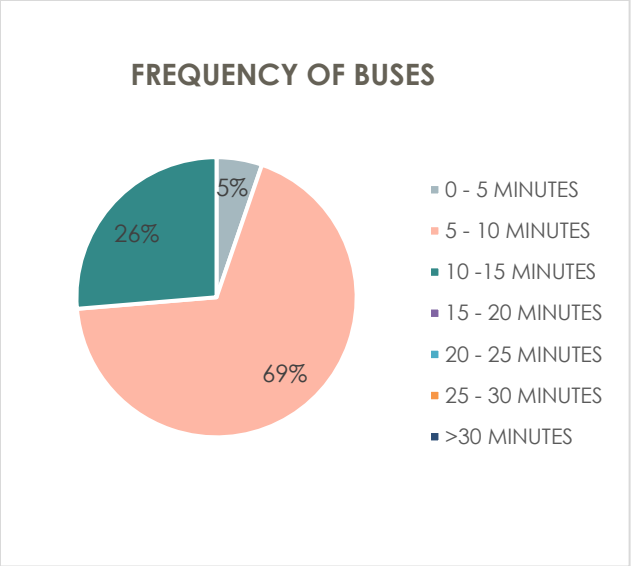
INCOME	**EXPENDITURE ON TRANSPORT MONTHLY**				
	0-500	500-1000	1000-1500	1500-2000	>2000
<10000	1	1	2	1	
10K-25K		1		1	
25K-50K	1	3	2		
50K-1LAKH	3		2	1	

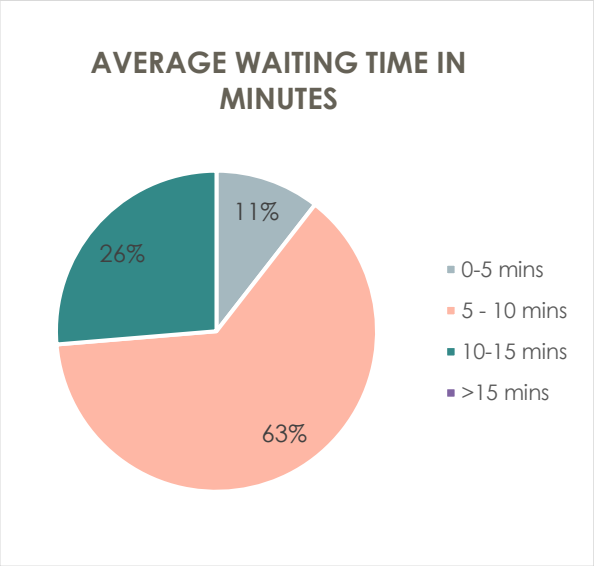
Table. No. 6 WARD 41 - Income vs expenditure on transport

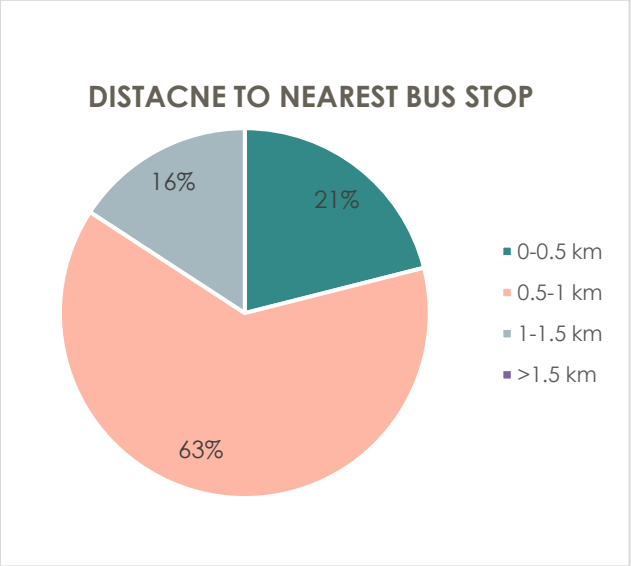
INCOME	**MODE**					
	Walk	Cycle	2-wheeler	Car	Bus	Auto
<10000	2	1	2			
10K-25K		1	1			
25K-50K			5	1		
50K-1LAKH			3	3		

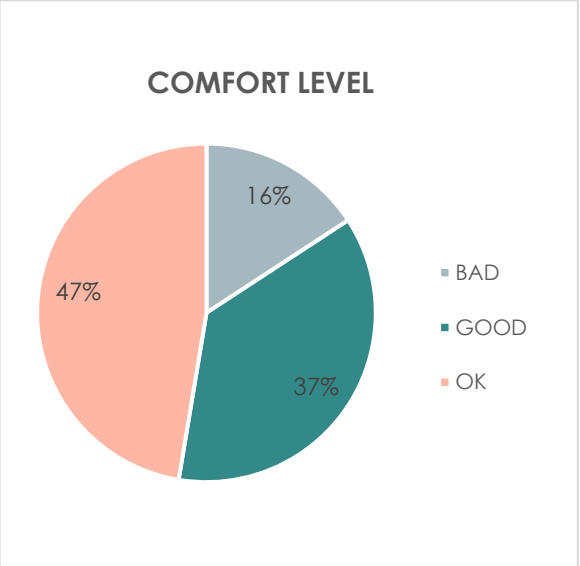
Table. No. 7 WARD 41 - Income vs mode of transport

Here we analyze income with respective to expenditure on transport monthly and mode of transport



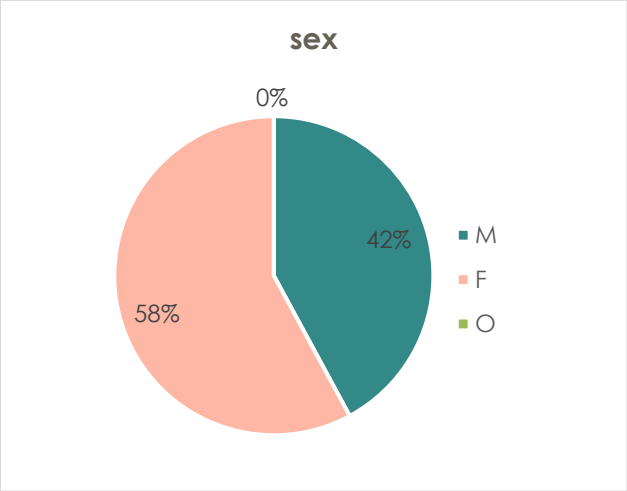


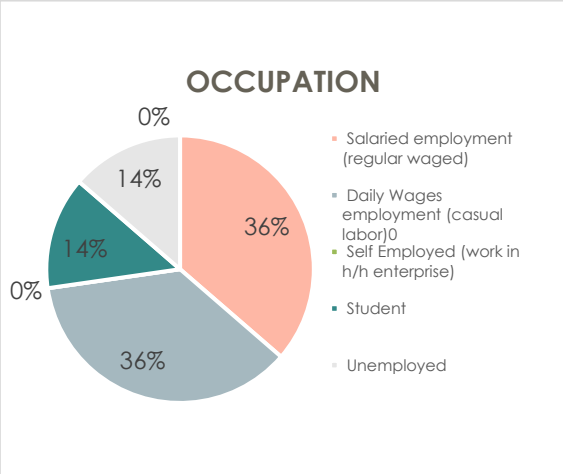


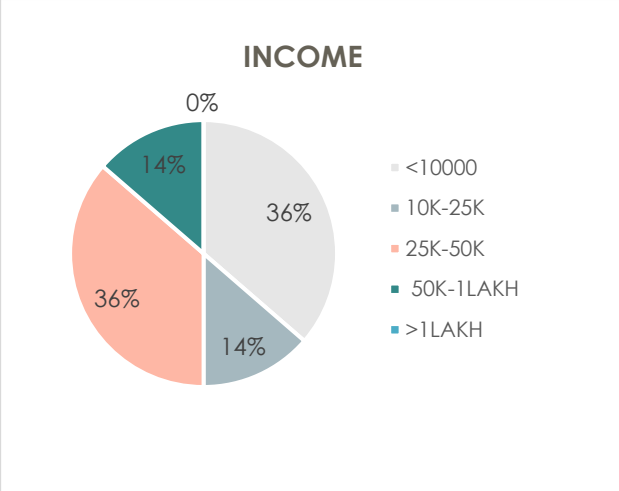


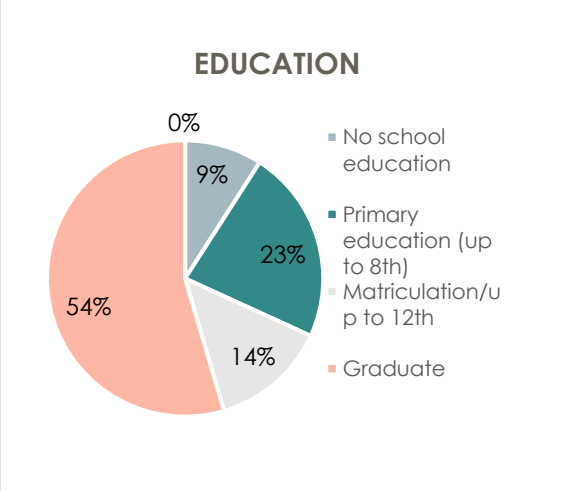
WARD NO 41 is in the core area. Major bus terminal is near to this ward. From the bus shelter to bus terminal the distance is 1.8km. As it is core area the trip characteristics like waiting time, frequency of buses, expenditure on transport, travel time is very less compared to ward 40 and 78. As it is core area people prefer 2wheeler most probable as all the facilities are available nearby. And additional trip characteristics like comfort level is less compared to ward 40 and 78 as it is core area it is busy with crowd and service reliability; punctuality and security level is high.

6.1.2 Ward 40









In ward 40 the socio-economic details are 58% are female and 42% are male. Income priority is of range 10k to 50k and major occupation is salaried employment and self-employed. Education qualification is majorly of graduates and primary education.

MODE	DISTANCE			
	0 - 4 km	4 - 8 km	8 - 12km	> 12 km
Walk				
2-wheeler	4	24	7	2

Car	2	4		
Bus	2	2		
Auto	2	2	6	

Table. No. 8 WARD 40 - Mode vs distance

MODE	COST				
	0-10k	10-20k	20-30k	30-40k	>40k
Walk					
2-wheeler	11	22	4		
Car			4	2	
Bus	2		2		
Auto		2		2	6

Table. No. 9 WARD 40 - Mode vs income

MODE	PURPOSE					
	Work	Education	Shopping	Recreational/Social	Others (Medical etc)	Return Home-Ret.
Walk						
2-wheeler	17	1	3	2	1	13
Car	2					3
Bus	1	2				1

Auto	1	1	1		2	5

Table. No. 10 WARD 40 - Mode vs purpose

MODE	FREQUENCY				
	Daily	Weekly	Few days a week	Monthly	Rarely
Walk					
2-wheeler	30	6	1		
Car	6				
Bus	4				
Auto	4	2			4

Table. No. 11 WARD 40 - Mode vs frequency

MODE	TRAVEL TIME				
	0-5 min	5- 10 min	10-15 min	15- 20 min	>20 min
Walk					
2-wheeler	3	8	15	5	6
Car			2	4	
Bus				2	2
Auto			3		7

Table. No. 12 WARD 40 - Mode vs travel time

Here we are analysis the different parameters like distance, cost, purpose, frequency, and travel time with respective to mode of transport that is walk, 2-wheeler, car, bus and auto.

