Md Muslim Ansari

Developing Sustainable Urban Freight Index for Fruit and Vegetable Markets A Case of Bhopa city

May 2024

Developing Sustainable Urban Freight Index For Fruit and Vegetable Markets: A Case of Bhopal City

Master of Planning
(Transport Planning and Logistics Management)

Md Muslim Ansari
[Sch. No. 2022MTPLM005]

SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL
NEELBAD ROAD, BHAURI, BHOPAL (MP)-462030

May 2024

Developing Sustainable Urban Freight Index for Fruit and Vegetable Markets: A Case of Bhopal city

The thesis submitted in partial fulfillment of the requirements for the award of the degree of

Master of Planning
(Transport Planning and Logistics Management)

By
Md Muslim Ansari
Scholar No. 2022MTPLM005

SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL
NEELBAD ROAD, BHAURI BHOPAL (MP)-462030

May 2024

DECLARATION

I **Md Muslim Ansari**, Scholar No. **2022MTPLM005** hereby declare that the thesis titled **"Developing Sustainable Urban Freight Index for Fruits and Vegetables Markets"** submitted by me in partial fulfilment for the award of **Master of Planning**, at the School of Planning and Architecture, Bhopal, India, is a record of bonafide work carried out by me. The matter/result embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.

Signature of the Student

Date: _____

Certificate

This is to certify that the declaration of **Md Muslim Ansari** is true to the best of my knowledge and that the student has worked under my guidance in preparing this thesis.

RECOMMENDED

_____

Signature of the Guide

Dr. Mohit Dev

ACCEPTED

_____

Prof. Saurabh Popli

Head, Department of Transport Planning

May 2024

ACKNOWLEDGEMENT

This thesis is the end of my journey to complete my master's degree. With the strong guidance and motivation of various individuals like my colleagues, faculties, and organizations, this research has been kept on track and completed. At this time, I would like to thank all people for making this happen and for making it an amazing experience for me. It is a pleasant task here to express my gratitude to all those who have contributed to the study in many ways.

First of all, I would like to express my overflowing indebtedness to my guide and thesis coordinator Dr. Mohit Dev (Asst. Professor) under whose guidance this report has been prepared. Her suggestions and comments at various stages of my thesis have been of immense help in the satisfactory and timely completion of the report.

I wish also to express my deepest gratitude to thanks the Head of the Department Prof. Saurabh Popli for setting up a wonderful opportunity and platform to work. I also like to thank Asst. Prof Dr. Mayank Dubey, Prof, Dr. Mohit Dev, Prof, Dr. Ashfaque Alam for all their insight on my thesis.

I am grateful to my parents my brothers, and my seniors Dharna Dang and Yash Partap Sing (SPAB alumni) for helping me understand the basic concepts I am thankful to my whole batch for helping me understand the concepts of software and other various skill sets. Thanks to my friends Akash Soni, and Azeem Akhtar, Chandan Kumar, Avinash Kumar for always being ready to help, and special thanks to Bharti Singh, Muskan who has helped at various stages of my work and in this course.

Hostel life in the School of Planning and Architecture played a significant role in shaping my life. During my stay I have met some of the amazing personalities in the hostel. I must thank my batchmates Satya, Ahad Khan, Raghavendra, Suhail Masood, Shubham, and Ashutosh, for helping me on various occasions. I am indebted to Isha Ejaj Khan, Tuhin Plit, Pratyush Nayak, Abhishek, and Saurav, for their presence around the hostel and thankful for their help in many ways. Due to their soulful presence, the Master’s life became more enjoyable. I never imagined that; Master’s life could be so enjoyable. This is only possible because of the SPA hostel. Thank you all for your support.

Abstract

With the increase in population and changing consumption patterns, urban freight has become a topic of concern today. Although sustainability is widely discussed in the context of passenger modes, freight transport, besides being a neglected sector of the probe, has hardly seen any initiatives or strategies for its sustainable operation in Indian cities. Aimed at creating a measurable tool for sustainable urban freight in the context of a developing environment like India, this thesis is an attempt to develop a sustainable urban freight index (SUFI) in the context of fruits and vegetable markets in a metropolitan city. The SUFI index developed for various markets was analyzed in terms of five pillars of sustainability (Environment, Economy, Social, Planning, and Policy) to highlight the area of concern for future F&V market planning. As part of this effort, the horizon year population and freight F&V tonnage were forecasted for the horizon year index, which was also calculated for the horizon year.

Many primary surveys have been conducted in 8 case study fruit and vegetable markets spread in Bhopal. In addition, a primary survey of experts and academicians has been conducted to decide the weights for various indicators of the SUFI using the Analytical Hierarchy Method. Further, a citizen perception survey has also been conducted in the residential areas adjoining the mandis to understand the underlying issues faced due to the presence of F& V mandis. Additionally, a mobile application-based noise survey was also conducted to perceive the noise impact of the fruits and vegetable markets. Extensive data analysis was carried out to understand the issues faced at each level of the fruit and vegetable market. An impact analysis of case markets on the bounding network was carried out along with the identification of time-based hotspots in different parts of the Zone of Bhopal.

The SUFI index developed for various markets was analyzed in terms of five pillars of sustainability (Environment, Economy, Social, Planning, and Policy) to highlight the area of concern for future F&V market planning. As part of this effort, the horizon year population and freight F&V tonnage were forecasted for the horizon year index, which was also calculated for the horizon year. Time-based alternate scenarios were created to check the change in the SUFI index values for different markets based on which short-term, medium-term, and long-term strategies and desired actions were evaluated leading to an improved value of SUFI compared to the BAU scenario. Requite improved infrastructure has been identified and planning guidelines and norms for siting new mandis and facility development have been recommended. Based on the evaluation, strategies have been proposed for short-term, medium-term, and long-term for all tier markets. Additionally, general recommendations on technology-based management strategies along with the potential use of an Intelligent transport system in the action plan to augment sustainable operations in the mandis have been provided.

सारांश

आज के समय में जनसंख्या में वृद्धि और उपभोक्ता पैटर्न में परिवर्तन के साथ, शहरी फ्रेट एक चिंता का विषय बन गया है। हालांकि पर्यावरणीयता को सार्वजनिक रूप से यात्री मोड़ों के संदर्भ में व्यापक रूप से चर्चा किया जाता है, फ्रेट परिवहन, जांच के अलावा, उपक्षित क्षेत्र होता है, इसके लिए भारतीय शहरों में उसके विश्वसनीय संचालन के लिए किसी भी पहल या रणनीतियों का कोई नमूना नहीं है। भारत जैसे विकासशील वातावरण के संदर्भ में संवेदनशील शहरी फ्रेट के लिए एक मापनीय उपकरण बनाने का उद्देश्य रखते हुए, यह थीसिस एक महानगर में फल और सब्जी मंडियों के संदर्भ में एक शहरी फ्रेट सूचकांक (एसयूएफआई) विकसित करने का प्रयास है। विभिन्न बाजारों के लिए विकसित एसयूएफआई सूचकांक का विश्लेषण पाँच पाइलर्स के संदर्भ में (पर्यावरण, अर्थव्यवस्था, सामाजिक, योजना और नीति) में किया गया था ताकि भविष्य के एफ और वी मार्केट प्लानिंग के क्षेत्र को हाइलाइट किया जा सके।

इस प्रयास के रूप में, जनसंख्या और फ्रेट एफ और वी टनेज को अंतरिक्ष वर्ष सूचकांक के लिए भविष्य के वर्ष के लिए पूर्वानुमान किया गया था, जिसे अंतरिक्ष वर्ष के लिए भी गणना की गई थी। भोपाल में फैले 8 मामूल फल और सब्जी मंडियों में अनेक मुख्य सर्वेक्षण किए गए हैं। इसके अतिरिक्त, विभिन्न सूचकों के लिए वजन निर्धारित करने के लिए विशेषज्ञों और शिक्षाविदों का मुख्य सर्वेक्षण एनालिटिकल हायरार्की मेथड का उपयोग किया गया। इसके अलावा, मंडियों के समीपस्थ आवासीय क्षेत्रों में अध्ययन के लिए नागरिक परिप्रेक्ष्य सर्वेक्षण भी किया गया है ताकि एफ और वी मंडियों के मौजूदा समस्याओं को समझा जा सके। इसके अतिरिक्त, फल और सब्जी मंडियों के शोर के प्रभाव को महसूस करने के लिए मोबाइल एप्लिकेशन पर आधारित शोर सर्वेक्षण भी किया गया है। फल और सब्जी मंडियों के प्रत्येक स्तर पर सामने आने वाली समस्याओं को समझने के लिए व्यापक डेटा विश्लेषण किया गया। अलग-अलग बाजारों के एसयूएफआई सूचकांक की बारहवीं वर्ष के लिए मापतोला गया और इसके आधार पर संक्षिप्त, मध्यम और लंबे समय की

रणनीतियों और इच्छित क्रियाओं का मूल्यांकन किया गया, जो बीएयू स्थिति की तुलना में अधिक बेहतर एसयूएफआई के लिए ले जाते हैं। आवश्यक सुधारित बुनियादी संरचना को पहचाना गया है और नई मंडियों का स्थानांतरण और सुविधा विकास के लिए योजना निर्देशिकाएं और आदर्श तैयार किए गए हैं। मूल्यांकन के आधार पर, सभी टियर बाजारों के लिए छोटे समय, मध्यम समय और लंबे समय के लिए रणनीतियाँ प्रस्तावित की गई हैं। साथ ही, तकनीक पर आधारित प्रबंधन रणनीतियों पर सामान्य सिफारिशें और मंडियों में सतत संचालन को बढ़ाने के लिए कार्रवाई योजना में एक बुद्धिमान परिवहन प्रणाली के संभावित उपयोग पर भी प्रस्ताव दिया गया है।

TABLE OF CONTENTS

List of Figures

List of Tables

ABBREVIATIONS

Abbreviation	Full Form
APMC	Agriculture Produce Marketing Committee
AHP	Analytical Hierarchy Process
CPCB	Central Pollution Control Board
EV	Electric Vehicle
F & V	Fruits and Vegetables
IFC	Integrated Freight Complex
NMT	Non-Motorised transport
SUFI	Sustainable Urban Freight Index
TCO	Total Cost of Ownership
LDV	Light Duty Vehicle
HDV	Heavy Duty Vehicle
MT	Metric Tonnes
GDP	Gross Domestic Product
PDA	Public Distribution system

CHAPTER 1 INTRODUCTION

1.1 Background

1.1.1 Importance of Urban Freight

In recent decades, there has been a substantial increase in the global significance of freight, with India's logistics sector experiencing remarkable growth at a compounded annual rate of 8.5%. This sector plays a vital role in contributing to the Gross Domestic Product (14%) of the country, as indicated by Khan (2019). With approximately 2.6 million trucks in operation, employing around 20 million individuals, as reported by UN-Habitat in 2013, the impact of freight on India's economy and workforce is evident.