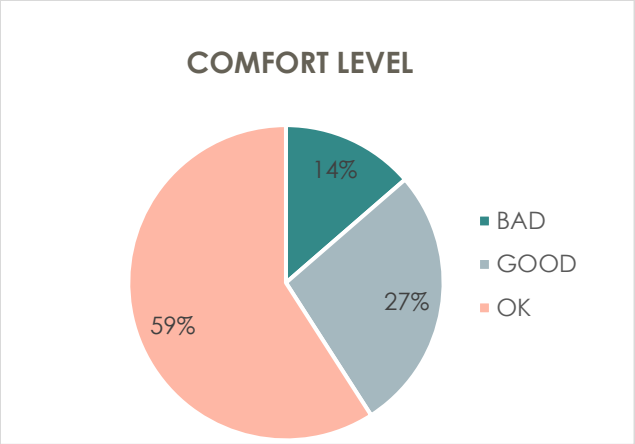
INCOME	MODE					
	Walk	Cycle	2-wheeler	Car	Bus	Auto
<10000	2	1	5			
10K-25K		1	2			
25K-50K			7	1		
50K-1LAKH			2	1		

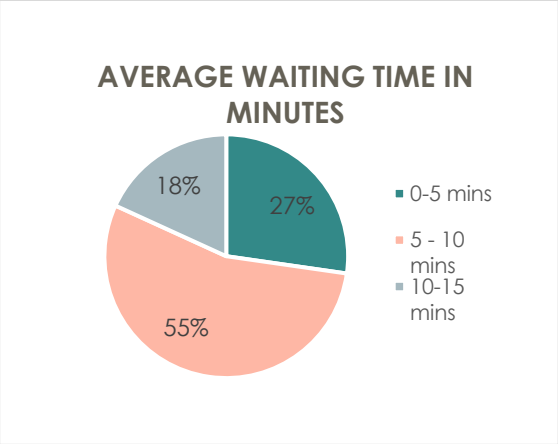
Table. No. 13 WARD 40 - Income vs mode of transport

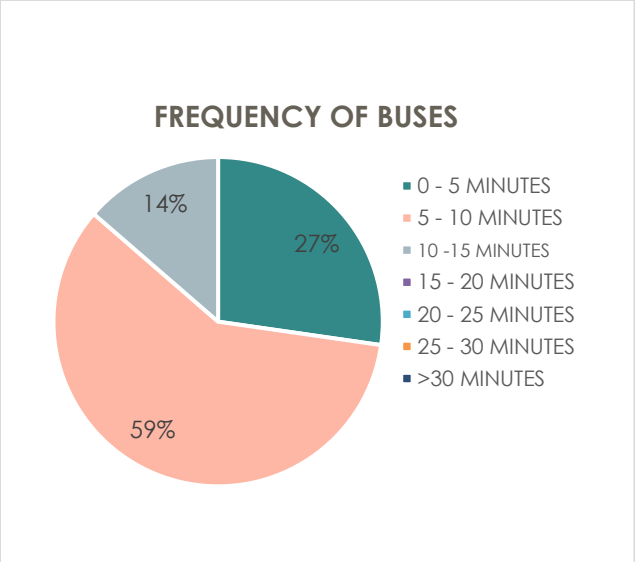
INCOME	EXPENDITURE ON TRANSPORT MONTHLY				
	0-500	500-1000	1000-1500	1500-2000	>2000
<10000	1	3	1	1	2
10K-25K		2			1
25K-50K	1	3		3	1
50K-1LAKH		1	1		1

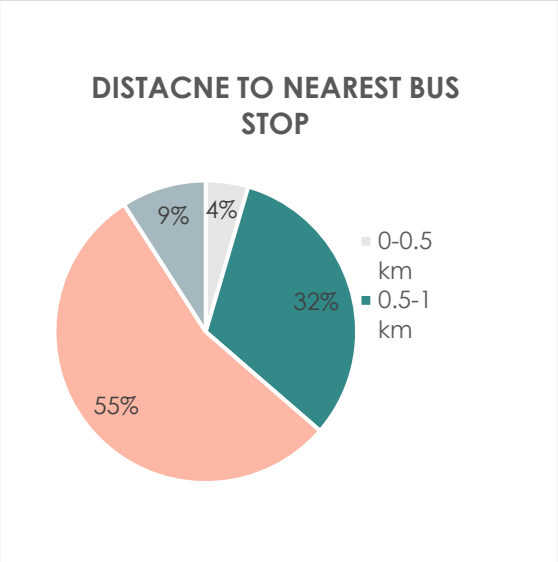
Table. No. 14 WARD 40 - Income vs expenditure on transport

Here we analyze income with respective to expenditure on transport monthly and mode of transport



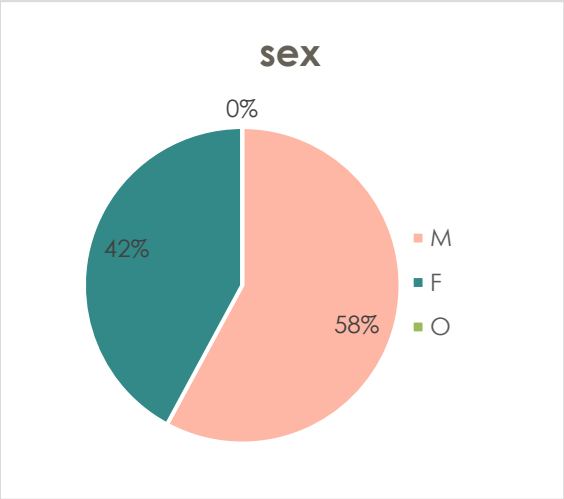


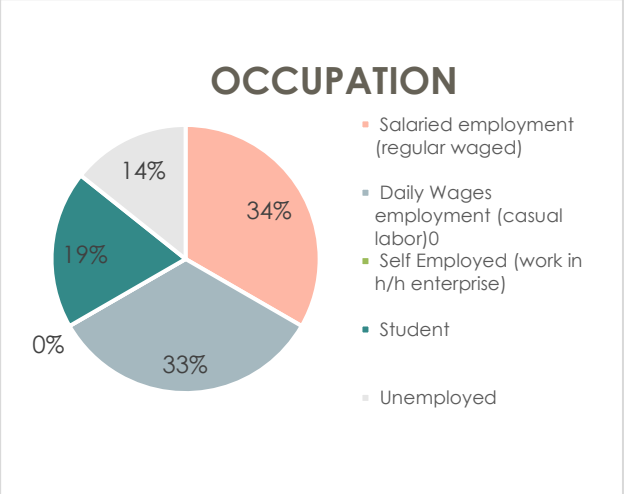


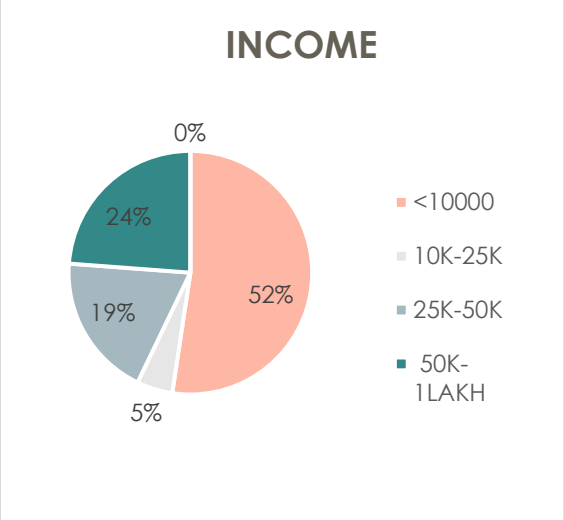


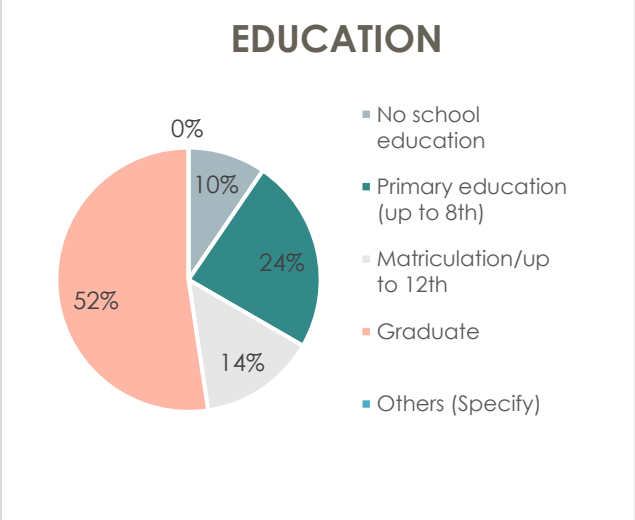
WARD NO 40 is in the area between periphery area and core area. As it is area between periphery area and core area the trip characteristics like waiting time, frequency of buses, expenditure on transport, travel time is very less compared ward 78 and high compared to ward 41. And additional trip characteristics like comfort level is less compared to ward 44 and more compared to ward 78.

6.1.3 Ward 78









In ward 78 the socio-economic details are 58% are male and 42% are female. Income priority is of range <10000 to 25k and major occupation is salaried employment and daily wages. Education qualification is majorly of graduates and primary education.

MODE	DISTANCE			
	0 - 4 km	4 - 8 km	8 - 12km	> 12 km
Walk				

2-wheeler	1	3	16	8
Car			6	6
Bus				4
Auto				10

Table. No. 15 WARD 78 - Mode vs distance

MODE	PURPOSE					
	Work	Education	Shopping	Recreational/Social	Others (Medical etc)	Return Home-Ret.
Walk						
2-wheeler	11	1	2	1	1	11
Car	4		1	2		5
Bus	1	2				1
Auto		2	1		2	5

Table. No. 16 WARD 78 - Mode vs purpose

MODE	COST				
	0-10k	10-20k	20-30k	30-40k	>40k
Walk					
2-wheeler	1	6	19	2	

Car					12
Bus					4
Auto					10

Table. No. 17 WARD 78 - Mode vs income

MODE	FREQUENCY				
	Daily	Weekly	Few days a week	Monthly	Rarely
Walk					
2-wheeler		25	1		
Car	9		1	2	
Bus	4				
Auto	4	2			4

Table. No. 18 WARD 78 - Mode vs frequency

MODE	TRAVEL TIME				
	0-5 min	5- 10 min	10-15 min	15- 20 min	>20 min
Walk					
2-wheeler	1		6		21
Car					12
Bus					14

Auto					

Table. No. 19 WARD 78 - Mode vs travel time

Here we are analysis the different parameters like distance, cost, purpose, frequency, and travel time with respective to mode of transport that is walk, 2-wheeler, car, bus and auto.