Traditionally, the sustainability of cities has been linked to factors such as employment opportunities, travel options, and the promotion of inclusivity. However, contemporary research underscores the critical role of freight distribution in sustaining the daily activities of urban centres. The increasing focus on the logistics sector sheds light on its significance in the overall framework of city sustainability.

1.1.2 Sustainable Urban Freight

In recent years, there has been a growing global concern for Sustainable Urban Transport, with a notable emphasis on Sustainable Urban Passenger Transport compared to Sustainable Urban Freight Transport. The United Nations' Sustainable Development Goals highlight the significance of Sustainable Cities and Communities, incorporating a focus on Urban Freight, as noted by (Nathanail, et al (2017). According to a report from UN-Habitat, although cities occupy only 2% of the Earth's land surface, they contribute significantly to global energy consumption (60%), Greenhouse Gas Emissions (70%), and global waste generation (70%) (United Nations, 2016).

The accelerated rate of urbanization worldwide has led to a surge in the production and consumption of goods and services, subsequently driving an increase in freight-based movements. This trend is emphasized by Him and Hans-Dietrich (2019), who point out that the urban population is expanding at an unprecedented pace. However, this urbanization has also brought about challenges in freight

transportation within urban areas, encompassing issues such as efficient freight distribution, as well as concerns related to noise, traffic congestion, safety, and environmental impact (Civitas, 2020).

Urban freight movements have adverse effects on the quality of life for city residents, giving rise to issues such as emissions, vibrations, road blockages, and visual disruptions. These externalities associated with urban freight have contributed to a decline in the overall liveability of major cities worldwide. Despite projections by the United Nations anticipating a global population increase, the demand for urban freight is expected to rise, posing additional challenges to the sustainability of cities. Furthermore, the absence of specific plans for managing freight in Indian cities exacerbates the inefficiency and non-sustainability of freight activities. The lack of tailored strategies for handling freight contributes to suboptimal conditions and challenges in urban freight management within Indian urban areas.

1.2 Research Need

1.2.1 Urbanization Trends in India.

According to the census of India, Indian cities have crossed the 35% urbanization rate mark. This implies an increase in the urban population along with an augmented demand for goods and services. This can be seen in which depicts the relationship between the daily goods demand and city size: There is a direct relationship between the intracity flow and the demand for daily goods. With the increase in population, the intracity flow increases and vice-versa.

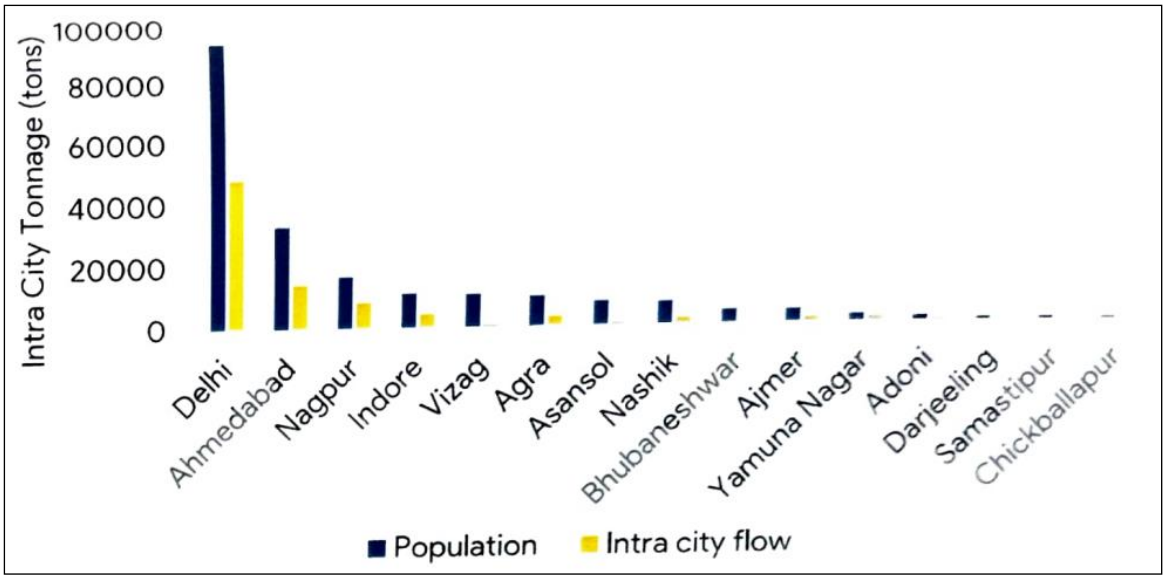


Figure 1: Population vs Intra City Goods Traffic
Source: CRRI (1991)

1.2.2 Increased Vehicle kilometres

Freight-related trip lengths have risen by 2.5 times in the past 13 years. i.e. from 207 to 2020 (Federal Ministry for Economic Cooperation and Development, (GIZ, 2015). Increased trip length has an implication on the fuel consumption environment as well as on the depletion of resources.

1.2.3 Augmented emissions

More than half of the emissions from the transport Sector of the capital city are due to freight-related movement 67% of $PM_{2.5}$ emissions, 61% of the total SO2 emissions, and 62 %of the NOx emissions in the city are from the freight sectors in Delhi (Niti Ayog,2018). Moreover, a study analysis found that surface transport is the major causal factor for emissions in a city.

1.2.4 Freight-related Safety Issues

In India, trucks Contribute to 6% of on-road vehicles but are involved in 26 % of road accidents (Intergovernmental Tenth Regional Environmental Sustainability (EST) Forum in Asian Vientiane Capital, (2017).

1.2.5 External Costs of Freight

In a study conducted in Europe, the external costs were calculated for passenger and freight vehicles (Sukri & Raicu,2012). These costs include the cost of GHG gases/ km Pollutants/ Km, Noise / Km, Safety/km, and Congestion/Km. A comparison of passenger and freight-related external costs was done, after which it was concluded that freight transport contributes to more than 2 times the external cost as compared to passenger transport.

1.2.6 Health Impacts of Urban Freight

Not only urban dwellers, but a lot of truck drivers also face health-related issues. In a survey conducted in 2019. It was found that health was not considered to be a priority in the truck industry 50% of trips have a duration of over 12 hours, and 46 % of drivers drive continuously for over 6 hours (Time of India, 2018). Sleep-related statistics also reveal that 60% sleep for four hours or less. and a maximum of them sleep within the truck while on assignment, The health issues faced by them are shown in Figure 1.

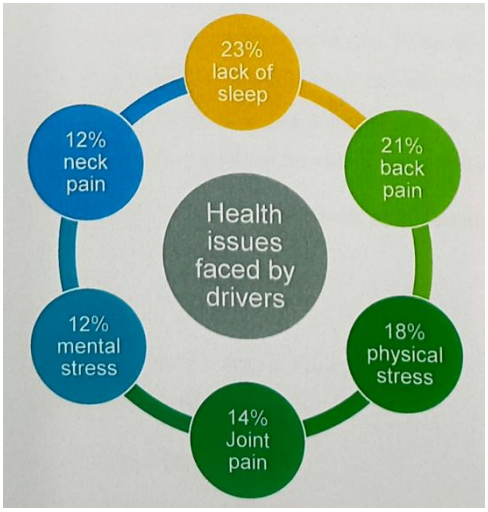


Figure 2: Health Issue faced by truck driver

1.2.7 Lack of Coordination among Freight Stakeholders.

There is a plethora of stakeholders, which can be categorized into private and public sector stakeholders. Private stakeholders include shippers, logistics providers, and carriers while the public sector stakeholders include transport

policymakers and law enforcers. land-use planners. and municipal bodies. Lack of coordination among stakeholders leads to an unsustainable urban freight system, which is characterized by loss of time, resources, capital, and additional costs (Ministry of Housing and Urban Affairs, 2015).

1.3 Need of Study in the Indian Context

In India, there is a lack of existence of any system for managing the entry and exit of the innumerable goods vehicles which enter the urban areas, except for the time restrictions, which exist in some cities. With this unmanageable number of goods vehicles moving on the city streets, the emission levels have increased in the cities. This has led to a deteriorated quality of air and excessive traffic congestion. Additionally, the goods vehicles enter the market areas which are devoid of proper parking spaces, leading to undesirable delays and inefficient market operations. This further has impacted the lives of people with an overall impact on the quality of life of the people.

In the context of this issue, no informed decisions have been taken till now to address issues related to ensuring the sustainability of market operations. There is a dearth of any policy documents and guidelines for ensuring efficient market operations, and no study has been conducted to manage the city-level markets sustainably. Moreover, Indian cities lack any kind of quantitative evaluation methods for checking the sustainability of markets.

1.4 Issues related to the Urban Freight Movement.

Various issues related to urban freight movement can be categorized into the following segments:

1. Environment Issues: Issues such as pollution arise due to the intensive usage of motorized freight vehicles leading to an increased carbon footprint and finally environmental degradation.
2. Economic Issue: A greater amount of tonnage in the Cities has led to delays and increased travel times and an impact on the timely delivery of goods. This has further led to increased fuel consumption and unreliable freight movement.

3. Social Issues: Higher pollution and congestion levels in the cities have led to a lot of health issues for the residents. Moreover, there has been an increase in the number of vehicle accidents taking place every day.
4. Planning Issues: In India, none of the Mobility or Master Plans have Proposals Specifically for Urban freight movement with 90% emphasis on Passenger transportation, specific Plans have not been made in India.
5. Institutional Issues: Indian policies lack clarity on urban freight transportation and management; there are no guidelines and norms for planning a freight-based infrastructure except a regional-level transport Nagar/ terminal.

1.5 AIM of the Study

To develop a sustainable urban freight index, particularly for the market for fruits and vegetables.

1.6 Objective of the Study

1. To assess the need for and importance of a sustainable urban freight index.
2. To review global best practices of sustainable urban freight index and data requirements.
3. To assess the urban freight transport profile of fruits and vegetable markets of Bhopal city and highlight issues related to sustainability.
4. To develop a sustainable urban freight index for Case Markets and create alternate scenarios.

1.7 Scope and Limitation

- To study freight operations in the markets of the city; with a focus on only one commodity. Fruit and Vegetables.
- The study is limited to the Mandis of the Planning zone of the Bhopal development authority.

1.8 Methodology

To achieve the specified goals, a comprehensive methodology was devised. Initially, extensive research was undertaken to ascertain the study's necessity, culminating in the formulation of the study's aim and objectives. This was followed by an in-depth literature review that delved into the fundamental concepts of Sustainable Urban Freight, Sustainable Urban Markets, the methodologies and applications of a Sustainable Urban Freight index, various index components, and sustainability strategies. Additionally, a background study on urban freight in Indian cities was conducted to highlight pertinent issues.

The selection of a case city, namely Bhopal, was the subsequent step, focusing on a specific Planning Zone within the Bhopal Development Authority. Profiling of this zone was meticulously carried out, leading to the selection of specific Fruits and Vegetable Markets within the planning zone. To further narrow down the focus, sustainability pillars were identified, and a Sustainable Urban Freight Index for the markets was formulated.