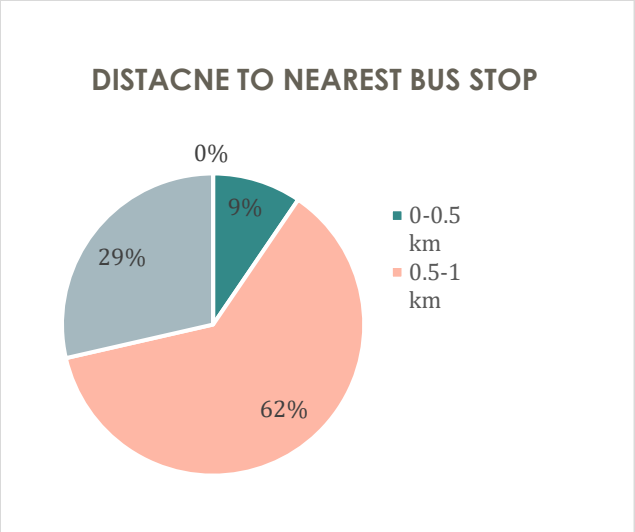
INCOME	EXPENDITURE ON TRANSPORT MONTHLY				
	0-500	500-1000	1000-1500	1500-2000	>2000
<10000			4	1	6
10K-25K					1
25K-50K				1	3
50K-1LAKH				1	4

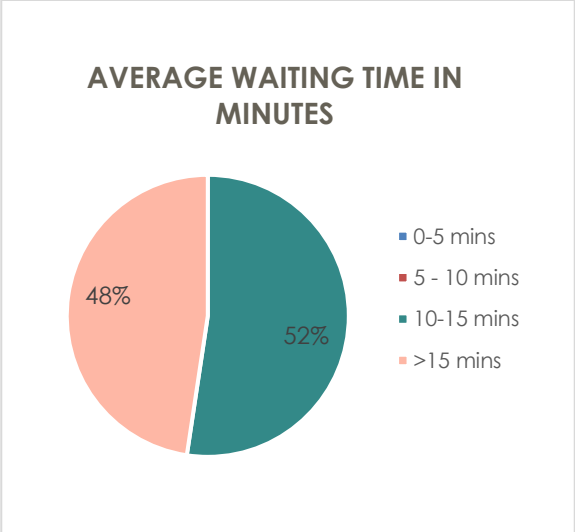
Table. No. 20 WARD 78 - Income vs expenditure on transport

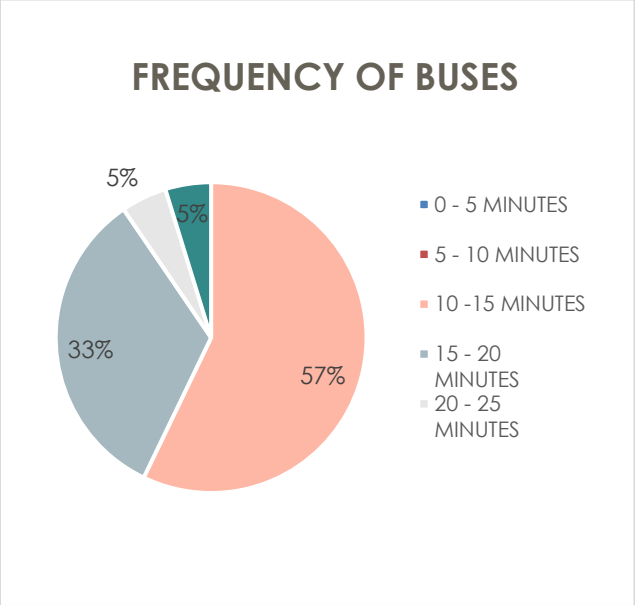
INCOME	MODE					
	Walk	Cycle	2-wheeler	Car	Bus	Auto
<10000	3	1	7			
10K-25K		1				
25K-50K			3	1		
50K-1LAKH			2	3		

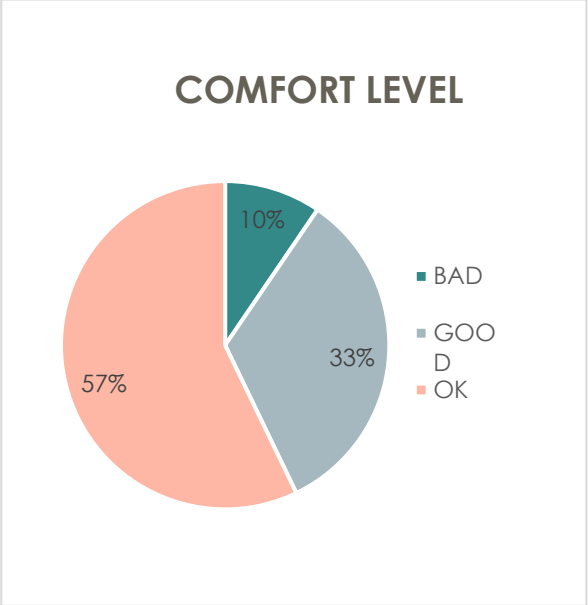
Table. No. 21 WARD 78 - Income vs mode of transport

Here we analyze income with respective to expenditure on transport monthly and mode of transport









WARD NO 78 is in the periphery area. The trip characteristics like waiting time, frequency of buses, expenditure on transport, travel time is high compared to ward 78 and 41. And additional trip characteristics like comfort level is more and service reliability, punctuality and security level is less compared to ward 44 & 78.

Fig. No. 20 Comparison of 3 wards i.e., 41,40 and 78

6.2 Mode choice modelling

The philosophy behind mode choice model is to effectively manage the transport demand and be able to provide for these demands by making changes in the existing system. Used to study the existing transportation system and forecast the future needs of the proposed transportation system as we get an insight to preferences and requirements of commuters. We have 3types of mode choice models first is Aggregate and Disaggregate mode choice model, Statistical mode choice model and soft computing mode choice model. In statistical mode choice model, we have Multinomial probit model, nested logit model, multinomial probit model and generalized extreme value model. And in soft

computing mode choice model we have artificial neural network model, fuzzy logic-based models, and hybrid mode choice model. Factors affecting mode choice behavior are social, environment, cultural and economic factors

The process includes first collecting data for mode choice model like trip information through surveys and doing the outliers test for the data then check the correlation between the variables using Pearson correlation coefficient in SPSS software. Variables which have high correlation are considered in logit model in SPSS software and with that variables we run and analyze the model.

6.2.1 Outliers test

An outlier is an observation that appears to deviate markedly from other observations in the sample. Identification of potential outliers is important for the following reasons. An outlier may indicate bad data. Outlier is a data point in the dataset that differs significantly from the other data or observations.

Test interpretation

G (Observed value)	0.000
G (Critical value)	0.019
p-value (one-tailed)	**<0.0001**
alpha	**0.05**

Table. No. 22 Test interpretation for outlier's test

H0: The variances are identical.

Ha: At least one of the variances is lower than the others.

As the computed p-value is lower than the significance level alpha = 0.05, one should reject the null hypothesis Ho, and accept the alternative hypothesis, Ha.

6.2.2 Correlation analysis

Correlation analysis, also known as bivariate, is primarily concerned with finding out whether a relationship exists between variables and then determining the magnitude and action of that relationship. This process includes importing the data in SPSS software and then go to analyze>>correlate>>bivariate. In bivariate we must choose Pearl son correlation then run the model we will get the correlation matrix. Now keep that matrix in excel and apply Pearl son minimum value -1, mid value 0 and maximum value 1 as condition format and give color code.

	WARDNO	SEX	AGE	DL	EDUC	OCCUP	INCOME	EXPENDITURE	VEHICLETYPE	AGEOFVEHICLE	PURPOSE	FREQUENCY	MODE	DISTANCE	COST	TIME	WAITINGTIME	DISTANCETONEARESTBUSSTOP	FREQUENCYOFBUSES	TRAVELTIME	SECURITY	COMFORT	SERVICE	PUNCTUALITY	WILLINGNESSTOSHIFT	SAFE	SATISFIED	S1	S2	S3
WARDNO	1	0.078	-0.007	-0.043	-0.020	0.089	-0.091	0.627	-0.016	-0.185	0.013	0.040	0.091	0.798	0.607	0.054	0.634	-0.148	0.818	0.78	0.037	-0.009	-0.070	-0.21	-0.025	0.133	0.069	0.076	-0.004	-0.092
SEX	0.078	1	-0.415	-0.365	0.105	0.026	0.191	0.228	-0.130	-0.136	-0.224	-0.185	0.138	0.036	0.158	-0.061	0.087	-0.050	0.003	-0.022	-0.224	0.007	-0.295	0.037	-0.214	-0.139	-0.348	-0.35	0.209	0.113
AGE	-0.007	-0.415	1	0.107	-0.713	0.387	-0.197	0.012	0.045	-0.054	0.042	0.502	0.114	0.062	-0.025	-0.082	0.044	0.217	0.164	0.179	0.267	-0.118	0.053	0.043	0.114	0.207	0.097	-0.165	0.039	0.044
DL	-0.043	-0.365	0.107	1	0.216	-0.65	0.622	-0.199	0.552	0.037	0.025	-0.092	-0.528	-0.120	-0.259	0.027	-0.345	-0.108	-0.004	-0.018	-0.108	-0.098	-0.031	0.104	0.051	0.292	0.171	0.329	-0.100	-0.138
EDUC	-0.020	0.105	-0.713	0.216	1	-0.525	0.412	-0.143	0.353	0.171	0.084	-0.38	-0.39	-0.094	-0.144	0.26	-0.222	-0.048	-0.143	-0.162	-0.274	-0.001	-0.116	0.018	-0.148	-0.065	0.17	0.274	0.044	-0.066
OCCUP	0.089	0.026	0.387	-0.65	-0.525	1	-0.724	0.21	-0.644	-0.296	0.083	0.446	0.622	0.194	0.279	-0.083	0.395	0.148	0.074	0.092	0.269	0.102	0.139	-0.17	0.118	-0.117	-0.052	-0.308	0.013	0.115
INCOME	-0.091	0.191	-0.197	0.622	0.412	-0.724	1	0.010	0.626	0.244	-0.003	-0.054	-0.83	-0.155	-0.109	0.068	-0.287	-0.228	-0.121	-0.206	-0.19	-0.195	-0.321	0.261	-0.131	-0.006	0.035	0.206	0.099	0.028
EXPENDITURE	0.627	0.228	0.012	-0.199	-0.143	0.21	0.010	1	-0.082	-0.297	0.082	0.18	0.426	0.711	0.863	0.058	0.797	-0.066	0.514	0.484	-0.053	-0.034	-0.053	-0.145	-0.095	-0.070	-0.156	-0.141	-0.014	0.030
VEHICLETYPE	-0.016	-0.130	0.045	0.552	0.353	-0.644	0.626	-0.082	1	0.163	0.028	0.070	-0.573	-0.165	-0.189	0.194	-0.391	-0.132	0.022	0.035	-0.22	-0.222	-0.017	0.184	-0.099	0.041	0.196	0.275	0.327	0.123
AGEOFVEHICLE	-0.185	-0.136	-0.054	0.037	0.171	-0.296	0.244	-0.297	0.163	1	-0.055	-0.138	-0.284	-0.150	-0.313	-0.192	-0.288	-0.040	-0.053	-0.069	-0.181	-0.135	-0.18	-0.213	-0.090	-0.135	-0.007	0.237	0.053	-0.202
PURPOSE	0.013	-0.224	0.042	0.025	0.084	0.083	-0.003	0.082	0.028	-0.055	1	0.251	0.088	0.023	0.105	0.8	0.078	-0.048	-0.056	-0.074	0.051	-0.083	-0.001	0.049	-0.123	-0.144	0.126	0.092	0.014	-0.023
FREQUENCY	0.040	-0.185	0.502	-0.092	-0.38	0.446	-0.054	0.18	0.070	-0.138	0.251	1	0.404	0.108	0.302	0.039	0.255	-0.023	0.032	0.002	0.129	-0.418	0.003	0.128	-0.110	-0.124	0.143	-0.115	0.089	0.352
MODE	0.091	0.138	0.114	-0.528	-0.39	0.622	-0.38	0.426	-0.573	-0.284	0.088	0.404	1	0.261	0.583	-0.037	0.572	-0.042	-0.014	-0.020	0.017	-0.005	0.010	-0.054	-0.061	-0.116	-0.113	-0.29	-0.193	0.176
DISTANCE	0.798	0.036	0.062	-0.120	-0.094	0.194	-0.155	0.711	-0.165	-0.150	0.023	0.108	0.261	1	0.767	-0.083	0.857	0.042	0.721	0.678	0.016	-0.103	-0.070	-0.296	0.000	0.037	-0.019	-0.090	-0.028	0.047
COST	0.607	0.158	-0.025	-0.259	-0.164	0.279	-0.109	0.863	-0.189	-0.313	0.105	0.302	0.583	0.767	1	0.030	0.905	-0.090	0.505	0.452	-0.053	-0.158	-0.020	-0.117	-0.100	-0.135	-0.035	-0.090	-0.034	0.16
TIME	0.054	-0.061	-0.082	0.027	0.26	-0.083	0.068	0.058	0.194	-0.192	0.8	0.039	-0.037	-0.083	0.030	1	-0.032	-0.016	-0.013	-0.049	-0.122	-0.009	0.030	0.114	-0.345	-0.134	0.130	0.024	-0.007	0.084
WAITINGTIME	0.634	0.087	0.044	-0.345	-0.222	0.395	-0.267	0.797	-0.351	-0.255	0.075	0.259	0.672	0.857	0.905	-0.032	1	-0.015	0.545	0.493	0.066	-0.107	-0.005	-0.223	-0.018	-0.062	-0.039	-0.187	-0.151	0.154
DISTANCETONEARESTBUSSTOP	-0.148	-0.050	0.217	-0.106	-0.048	0.148	-0.228	-0.065	-0.132	-0.040	-0.048	-0.023	-0.042	0.042	-0.090	-0.016	-0.015	1	0.093	0.181	0.118	-0.118	0.121	-0.089	0.187	0.078	0.213	-0.308	0.171	0.025
FREQUENCYOFBUSES	0.818	0.003	0.164	-0.004	-0.143	0.074	-0.121	0.514	0.022	-0.053	-0.056	0.032	-0.014	0.721	0.508	-0.013	0.545	0.093	1	0.934	0.034	-0.157	-0.048	-0.278	0.019	0.033	0.127	-0.026	0.094	-0.081
TRAVELTIME	0.78	-0.022	0.179	-0.018	-0.162	0.092	-0.206	0.484	0.036	-0.069	-0.074	0.002	-0.020	0.678	0.452	-0.049	0.493	0.181	0.934	1	0.002	-0.138	-0.010	-0.373	0.078	0.085	0.141	0.005	0.095	-0.066
SECURITY	0.037	-0.224	0.267	-0.108	-0.274	0.269	-0.19	-0.053	-0.22	-0.181	0.051	0.129	0.017	0.016	-0.053	-0.122	0.066	0.118	0.034	0.002	1	0.033	0.31	0.093	0.32	0.113	0.208	-0.134	0.044	-0.012
COMFORT	-0.009	0.007	-0.118	-0.098	-0.001	0.102	-0.106	-0.034	-0.222	-0.135	-0.083	-0.006	-0.430	-0.103	-0.158	-0.009	-0.107	-0.118	-0.157	-0.138	0.033	1	0.186	0.024	0.091	0.137	-0.087	0.111	-0.203	-0.417
SERVICE	-0.070	-0.295	0.053	-0.031	-0.116	0.139	-0.321	-0.053	-0.017	-0.18	-0.001	0.003	0.010	-0.070	-0.020	0.030	-0.005	0.121	-0.048	-0.010	0.31	0.186	1	0.17	0.241	0.071	0.29	-0.177	-0.179	0.289
PUNCTUALITY	-0.21	0.037	0.043	0.104	0.018	-0.17	0.261	-0.145	0.184	-0.213	0.049	0.128	-0.054	-0.298	-0.117	0.114	-0.223	-0.089	-0.378	-0.373	0.093	0.024	0.17	1	0.011	0.072	-0.090	-0.098	0.118	0.093
WILLINGNESSTOSHIFT	-0.025	-0.214	0.114	0.051	-0.148	0.116	-0.131	-0.095	-0.099	-0.090	-0.123	-0.110	-0.061	0.000	-0.100	-0.345	-0.018	0.187	0.019	0.078	0.32	0.091	0.241	0.011	1	0.393	0.006	0.031	0.192	-0.031
SAFE	0.133	-0.139	0.207	0.292	-0.065	-0.117	-0.006	-0.070	0.041	-0.135	-0.144	-0.124	-0.116	0.037	-0.136	-0.134	-0.082	0.078	0.033	0.085	0.113	0.137	0.071	0.072	0.393	1	-0.010	0.122	-0.282	-0.118
SATISFIED	0.069	-0.348	0.097	0.171	0.17	-0.082	0.035	-0.156	0.196	-0.007	0.126	0.143	-0.113	-0.019	-0.035	0.130	-0.039	0.213	0.127	0.141	0.208	-0.087	0.29	-0.090	0.005	-0.010	1	0.166	-0.212	0.118
S1	0.076	-0.35	-0.165	0.329	0.274	-0.308	0.206	-0.141	0.275	0.237	0.092	-0.115	-0.29	-0.090	-0.090	0.024	-0.187	-0.308	-0.025	0.005	-0.134	0.111	-0.177	-0.098	0.031	0.122	0.166	1	-0.197	-0.233
S2	-0.004	0.209	0.039	-0.100	0.044	0.013	0.099	-0.014	0.327	0.053	0.014	0.089	-0.193	-0.028	-0.034	-0.007	-0.151	0.171	0.094	0.095	0.044	-0.203	-0.179	0.118	0.192	-0.282	-0.212	-0.197	1	0.117
S3	-0.092	0.113	0.044	-0.138	-0.066	0.115	0.028	0.030	0.123	-0.202	-0.023	0.352	0.176	0.047	0.16	0.084	0.154	0.025	-0.081	-0.066	-0.012	-0.417	0.289	0.093	-0.031	-0.118	0.118	-0.233	0.117	1