The next phase involved identifying sub-indicators and their parameters, leading to the preparation of a data checklist. Primary and secondary data collection ensued to gather information on the freight-related characteristics of these markets. Surveys, including establishment and reconnaissance, were conducted at three levels: wholesale (Mandi 1), wholesale cum retail (Mandi 2), and purely retail fruits and vegetable markets (Mandi 3). Subsequently, data analysis was performed to comprehend the physical, operational, socio-economic, and environmental aspects of these markets.

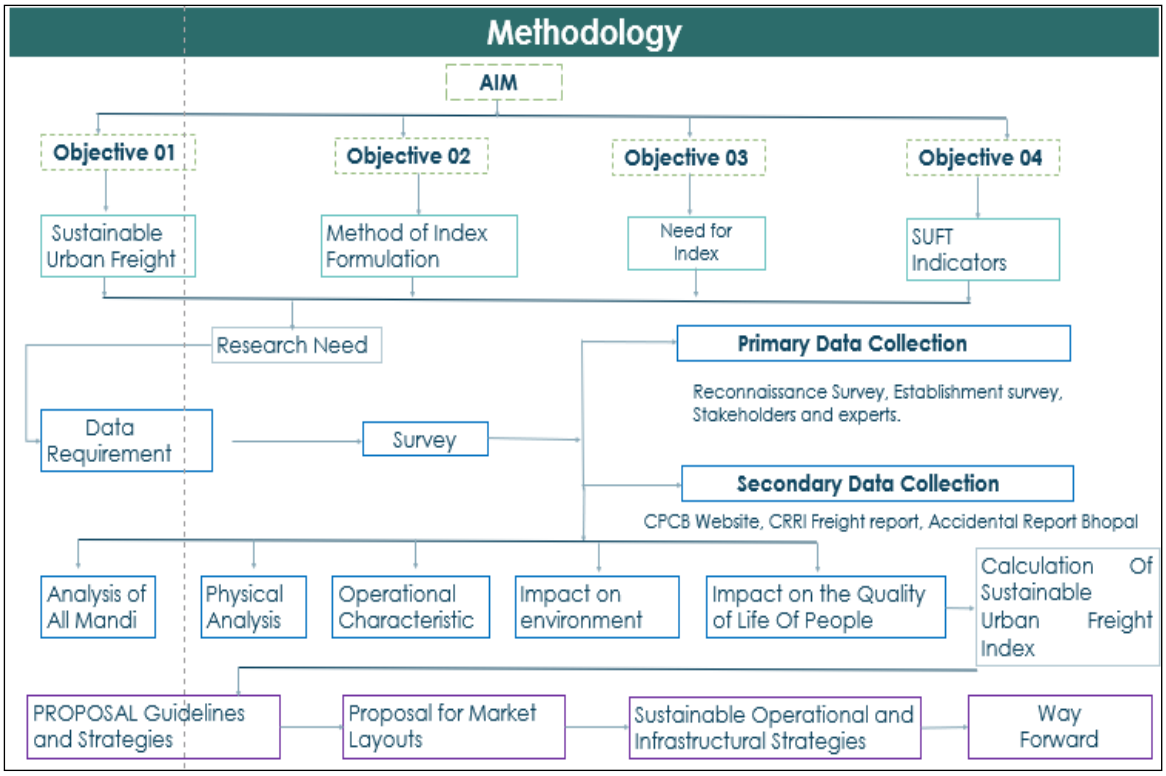


Figure 3: Methodology

CHAPTER 2 LITERATURE REVIEW

2.1 Sustainable Urban Freight

Sustainability has been defined in the Brundtland report in the 1980s, as the "development that meets the needs of the present without compromising the ability of the future generations to meet their needs". On the same lines, sustainable urban freight has been defined by many researchers. A sustainable urban freight system aims to ensure accessibility concerning all types of freight modes and systems. At the same time, it aims at reducing air pollution. greenhouse gas emissions, waste production and noise to ensure a healthy realm. It also emphasizes improving resource and energy efficiency along with costs associated with freight transportation. The researcher's definition also emphasizes contributing to the enhancement of the quality of life, reduction in accidents, minimizing the use of land, and not affecting passenger mobility (Russoa & Comi, 2012).

2.2 Sustainable Development Goals and Urban Freight

Sustainable development goals had come up in 2015, intending to ensure sustainability in all its forms. 17 Sustainable Development Goals had come up, out of which 4 focus on urban freight sustainability.

1. SDG 1: No Poverty: It emphasizes ensuring efficient truck trade, and at the same time contributes to reducing poverty and ensuring prosperity.
2. SDG 3: Good Health and Well-Being; It throws light on ensuring safe driving behaviour along with the reduction of emissions of air pollutants.
3. SDG 7: Affordable and Clean Energy; It highlights the usage of clean energy, lesser polluting fuel, and developing infrastructure for the same.
4. SDG 11: Sustainable Cities and Communities; Sustainability in cities can be obtained with efficient logistics systems, which reduce the overall freight vehicle kilometres.

Similarly, Organised movement combats congestion, reduces noise pollution, and contributes to urban liveability. Moreover, cleaner vehicles will ensure a reduction

in Greenhouse gas emissions, resulting in a better environment (Intergovernmental Tenth Regional Environmentally Sustainable Transport (EST) Forum in Asia Vientiane Capital, 2017).

2.3 Impact of Urban Freight on Sustainability

Although many policy initiatives have come up for reducing the impact of urban freight activities on sustainability, the impact of urban freight on the pillars of sustainability are huge.