Fig. No. 21 Correlation matrix with Pearl son color code

From the correlation analysis the parameters which have high correlation are distance, cost, waiting time, comfort, occupation, and income which will be considered in modelling.

6.2.3 Multinomial logit models

Multinomial logistic regression is used to predict categorical placement in or the probability of category membership on a dependent variable based on multiple independent variables. We used multinomial logit model because it gives us the 22 probability of categories.

$Y = ax_1 + bx_2 + cx_3 + \ldots\ldots + m$ $\quad U_{2wheelers} = m + ax_1 + bx_2 + cx_3 + \ldots\ldots\ldots$ $\quad P(BUS) = e^{Ubus} / e^{Ubus} + e^{Uk}$

$Y = U_k$ $\quad U_{bus} = m + ax_1 + bx_2 + cx_3 + \ldots\ldots\ldots$

a,b,c,d are the values of B from parameter estimates, x_1, x_2, x_3 are from input data

Fig. No. Utility equation

It processes include go to SPSS software then go to analyze>> regression>> multinomial regression. Then one popup box will be open in that use correlation factor we got in correlation analysis i.e., distance, cost, waiting time, comfort, occupation and income and mode choice as dependent variable and open model option and tick required data and run the model.

MODE[a]		B
2-Wheeler	Intercept (m)	-32.308 (m)
	OCCUPATION (X1)	-73.986 (a)
	INCOME (X2)	-25.961 (b)
	DISTANCE (X3)	26.142 (c)
	COST (X4)	-5.742 (d)
	WAITINGTIME (X5)	17.507 (e)
	COMFORT (X6)	-3.681(f)

Table. No. 23 B values from the model results for 2-wheeler

MODE[a]		B
Car	Intercept (m)	-106.956 (m)
	OCCUPATION (X1)	-3.516 (a)
	INCOME (X2)	31.341 (b)

	DISTANCE (X3)	-37.056 (c)
	COST (X4)	17.600 (d)
	WAITINGTIME (X5)	3.082 (e)
	COMFORT (X6)	-1.381 (f)

Table. No. 24 B values from the model result for car

MODE[a]		B
Bus	Intercept (m)	169.609 (m)
	OCCUPATION (X1)	-47.806 (a)
	INCOME (X2)	-107.552 (b)
	DISTANCE (X3)	-12.945 (c)
	COST (X4)	13.310 (d)
	WAITINGTIME (X5)	1.511 (e)
	COMFORT (X6)	-60.691(f)

Table. No. 25 B values from the model result for bus

MODE[a]		B
Auto	Intercept (m)	-66.424 (m)
	OCCUPATION (X1)	15.1829 (a)
	INCOME (X2)	17.189 (b)
	DISTANCE(X3)	-13.568 (c)

	COST (X4)	13.582 (d)
	WAITINGTIME (X5)	1.330 (e)
	COMFORT (X6)	-30.959 (f)

Table. No. 26 B value from the model result for auto

$$U_{bus} = 169.6 + \text{OCCUPATION } (-47.8) + \text{INCOME } (-107.5) + \text{DISTANCE } (-12.9) + \text{COST } (13.3) + \text{WAITING TIME } (1.51) + \text{COMFORT } (-60.691)$$

Fig. No. 23 Utility equation for bus

Observed	Predicted					
	WALK	2WHEELER	CAR	BUS	AUTO	Percent Correct
WALK	4	0	0	0	0	72%
2WHEELER	0	38	0	0	0	85.4%
CAR	0	0	7	0	0	80%
BUS	0	0	0	20	0	89%
AUTO	0	0	0	0	10	84%
Overall Percentage	4%	43%	10%	21%	11%	**89%**

Table. No. 27 predicted ridership for various modes from survey data

The model is 89% percentage accuracy and in table it is showing the percentage of ridership for different modes from survey data. Bus ridership showing is 21% from survey data.

6.2.4 Scenario Analysis

In this scenario analysis we will refer literatures and select 3 scenarios and we will change the survey data according to the scenarios and we will run the model and we will see in which scenario there is increase in public transport ridership that is bus and we will try to develop that scenario through proposals.

	EXISTING	SCEANRIO 1	SCENARIO 2	SCENARIO 3
COST	10	15	15	20
COMFORT	LOW	LOW	MED	HIGH
TIME	25	20	18	15
DISTANCE	5	5	5	5

Table. No. 28 Scenarios for scenario analysis

Observed	Predicted					
SCENARIO 1	WALK	2WHEELER	CAR	BUS	AUTO	Percent Correct
WALK	4	0	0	0	0	72%
2WHEELER	0	35	0	0	0	89%
CAR	0	0	6	0	0	78%
BUS	0	0	0	29	0	85%
AUTO	0	0	0	0	9	82%
Overall Percentage	4%	35%	6%	**29%**	9%	83%

Table. No. 29 Result for scenario 1

Observed	Predicted					
SCENARIO 2	WALK	2WHEELER	CAR	BUS	AUTO	Percent Correct
WALK	4	0	0	0	0	72%
2WHEELER	0	30	0	0	0	82%

CAR	0	0	4	0	0	75%
BUS	0	0	0	36	0	89%
AUTO	0	0	0	0	7	79%
Overall Percentage	4%	32%	5%	**36%**	8%	85%

Table. No. 30 Result for scenario 2

Observed	Predicted					
SCENARIO 3	WALK	2WHEELER	CAR	BUS	AUTO	Percent Correct
WALK	4	0	0	0	0	72%
2WHEELER	0	36	0	0	0	89%
CAR	0	0	6	0	0	79%
BUS	0	0	0	26	0	84%
AUTO	0	0	0	0	7	81%
Overall Percentage	4%	36%	7%	**26%**	8%	81%

Table. No. 31 Result for scenario 3

SCENARIO 2 has the highest percentage in shifting toward public transport that is bus. In which cost and comfort is increasing and waiting time is reducing we will try to develop scenario2 by proposing strategies and recommendations.

Chapter 7. Results and findings

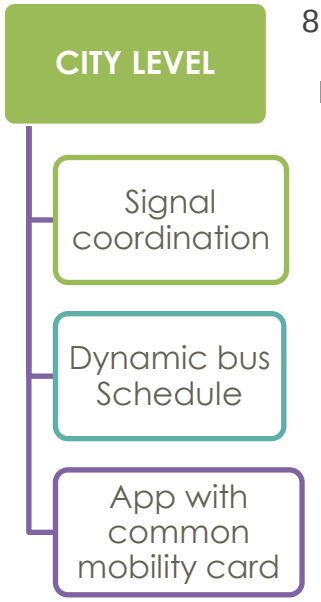
After running the model with these 3 scenarios. In this we will see which scenario have more ridership shift towards public transport. The result that we got are in scenario 1 we got 29% shift towards public transport, in scenario 2 we have 36% shift towards public transport and in scenario 3 we have 26% shift towards public transport. So, in scenario 2

has the highest shift towards the public transport in which comfort has to increase and time has to be reduced so we will propose strategies according to that.

Chapter 8. Proposals

In proposals we are trying to increase comfort and reduce time as we got scenario 2. So, in this we are giving generic proposals at city level that are signal coordination, dynamic bus schedule and app with common mobility card and detail proposals at ward level where we are trying to develop bus stop as integrated by redesigning bus stop design with proper infrastructure and cycling stand integrated with the bus stop, Integrated halt time go stand for IPT and Revised Road cross sections ward wise by providing well connected access by footpath or pavements at ward level.

8.1 City level



8.1.1 Signal Coordination

Designing traffic signal corridors with minimal stops and/or delays in mind allows for efficient movement of traffic from one end of the corridor to the other. In order to reduce pauses and delays, traffic signals along a road are linked together in a process known as signal coordination. When they are near together, it is done so that a vehicle travelling in a dominant direction can receive continuous green.

Signal coordination is crucial when: When signals are placed close together, it is important to synchronise the green time to allow cars to pass through the series of signals quickly. Two signals may occasionally be so close together that they should be considered a single signal. Other times, the signals are so widely apart that it is possible to treat them separately. Vehicles released from a signal frequently keep grouped together for much longer than 335m.

The following four factors should be considered when coordinating signals:

1. Benefits: minimal air pollution and fuel conservation. Keep moving at your own pace and prevent stops and delays. Possibility of dispatching a rolling platoon of vehicles through subsequent crossings.
2. Signal system function: The function of the signal system is determined by the physical organization of the street system and the main traffic flows. The sort of system, whether it be a one-way, two-way, one-way, two-way, or mixed network, must be considered. the ability to travel in both directions on some streets, the future movements, and the choice of preferred routes.
3. Factors reducing the benefits include: insufficient roadway capacity, the presence of significant side frictions, such as parking, high levels of speed variation, very close signal intervals, and high turn volumes, either into or out.
4. Exceptions: It is difficult to easily coordinate all signals. When a problematic crossing directly opposes the design of the signal coordination plan, two different systems—one on either side of the problematic intersection—can be taken into consideration. A busy intersection is an important intersection Coordination can be accomplished using a few methodologies, however the most prevalent is time-based coordination:

   By methodically offsetting the green indicator for the coordinated phase(s), time-based coordination establishes cooperation. The cycle duration, which is the interval between consecutive yellow indications for the coordinated phase, must be the same for all traffic lights within a time-based coordinated corridor in order to maintain uniform operations. The controllers' internal clocks must be in sync with one another in order to prevent any

clock time drift from impairing the progression's quality.

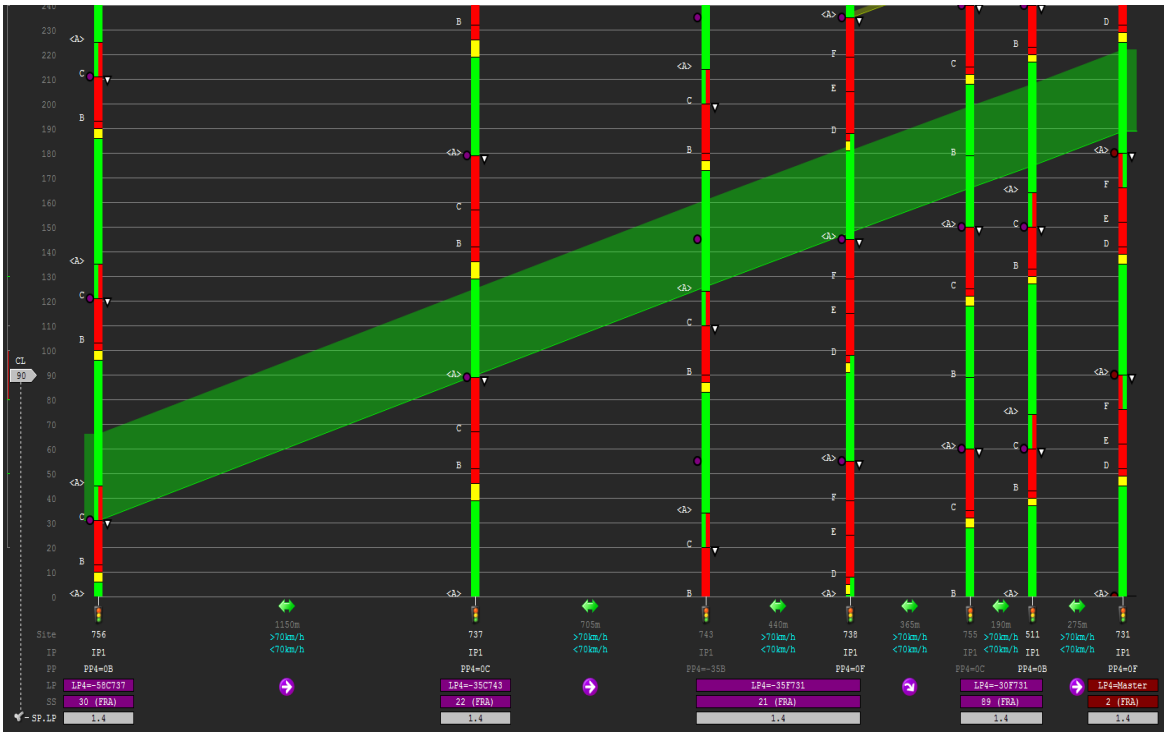


Fig. No. 24 Signal coordination time and distance graph

The horizontal axis indicates distance, and the vertical axis is time. The length of the green and red traffic signals on the major road are displayed. The green band depicts how one-way traffic flows across numerous crossroads without halting. The connecting offset is the amount of time between the beginning of green at one intersection and the beginning of green at the next intersection. Linking offsets may be chosen to favor traffic

in the peak direction during the morning and afternoon peaks.

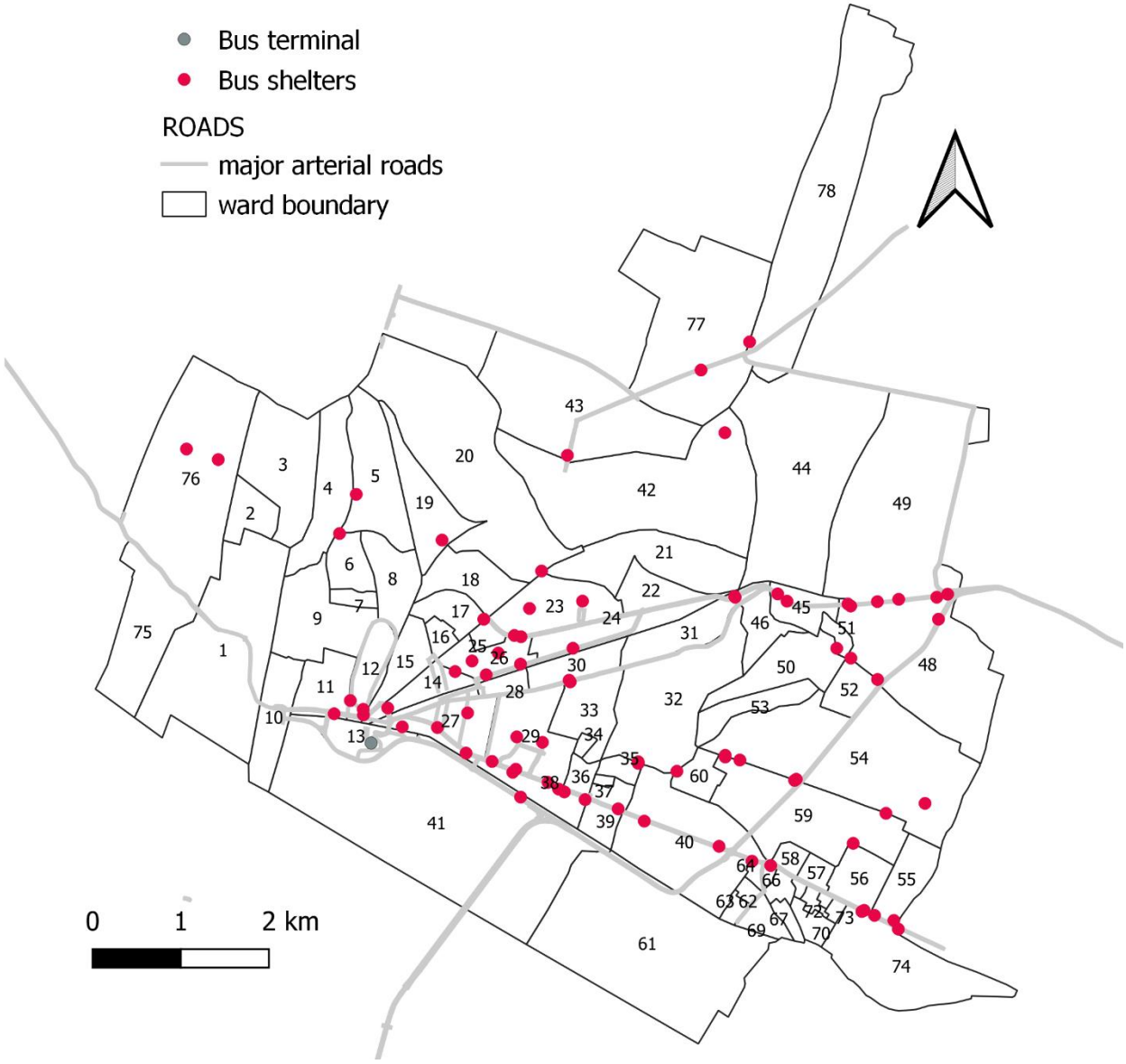


Fig. No. 25 Major arterial roads where this signal coordination will work

Synchronization of Traffic Signals "A Case StudyMr-10 Road, Indore"

For 12 of the MR-10 Road's intersections, signal design and synchronization have been completed in order to reduce delays and boost the road's traffic capacity. From Radisson Square to Lavkush Square, it takes 266 less seconds. & The distance from Lavkush Square and Radissons Square may be travelled in 225 seconds less. Journey speed improves from 31.43 kmph to 44.14 kmph, or 12.71 kmph more, from Lavkush Square to Radissons Square, and journey speed increases from 33.23 kmph to 46.94 kmph, or

13.71 kmph more. Savings of 390 kl of petrol and 517 kl of diesel per year have been made, and losses of Rs. 2.00 million, 54.15 million, and 47.01 million per year have been suffered as a result of vehicle delays, low vehicle running speeds, and lost people's time, respectively. According to estimates, CO2 emissions will drop by 2.29 million kg annually. (Gaurav Dane, 2015).