These have been detailed as follows:

1. **Economic Impacts**: Urban freight, i.e., the movement of trucks, small commercial vehicles, cycle rickshaws. thelas, etc leads to a lot of delay on the roads, leading to road congestion and inefficient movement. Moreover, the added delays due to the mix of goods and passenger traffic add to the inefficiency of the transport system. This translates to the monetary loss, in term of delays and excessive time taken in idling and finding a parking spot.

2. **Environmental Impacts**: Urban freight has been responsible for a lot of environmental. impacts, ranging from greenhouse gas emissions to Nitrous oxides, which has often led to the deterioration of air quality. In addition, noise from goods vehicles impacts the Tiveability and often leads to health issues. Usage of diesel and petrol vehicles for transportation of goods has contributed to a deteriorating realm. Additionally, infinite waste produced due to the delayed transportation of goods from the origin to the destination creates a lot of wastage, resulting in added carbon footprint.

3. **Social Impact**: Although the urban freight transport system is responsible for providing jobs to millions of people in the city, it is also responsible for impacting the lives of the people, with multiple goods vehicles involved in fatal accidents, noise pollution, and even public health issues. The presence of a freight-generating entity in the residential area impacts the quality of life leads to visual disturbance and even creates safety issues (Civitas, 2020). All these contribute to the social impact of the urban freight movement.

2.4 Other Issue associated with Urban Freight in cities.

Urban Freight is an essential aspect of the city, like any other aspect that is studied deeply while preparing a master plan. In this context, several infrastructure developments and policy decisions become crucial in ensuring an efficient freight system in the cities. Therefore, infrastructure ranging from storage and warehousing facilities to parking areas becomes crucial in the overall sustainability of the entire urban freight system. Moreover, strict policies which ensure less emission, lesser noise and put some time restrictions on the movement of goods are essential**.** In addition, there are issues related to the presence of a plethora of stakeholders in the entire Urban Freight process. Ranging from government-based stakeholders like the Transport Separiment and the Public Works Department, there are a lot of informal and private players also, including the transport operators, truck drivers and unregistered retailers. It is a very tough task to integrate the operations of all these entities on account of lack of data base for the same.

The Traflic Police is unable to track and estimate the daily movement of the trucks and light commercial vehicles in the city, adding to the traffic congestion woes in Indian cities. The movement of goods vehicles is completely unregulated, except for the entry restrictions that exist in some of the Indian cities like Delhi. Such restrictions have led to a sudden increase in the truck traffic in the city, leading to a bigger impact on the city sustainability.

Additionally, the rise in the population has led to an increased demand for deliveries in the city. adding to the goods vehicle-based vehicle kilometres, and further a huge quantum of environmental degradation.

2.5 Freight Generators in the Cities

A city is an economic engine, responsible for the growth in terms of finances, employment, and an overall development of the city. There are various entities in a city which are responsible for freight generation. The city receives the required commodities from a manufacturing unit, which is either located on the periphery of that city or is coming from another larger city.

Additionally, the trucks and LCVs bring the required commodities from the surrounding towns and cities from the major wholesale markets for that commodity.

For instance, building materials are rich in the state of Rajasthan in India and are procured from here by all the states in the country. Similarly, Delhi is a hub of plastics and food items in the country and many traders from across the states come to these markets to buy for their markets. At a local level, there are local bazaars and even small shopkeepers from whom the buyers can buy directly. Overall, the freight generators of the city include industrial units, wholesale markets as well as small retailers.

2.6 Best Practices of Managing Markets

2.6.1 Barcelona, Spain

With a special Marketing Strategic Plan for Barcelona, certain strategies have been proposed for the better management of the markets in Barcelona. With fixed market timings. Barcelona markets have come up with certain market communication strategies. This has been done to make people aware of the advantages of the markets to attract consumers towards them, also. Barcelona has a Barcelona Institute of Markets, which is a connected network of 24 markets**.** it is a platform that helps in consolidating consignments and enhancing and improving the condition of the markets**.**

2.6.2 Suceava, Romania

This city was successful in promoting electric vehicles for fruit and vegetable delivery. The municipality has bought 15 electric vehicles and has installed 24 recharging points. Out of these 24 charging points, 2 shall be used by the city's market administration, while 6 shall be near the underground parking, near the on-street parking area.

2.6.3 London, England

The markets of London follow a sustainability objective for their markets, ensuring resource efficiency and reduced carbon emissions. With a very well-equipped recycling and cold storage system, there has been a reduction in the carbon footprint of the market. (PWI C Projects, London, 2017).

2.6.4 Torino, Spain

A project. "fa bene' in the farmers market in Torino helps in reducing the market waste. All the buyers buy "a little more' and donate it for this project. This project gives the stuff to the low-income households in the neighborhood. In return, the people from this neighborhood help in the voluntary activities of these markets (URBACT, 2015).

2.6.5 Kathmandu, Nepal

In Kathmandu, too, two major fruits and vegetables markets were assessed for their sustainability, and it was found for the infrastructural shortage. With limited infrastructure and tons of vegetables and fruits arriving daily at this market, this market has been planned as a lower-level market, and more such markets in other parts of the city have been proposed. In addition, proper storage, cooling facilities, parking facilities have been proposed to be provided in the existing market as well as the newly planned markets (Lama, 2018).

2.7 Need for an Index

An index has been an excellent tool in quantifying impacts and measuring the impact of any new policies. A lot of indices have been prepared to date. These are as follows:

1. Pilot Environment Performance Index
2. Internal Market Index
3. Human Development Index
4. Dow Jones Sustainability Index
5. Sustainable Urban Transport Index (UNESCAP)

Therefore, indexing becomes essential in integrating information on sustainable development to make decisions (East, 2014).