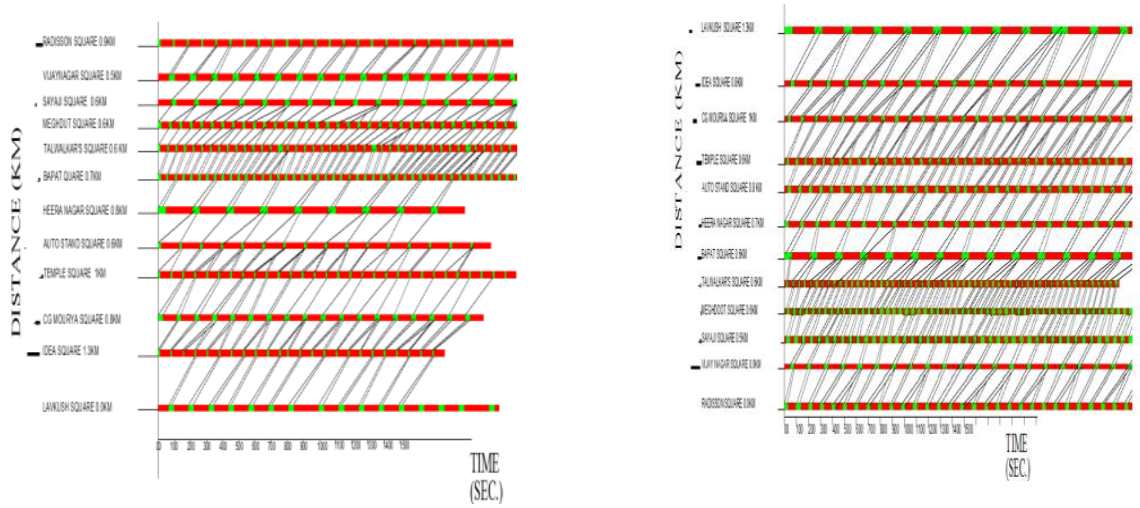


Fig. No. 26 Time and Distance Diagram Radisson Square to Lavkush Square and Lavkush Square to Radisson

Direction	Raddisson to Lavkush(E-W)	Lavkush to Radisson(W-E)	Total
Due to save time			
Time Saving in Rs.(Per Day)	63,332	65,482	1,28,814
Time Saving in Rs.(Per Annum)	2, 31, 16,334	2, 39, 01,021	4,70,17,355
Due to Low Running Speed			
Loss of fuel in Rs.(Per Day)	81,126	76,122	1,57,248
Loss of fuel in Rs.(Per Annum)	2, 96, 10, 990	2, 47, 84,530	5,43,95,520
Due to Delay			
Loss of fuel in Rs.(Per Day)	2,416	3,082	5,498
Loss of fuel in Rs.(Per Annum)	8, 82,088	11, 25,209	20,07,297
Total Rs.(Per Day)	1,46,874	1,44,686	2,91,560
Total Rs.(Per Annum)	5,36,09,412	4,98,10,760	10,34,20,172

Fig. No. 27 Benefits in terms of Money

	E to W Time Saving		W to E Time Saving	
	Before	After	Before	After
Journey time (sec)	910	644	962	685
Journey Speed (kmph)	33.23	46.94	31.43	44.14
Delay time (sec)	35	0	45	0
No of Passengers per hr	4217		4187	
Time Saving Sec/hr/pass	266		277	

Fig. No. 28 Results of Synchronization

8.1.2 Dynamic Bus Schedule

Fig. No. 29 Vijayawada fixed bus schedule

There is a fixed bus schedule in Vijayawada. Regular bus service on a set timetable. A fixed timetable with a constant headway, however, may result in an insufficient number of buses during peak hours and a system that is underutilized during off-peak hours, which may not be advantageous for the operator as passenger demand varies over time and space. Additionally, variations in traffic circumstances could result in deviations from the predetermined schedule, causing users to miss their bus or wait longer.

The current study suggests a Demand and Travel Time Responsive (DTR) model to maximise the benefit of the operator by creating an optimal schedule that can adapt to changes in passenger demands and traffic conditions in real-time, while minimising passenger waiting times and bus capacity restrictions to achieve the maximum financial benefit and social satisfaction. The use of a dynamic bus schedule has a number of benefits, including improved travel experiences, reduced waiting times for passengers, increased accessibility, better traffic management, and cost savings.

There are numerous techniques to implement a dynamic bus schedule:

Transportation companies may need to make investments in new technology, like GPS tracking or real-time passenger data collection systems, in order to implement dynamic bus schedules. Additionally, they might need to do real-time schedule adjustments and

teach workers on how to use these technologies. or by way of manual modifications made by transport companies based on several parameters.

Dynamic scheduling of buses on a corridor and sensitivity analysis for generation of primary bus routes – A case study of New Delhi:

The New Delhi Ring Road system is used to test the model. The morning peak hour from 7:30 am to 10:30 am is recreated for the circular bus transit system on the ring route. One hundred buses were taken, and a preliminary timetable was created based on the average link flow criterion. This is provided to the model as input. The model recommends 21 extra buses. Along with the time saved at all stops due to the scheduling of 21 additional buses, the output also includes the average amount of time passengers spend waiting, the average queue length, and the maximum line length generated at each stop. quality of service. With more terminals, system performance also increases, albeit the overall number of buses needed for scheduling does not change noticeably. When comparing the results of dynamic scheduling with fixed scheduling, it is evident that dynamic scheduling offers a higher quality of service. (Dr.B.R.Marwah, n.d.).

	Dynamic scheduling	Conventional scheduling
Total buses operated	129	130
Average waiting time (minutes)	7.65	8.56
Avg. Queues lengths	23.08	24.03
Maximum queue lengths	103	124

Fig. No. 30 Comparison between dynamic scheduling and fixed scheduling

8.1.3 App developing with common mobility card

Lack of information access to plan trips is one of the biggest problems experienced by bus riders. to increase the convenience, dependability, and safety of public transportation for its users. The Andhra Pradesh government did not have a dedicated mobile platform that allowed users to access a static or dynamic bus schedule, find bus stops, view bus arrival times, or schedule trips. Therefore, we may create an app that can alert those who have a common mobility card, which they can use to pay for buses, IPT, etc.

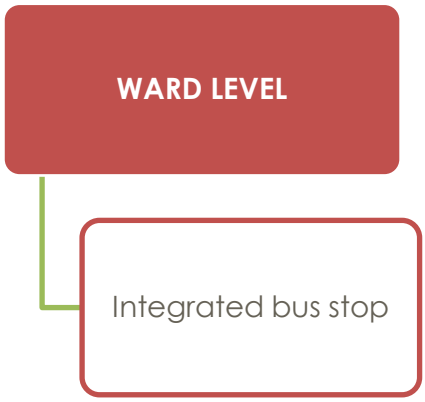
Case study – Delhi Mobility App

One of the major issues facing bus users is the lack of information availability to plan trips. to improve passengers' access to reliable, safe, and convenient public transit. The Andhra Pradesh government lacked a specialized mobile platform that provided users with access to a static or dynamic bus schedule, helped them locate bus stops, showed them the times of bus arrival, and let them plan excursions. In order to warn those who have a common mobility card—which they can use to pay for buses, IPT, etc.—we may develop an app. A new beta version of the one Delhi app with features like live bus monitoring, contactless ticketing, travel planning, EV charging, and passenger and official complaint and feedback system was released in early 2022.

Fig. No. 31 Delhi mobility cards

The Dialogue and Development Commission (DDC) of Delhi came up with the idea of a single mobility app to meet all of the public transport demands of Delhi residents in late 2018, following the introduction of the universal mobility card (ONE card), which could be used to pay for bus and metro fares in Delhi. One Delhi App, the first official universal mobility app for the Delhi Government, was designed and developed by DDC in collaboration with the Transport Department and IIIT Delhi. The app was introduced in March 2019 by the honorable vice chairperson (DDC) and minister of transportation. The Delhi Cabinet approved the 10% fare reduction for DTC and Cluster Bus riders who purchase bus tickets using the contact-less system in July 2021. (Sh. Gopal Mohan, 2023).

8.2 Ward level



8.2.1 Integrated bus stop

Integrated bus stop can be made by redesigning bus stop design with proper infrastructure and cycling stand integrated with the bus stop. Integrated halt time go stand for IPT. Revised road cross sections ward wise by providing well connected access by footpath or pavements.

Redesigning of Bus stop:

To show an example on redesigning bus stop with integrated cycle stand I took an example of ward 40.

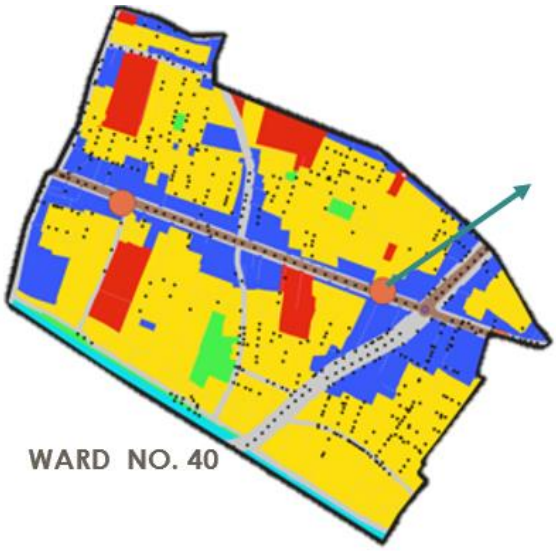


Fig. No. 32 Ward 40 existing bus stop design

To implement the bus stop design with integrated cycle stand, I have taken the case study of Bengaluru smart bus stop under electronic city industrial township authority.

Bengaluru has recently been experiencing a rebirth. As part of its pilot project, the Electronic City Industrial Township Authority (ELCITA) will install four "smart" bus shelters. The project's goal is to put in place the first Metro Neo network in the city, which is an electric trolleybus system. Also included in it will be these shelters. There will be 15 smart bus shelters installed altogether. However, the first four will initially be situated

across from 3M India, Infosys, Otium, and Phase 2 (XIME College). This is a positive step given the absence of suitable bus stops from the BBMP in the neighbourhood. Vending machines, health kiosks, emergency SOS buttons, charging stations, public speech systems, solar panels, EV bicycle bays, and basic infrastructural facilities are listed as specifications. The group plans to build 24 more of these bus stations throughout the region at a cost of Rs 20 lakh, according to ELCITA chairperson Veerappan. "We want 25 intelligent bus stations spread across E-City's 900 acres. We are in discussions with Infosys, Wipro, and other companies to take on work on the upcoming smart bus stop, and each of them will be sponsored by a business that operates outside the area. (Luthra, 2023).