2.8 Implication for policy

The UFT has become an important and complex management issue for local policy makers. Negative externalities and their impact on urban liveability and quality of life are highlighted and call for an integrated approach to increase overall efficiency and sustainability. To this end, several elements are considered necessary for policy making, such as recognizing the problem at hand and accepting the

proposed solution. The policy evaluation framework presented in this research paper contributes to regional policy making for sustainable UFT in three ways. First, this study summarizes four complementary and qualified evaluation methods that can be used at the local policy level. In addition, it provides insight into the relevant features to be considered when choosing the appropriate method, such as the number of possible alternatives, the effects considered, and stakeholder information. Second, this study highlights the critical importance of including diverse stakeholder perspectives in the UFT policymaking process.

2.9 Review of Good Practices in Urban Freight Transportation

For every nation to prosper economically, freight transportation is essential. A nation's ability to compete in the global economy can be enhanced by having effective logistics and freight transportation infrastructure. The cost of logistics is calculated as a proportion of a nation's GDP. A 2007 Bangkok Bank report states that the cost of logistics is approximately 10% of GDP in developed nations like Japan and the United Kingdom of Great Britain and Northern Ireland, but it is 11.6 percent of GDP on average in Asia and the Pacific.

Since the 1990s, developed nations have been debating whether and how to implement legislation and other steps to mitigate the environmental effects of freight transportation. Of the measures that have been put into place, many have failed and some have succeeded. This paper provides a general overview of sustainable freight transport policies and highlights the critical factors that determine whether they succeed or fail. It also summarizes policies and measures that have been put into place in a few different nations, classifies those policies and measures along with their benefits and drawbacks, and ends with a set of conclusions and recommendations.

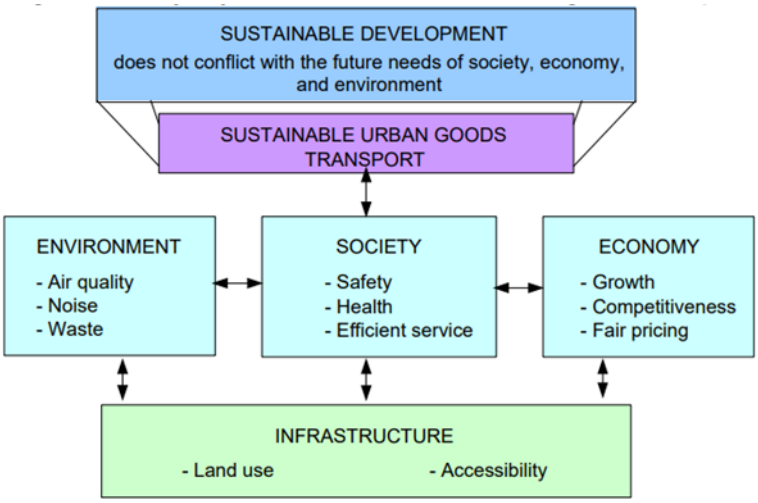


Figure 4: Sustainable Urban Goods Transport

2.10 Licensing and Regulations

The most common approach is this one. Licensing and regulatory examples include truck prohibitions during specific hours, eco-zoning, and weight limits. For example, imposing weight restriction systems to stop huge vehicles from entering restricted zones—typically residential neighbourhoods and city center—can be a successful use of government rules. A recent development is eco-zoning systems, which limit access to limited zones to low-emission automobiles only. Depending on the time frame, emissions level, weight limit, and vehicle size, different limits may apply.

The Kingdom of Sweden, Amsterdam, the Kingdom of the Netherlands, and London, the United Kingdom have all enacted **low-emission zones**. The local authority establishes emission standards so that only cars that fulfil the targeted emission level are permitted entry into the restricted areas.

Combined use lanes: Variable Message Signs (VMS) change the use of lanes at different times of the day. In Barcelona, the Kingdom of Spain, for instance, VMS change the usage of lanes to allow through traffic only during peak hours, temporary truck loading stops during the day, and on-street parking on weekends. As the name suggests, incentives for off-peak delivery are policies meant to move deliveries to the off-peak time. The imposition of a tax on commercial vehicles entering a restricted zone during peak hours is one example of such an action. In 2005, this was put into effect in the Ports of Los Angeles and Long Beach. Truck travels during peak hours are subject to a traffic mitigation fee. According to the

Seattle Urban Mobility Plan (2008), after the measure's implementation, 30-35 percent of regular day containers have been moved to off-peak hours.

One of the most well-liked policies, restricted delivery hours are being used in several places. For instance, in Boston, except during specific hours, driving on specific downtown streets is forbidden to cars bearing commercial license plates. Only specific businesses, such as newspaper delivery services and the US Postal Service, are permitted entry into the restricted zone after 2:00 p.m.; other businesses must request for a one-day special permit to enter.

Restricted delivery hours are comparable to laws that prohibit trucks. The distinction is that larger commercial vehicles are typically the target of truck restrictions. In this context, "truck ban" refers to limitations on a particular type of truck that are forbidden from entering the specified zones for a predetermined amount of time. The Republic of the Philippines' Manila has instituted a truck ban. According to the survey, truck drivers prefer to drive on their regular routes and move their driving hours to the evening or between truck prohibition times. Evidently, driving at night has negative effects on truck drivers and operators since it throws off their sleep schedules and raises the possibility of accidents.