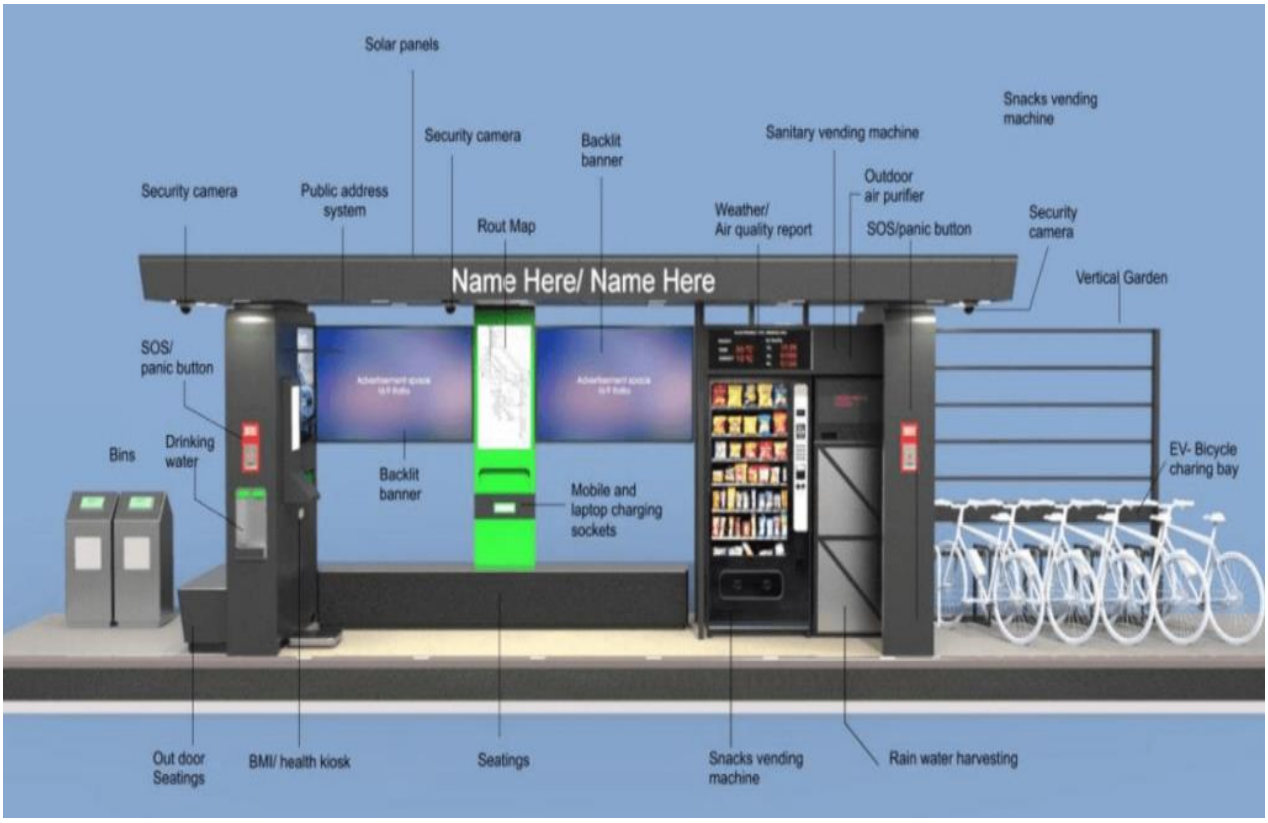


Fig. No. 33 Smart bus stop design – Bengaluru

Fig. No. 34 Smart bus stop design model

Fig. No. 35 Bengaluru bus stop design

Integrated halt and go stand for IPT:

When a passenger requests to be taken, integrated halt and go stands allow drivers to stop their vehicles for a short period of time and take them. In general, it is the best option to provide last-mile connectivity through IPT because there is no special space requirement for the cars; they will simply sit there for a short period of time and pick up

people as needed. These stop-and-go locations don't require any fundamental infrastructure. They will all have GPS capabilities and be trackable on mobile devices.

Fig. No. 36 Delhi integrated halt and go stand

For auto-rickshaws, Delhi has 402 approved stop-and-go locations, each of which allows for a maximum of five vehicles in a queue. Most of these locations operate clandestinely as auto-rickshaw stands along highways with little to no traffic but lack basic infrastructure. Delhi began notifying drivers of halt-and-go locations in 2010 (Anon., 2019).

Revised road cross sections ward wise by providing well connected access by footpath:

In this we are looking into 3 wards how are the footpath designs in that three wards that is ward 41, 40 and 78.

Fig. No. 37 Ward 41and 40 Existing footpath condition

Ward 41 which is core area has road width of 32m roads including service road and it has 2m footpath on one side of the road and 40 which is area between core areas and area between periphery has road width of 40m road and it has 2m footpath on both sides of the road. So, this ward had very good connectivity with footpaths of 2m with paved floors as shown in the images. For wards 41 and 40 can be designed with dedicated bus rotate and NMT (Anon., 2017).

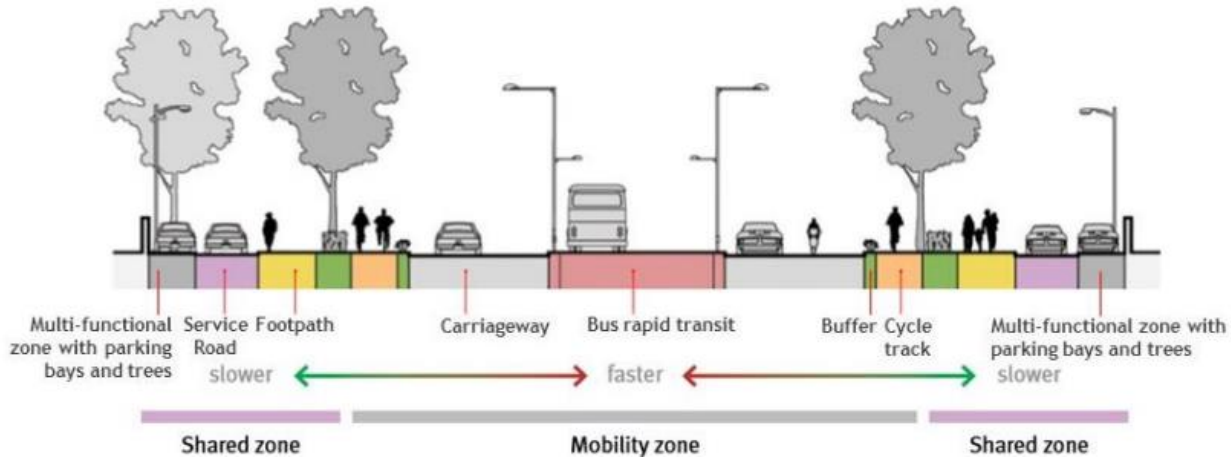


Fig. No. 38 Road cross section with dedicated bus route and NMT

Fig. No. 39 Ward 78 Existing footpath condition

Ward 78 which is periphery area has road width of 9m and it does not have specific footpath as shown in images, so it has to revised with a proper road section which include footpath, which will provide well connection to the bus stand located in that ward. So, we are proposing cross section according to IRC standards (Anon., 1991).

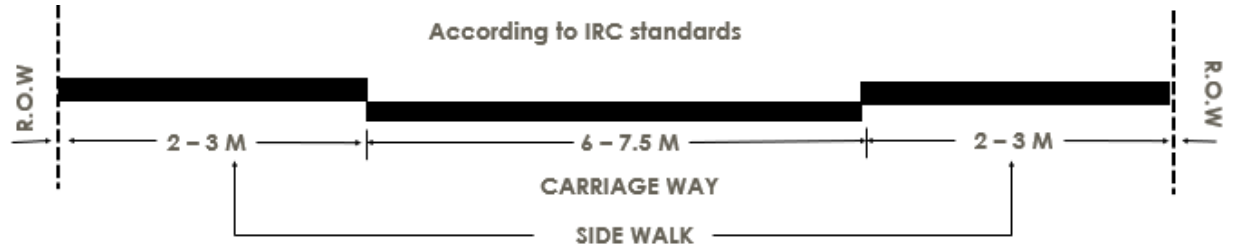


Fig. No. 40 Road cross section according to IRC Standards

Fig. No. 41 Side walks

In order to provide for efficient drainage and avoid puddles from accumulating, side walks should have flat walking surfaces (IRC: SP:50 and IRC:103-2012, 6.1.6). To help those who have vision

problems, guide tiles should be placed all the way down the pavement (IRC: 103-2012, 6.1.4). According to the case study of Taranga Hill in Gujarat, building a 1-kilometer side path cost around 1 crore. (Patel, 2019).

Chapter 9. Way Forward

For numerous reasons, including efficient use of public transportation, sustainability, social equality, and economic advantages, it is necessary to concentrate on public transportation (PT) and to examine the elements that influence the usage of public transportation. Due to the infrequent and unreliable nature of public transit, many also wish to switch to private transport when income levels rise. The result is a decline in the use of desirable modes of transportation (like NMT or PT) and an increase in the use of unfavourable modes (like cars and 2-wheelers). As a result, evaluating the variables that affect the use of public transport under various urban characteristics can assist policymakers in creating public transport policies and strategies that are more effective and suited to their needs. Additionally, it is hoped that this study would inspire more investigation into this significant occurrence.

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Annexure

Annexure 1 – Weighted mean method

WARDS	POPULATION	AREA IN SQKM	POPULATION DENSITY PER SQKM	Normalizing to scale - pop density	Normalizing to weightage - pop density	LAND VALUE PER SQ YARD	Normalizing to scale - land value	Normalizing to weightage - land use	NUMBER OF BUS SHELTER	BUS SHELTHER DENSITY	Normalized to scale - bus shelters density	Normalized to weightage - bus shelters density	DISTANCE FROM CBD(KM)	Normalized to scale - distance from CBD	Normalized to weightage - distance from CBD	TOTAL SCORE
1	43624	2.41	18101.24	1	0.25	25000	1	0.25	0	0	1	0.25	2	3	0.75	1.5
2	2422	0.29	8351.72	1	0.25	25000	1	0.25	0	0	1	0.25	3	2	0.5	1.25
3	15927	1.02	15614.71	1	0.25	17000	1	0.25	0	0	1	0.25	3	2	0.5	1.25
4	37039	0.71	52167.61	2	0.5	35000	2	0.5	0	0	1	0.25	3	2	0.5	1.75
5	21419	0.87	24619.54	1	0.25	17000	1	0.25	1	1.15	1	0.25	3	2	0.5	1.25
6	28235	0.29	97362.07	3	0.75	25000	1	0.25	1	3.45	1	0.25	2	3	0.75	2
7	8151	0.09	90566.67	3	0.75	25000	1	0.25	0	0	1	0.25	2	3	0.75	2
8	28021	0.46	60915.22	2	0.5	25000	1	0.25	0	0	1	0.25	2	3	0.75	1.75
9	41586	0.84	49507.14	2	0.5	25000	1	0.25	0	0	1	0.25	1	3	0.75	1.75
10	11795	0.52	22682.69	1	0.25	25000	1	0.25	0	0	1	0.25	1	3	0.75	1.5
11	16233	0.41	39592.68	2	0.5	75000	3	0.75	1	2.44	1	0.25	1	3	0.75	2.25
12	2882	0.35	8234.29	1	0.25	95000	3	0.75	3	8.57	1	0.25	1	3	0.75	2
13	1143	0.34	3361.76	1	0.25	25000	1	0.25	1	2.94	1	0.25	1	3	0.75	1.5
14	2047	0.28	7310.71	1	0.25	58000	2	0.5	2	7.14	1	0.25	1	3	0.75	1.75
15	1713	0.34	5038.24	1	0.25	58000	2	0.5	0	0	1	0.25	1	3	0.75	1.75
16	3869	0.1	38690	2	0.5	25000	1	0.25	0	0	1	0.25	2	3	0.75	1.75
17	12272	0.27	45451.85	2	0.5	17000	1	0.25	1	3.7	1	0.25	2	3	0.75	1.75
18	13233	0.5	26466	1	0.25	25000	1	0.25	0	0	1	0.25	3	2	0.5	1.25
19	12214	0.62	19700	1	0.25	15000	1	0.25	1	1.61	1	0.25	3	2	0.5	1.25
20	31425	2.73	11510.99	1	0.25	25000	1	0.25	1	0.37	1	0.25	4	2	0.5	1.25
21	38143	0.99	38528.28	2	0.5	28000	1	0.25	0	0	1	0.25	4	2	0.5	1.5
22	5905	0.3	19683.33	1	0.25	38000	2	0.5	0	0	1	0.25	4	2	0.5	1.5
23	21861	0.66	33122.73	1	0.25	30000	1	0.25	3	4.55	1	0.25	3	2	0.5	1.25
24	21349	0.53	40281.13	2	0.5	35000	2	0.5	1	1.89	1	0.25	4	2	0.5	1.75
25	2511	0.09	27900	1	0.25	30000	1	0.25	0	0	1	0.25	2	3	0.75	1.5
26	3850	0.37	10405.41	1	0.25	58000	2	0.5	5	13.51	1	0.25	2	3	0.75	1.75
27	4119	0.63	6538.1	1	0.25	86000	3	0.75	4	6.35	1	0.25	2	3	0.75	2
28	3302	0.11	30018.18	1	0.25	65000	2	0.5	0	45.45	1	0.25	2	3	0.75	1.75
29	10567	0.8	13208.75	1	0.25	86000	3	0.75	5	0	1	0.25	3	2	0.5	1.75
30	12783	0.32	39946.88	2	0.5	41000	2	0.5	1	3.13	1	0.25	3	2	0.5	1.75
31	11585	0.46	25184.78	1	0.25	49000	2	0.5	2	4.35	1	0.25	4	2	0.5	1.5
32	36385	1.49	24419.46	1	0.25	44000	2	0.5	1	0.67	1	0.25	4	2	0.5	1.5
33	6775	0.52	13028.85	1	0.25	50000	2	0.5	1	1.92	1	0.25	3	2	0.5	1.5

34	2502	0.04	62550	2	0.5	41000	2	0.5	0	0	1	0.25	3	2	0.5	1.75
35	4643	0.11	42209.09	2	0.5	28000	1	0.25	1	9.09	1	0.25	4	2	0.5	1.5
36	4590	0.12	38250	2	0.5	25000	1	0.25	0	0	1	0.25	3	2	0.5	1.5
37	1929	0.02	96450	3	0.75	29000	1	0.25	0	0	1	0.25	4	2	0.5	1.75
38	2696	0.29	9296.55	1	0.25	55000	2	0.5	4	13.79	1	0.25	3	2	0.5	1.5
39	7474	0.29	25772.41	1	0.25	63000	2	0.5	1	3.45	1	0.25	4	2	0.5	1.5
40	25953	1.6	16220.63	1	0.25	61000	2	0.5	2	1.25	1	0.25	5	2	0.5	1.5
41	85990	4.48	19194.2	1	0.25	40000	2	0.5	1	0.22	1	0.25	2	3	0.75	1.75
42	49247	2.76	17843.12	1	0.25	2200	1	0.25	1	0.36	1	0.25	5	2	0.5	1.25
43	17446	2.08	8387.5	1	0.25	17000	1	0.25	1	0.48	1	0.25	5	2	0.5	1.25
44	8557	2.79	3067.03	1	0.25	25000	1	0.25	0	0	1	0.25	6	1	0.25	1
45	4481	0.29	15451.72	1	0.25	25000	1	0.25	2	6.9	1	0.25	6	1	0.25	1
46	3299	0.33	9996.97	1	0.25	25000	1	0.25	0	0	1	0.25	5	2	0.5	1.25
47	2731	0.62	4404.84	1	0.25	25000	1	0.25	0	0	1	0.25	6	1	0.25	1
48	7925	2.03	3903.94	1	0.25	30000	1	0.25	7	3.45	1	0.25	7	1	0.25	1
49	7943	2.92	2720.21	1	0.25	16000	1	0.25	2	0.68	1	0.25	7	1	0.25	1
51	1224	0.08	15300	1	0.25	25000	1	0.25	1	12.5	1	0.25	6	1	0.25	1
52	4333	0.25	17332	1	0.25	51000	2	0.5	0	0	1	0.25	6	1	0.25	1.25
53	11604	0.33	35163.64	2	0.5	25000	1	0.25	0	0	1	0.25	5	2	0.5	1.5
54	18478	2.76	6694.93	1	0.25	49000	2	0.5	4	1.45	1	0.25	6	1	0.25	1.25
55	217	0.4	542.5	1	0.25	40000	2	0.5	2	5	1	0.25	7	1	0.25	1.25
56	6366	0.36	17683.33	1	0.25	46000	2	0.5	1	2.78	1	0.25	7	1	0.25	1.25
57	5811	0.11	52827.27	2	0.5	46000	2	0.5	0	0	1	0.25	6	1	0.25	1.5
58	3778	0.1	37780	2	0.5	65000	2	0.5	0	0	1	0.25	6	1	0.25	1.5
59	15378	1.46	10532.88	1	0.25	55000	2	0.5	4	2.74	1	0.25	6	1	0.25	1.25
60	4959	0.22	22540.91	1	0.25	55000	2	0.5	1	4.55	1	0.25	5	2	0.5	1.5
61	28858	3.19	9046.39	1	0.25	24000	1	0.25	0	0	1	0.25	5	2	0.5	1.25
62	1613	0.05	32260	1	0.25	40000	2	0.5	0	0	1	0.25	6	1	0.25	1.25
63	1449	0.06	24150	1	0.25	40000	2	0.5	0	0	1	0.25	6	1	0.25	1.25
64	2187	0.04	54675	2	0.5	46000	2	0.5	1	25	2	0.5	6	1	0.25	1.75
65	1132	0.03	37733.33	1	0.25	40000	2	0.5	1	33.33	3	0.75	6	1	0.25	1.75
66	1659	0.09	18433.33	1	0.25	40000	2	0.5	0	0	1	0.25	6	1	0.25	1.25
67	5280	0.08	66000	2	0.5	46000	2	0.5	0	0	1	0.25	6	1	0.25	1.5
68	1078	0.02	53900	2	0.5	46000	2	0.5	0	0	1	0.25	6	1	0.25	1.5
69	2517	0.16	15731.25	1	0.25	40000	2	0.5	0	0	1	0.25	6	1	0.25	1.25
70	6721	0.13	51700	2	0.5	46000	2	0.5	0	0	1	0.25	6	1	0.25	1.5
71	836	0.02	41800	2	0.5	46000	2	0.5	0	0	1	0.25	7	1	0.25	1.5
72	682	0.05	13640	1	0.25	46000	2	0.5	0	0	1	0.25	6	1	0.25	1.25
73	2285	0.04	57125	2	0.5	46000	2	0.5	0	0	1	0.25	7	1	0.25	1.5
74	23158	1.23	18827.64	1	0.25	41600	2	0.5	2	1.63	1	0.25	8	1	0.25	1.25
75	27873	0.99	28154.55	1	0.25	30000	1	0.25	0	0	1	0.25	3	2	0.5	1.25
76	34470	2.5	13788	1	0.25	30000	1	0.25	2	0.8	1	0.25	3	2	0.5	1.25
77	51228	2.5	20491.2	1	0.25	15000	1	0.25	1	0.4	1	0.25	7	1	0.25	1

78	12552	2.68	4683.58	1	0.25	9500	1	0.25	1	0.37	1	0.25	8	1	0.25	1

Annexure 2 – Weighted score with residential area

SCORE 1	RESIDENTIAL AREA (SQ.KM)
WARD 2	0.085
WARD 3	0.542
WARD 5	0.279
WARD 18	0.198
WARD 19	0.311
WARD 20	2.111
WARD 23	0.351
WARD 42	1.699
WARD 43	1.373
WARD 44	2.54956
WARD 45	0.06
WARD 46	0.017
WARD 47	0.049
WARD 48	1.07
WARD 49	1.884
WARD 50	0.049
WARD 51	0.065
WARD 52	0.195
WARD 54	1.147
WARD 55	0
WARD 56	0.196
WARD 59	0.819
WARD 61	0.407
WARD 62	0.024
WARD 63	0.031
WARD 66	0.028
WARD 69	0.1054
WARD 72	0.00065
WARD 74	1.09
WARD 75	0.107
WARD 76	1.55
WARD 77	1.819
WARD 78	**2.5409**

SCORE 2	RESIDENTIAL AREA (SQ.KM)
WARD 1	0.448
WARD 10	0.048
WARD 13	0
WARD 21	0.65
WARD 22	0.065
WARD 25	0.023
WARD 31	0.193
WARD 32	0.405
WARD 33	0.282
WARD 35	0.04
WARD 36	0.027
WARD 38	0.026
WARD 39	0.137
WARD 40	**0.736**
WARD 53	0.059
WARD 57	0.066
WARD 58	0.067
WARD 60	0.098
WARD 67	0.019
WARD 73	0.025
WARD 68	0.003
WARD 70	0.06
WARD 71	0.014

SCORE 3	RESIDENTIAL AREA (SQ.KM)
WARD 4	0.258
WARD 6	0.13
WARD 7	0.029
WARD 8	0.173
WARD 9	0.162
WARD 11	0.00013
WARD 12	0.052
WARD 14	0
WARD 15	0
WARD 16	0.067
WARD 17	0.067
WARD 24	0.291
WARD 26	0.019
WARD 27	0
WARD 28	0.027

WARD 29	0.0054
WARD 30	0.145
WARD 34	0.0084
WARD 37	0.011
WARD 41	0.785
WARD 64	0.007
WARD 65	0.006

Annexure 3 – Data required

DATA REQUIRED	PRIMARY / SECONDARY	OFFICES/SURVEYS
TRAVEL CHARACTERISTICS		
Trip length	Primary	Surveys
trip length frequency	Primary	Surveys
Mode of transport	Primary	Surveys
trip purpose	Primary	Surveys
travel time	Primary	Surveys
Travel cost	Primary	Surveys
transport expenses	Primary	Surveys
waiting time	Primary	Surveys
PUBLIC TRASNPORT CHARACTERISTICS		
Passenger footfall	Secondary	offices

Comfort level	Primary	Surveys
Service reliability	Primary	Surveys
security	Primary	Surveys
Punctuality	Primary	Surveys
URBAN CHARACTERISTICS		
Land use	Secondary	Offices/websites
Population density	Secondary	Offices/websites
Distance from CBD	Secondary	Offices/websites
Bus shelter density	Secondary	Offices/websites

Annexure 4 – Survey form

Name of Enumerator:	Day/Date:
Name of the Respondent:	TAZ-Location No. …...Street Name.....….....House no……...

DEMOGRAPHIC DETAILS								**Vehicle Ownership**			
S. No	SEX	AGE	DRIVING LICENSE	EDUCATION	OCCUPATION	INCOME	EXPENDITURE ON TRANSPORTATION (MONTHLY)	Type	Age	Fuel	Mile Age

1											
2											
3											
4											
5											
6											
7											

TRIP INFORMATION:

S. No	Trip no.	Purpose	Frequency	Time of the day	Mode	Link trips	Origin	Destination	Distance	Cost	Travel Time
1											
2											
3											
4											
5											
6											
7											
8											
9											

	EXISTING	Scenario 1	Scenario 2	Scenario 3
COST	10	15	15	20
COMFORT	LOW	LOW	MED	HIGH
TIME	25	20	18	15
DISTANCE	5	5	5	5
Preference (Yes/No)				

IF USER USES PT THEN TRIP INFORMATION

S.no of above PT trip	Avg. Waiting time	Comfort			Service reliability			SECURITY			PUNCTUALITY		
		Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad
		Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad
		Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad
		Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad
		Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad	Good	Ok	Bad

Willingness to shift to public transport: Yes/No

Do you think it is safe and convenient to walk on roads of Vijayawada city?

Are you satisfied with the way you travel in the city?

No, What If do you think needs to be improved?

CODE SHEET

CODE	EDUCATION (5)	OCCUPATION (6)	PURPOSE OF TRAVEL	MODE

0	No school education	Salaried employment (regular waged)	Work	Walk
1	Primary education (up to 8th)	Daily Wages employment (casual labor)0	Education	Cycle
2	Matriculation/up to 12^{th}	Self Employed (work in h/h enterprise)	Business	Cycle Rickshaw
3	Graduate	Student	Shopping	2-wheeler
4	Others (Specify)	Unemployed	Recreational/Social	Car
5		Others – specify	Others (Medical etc.)	Bus
6			Return Home- Ret.	Auto
7				Taxi
8				Trucks
9				Others