Different types of parking restrictions are extensively used. One of the most important issues is the lack of parking spots for business cars, particularly in the central districts. Double parking is one of the issues caused by inadequate loading space for truck operations. For these vehicles, regulations must be applied consistently and successfully. In Japan, a few instances include designating a spot reserved only for commercial vehicles in low-traffic locations or allocating a particular area for commercial vehicles in each city centre parking area.

In several nations, road charging is widely implemented. Both passenger and freight vehicles are subject to the fees. The goal of road pricing schemes is to decrease the amount of automobiles that enter cities. The goals are to control demand, make money for the upkeep and operation of the infrastructure, and collect external expenses straight from the infrastructure's users. Nevertheless, fair pricing is necessary while using this strategy. According to Allen and Eichhorn's 2007 research, urban goods transport pricing is unable to control demand in the case of commercial vehicles since most commodities must be delivered to their destinations, and reducing vehicle operation is a challenging task.

Shortly, licensing and regulation implementation should provide results. Policies that prohibit huge trucks, for instance, should improve the ecology in the restricted area. Furthermore, a prohibition may be beneficial from a safety standpoint because big trucks navigating through crowded city centres present several safety hazards. On the other hand, imposing limitations without considering their effects on the economy and society may eventually lead to further issues.

2.11 Freight centres and consolidated delivery

Consolidated delivery networks and freight centres appear to be the most effective approaches for achieving sustainable freight development. Consolidation works similarly to how passenger transportation works (buses, trains, etc.); shipments that have the same origin and destination are combined into a single vehicle in order to minimize the number of vehicles needed. Shipments from a single company are typically delivered by consolidated delivery. It might be possible to arrange consolidated deliveries for several companies. Putting this into effect is challenging, though, as it affects their competitors and can make businesses hesitant to share their delivery technology.

Consolidated deliveries are encouraged by the design of freight centers. Before these smaller vehicles enter the city center, large long-haul trucks stop at the freight center and transship their supplies to smaller trucks. This procedure is known as transshipment. Furthermore, it is feasible to combine goods from several businesses using freight centers prior to sending delivery to downtown. With this kind of setup, fewer trucks should be operating in crowded city centers, resulting in less traffic and a safer atmosphere.

2.12 Advantages of urban freight consolidation centers are as follows

Environment: Reduced truck traffic in the city center means less noise and pollutants;

- Greater possibilities to use other non-road, more environmentally friendly forms of transportation, such rail and road transportation.

Social Aspect:

- Better health and safety since there are fewer vehicles (especially large trucks) manipulating through the city centre;
- Less traffic because there are fewer trucks;
- Faster delivery means more effective services for clients.

Economic Aspect:

- Reductions in car journeys and vehicle kilometers benefit participating enterprises.
- An increase in load factor that lowers the cost per unit of commodities transported.
- Possibilities to carry some goods back on the return trip rather than driving an empty truck to make money.

2.13 It and Driver Training

Developing technology to improve efficiency and train drivers is the most attractive option for the private sector. Encouraging the use of these technologies is the easiest way to achieve win-win solutions for the public and private sectors. Businesses benefit from improved services such as reduced energy waste through efficient delivery routes. At the same time, city dwellers can expect an improvement in the quality of life due to the environmental and social benefits of this measure. Several projects related to the application of the technology have been launched in Europe. The European Commission (2006) recommends supporting the development of web-based technologies and electronic commerce and the standardization of traffic information data. For example, web-based technologies can be used to find the shortest routes for delivery services, online vehicle routing, tracking systems, and vehicle fleet management.

The economic benefits of greener driving methods cannot be ignored. A driver training program not only improves safety, but also saves energy. A report on Japan's eco-driving system shows that businesses can save 12 percent on fuel if they offer such a system. For example, truck manufacturer Mercedes-Benz noted that it achieved a 5-10% reduction in fuel consumption because of organizing

courses and training programs for its drivers. In addition, the British company's driver training program reportedly achieved an 18 percent reduction in fuel consumption. Improving fuel efficiency is achieved by encouraging drivers to use proper gear, turn off the engine when the vehicle is stopped, and avoid sudden acceleration.

2.14 Conceptual framework

There are a number of problems with the way freight is currently distributed in Adelaide's Rundle Mall Precinct and the high-density pedestrian zones. These concerns include noise pollution, safety, damage to pavement and other infrastructure from parking spaces, inefficiency and difficulty moving around in busy public areas, and the overall bad effect of trucks on the Precinct's atmosphere. Transport planners have taken into consideration several possible approaches for the distribution of freight within cities. However, in addition to their social and environmental effects, alternative techniques' economic benefits must also be taken into account when evaluating them.

The key stakeholders, their objectives and behavior assumed can be described as follows:

Retailer: The goal is to boost revenue. Retailers must maintain product availability while increasing sales and lowering overall expenses in order to meet the goal. Retailers will choose freight forwarders and submit delivery requests.

Freight Carriers: Profit maximization is the objective. In addition to increasing sales, freight carriers must reduce operating expenses to meet the goal. Delivering or collecting goods to/from retailers in accordance with the quantity, location, and time stated are the responsibilities of freight carriers in addition to providing shippers and retailers with transport services.

Residents: Ensuring a high-quality living environment is the goal. As a result, they want to minimize any detrimental effects on their living space, such as noise, visual intrusion, and air pollution from traffic. If the adverse effect surpasses their predetermined threshold, we anticipate that they will file a complaint with the local authorities.

Transport Planners or Local Authorities: The follows oversee overseeing citizens' welfare and fostering environmental and economic growth. The goal is to reduce the degree of discontent among the locals and determine whether new urban freight distribution policies should be introduced in the regions where complaints were received or where the effects of freight distribution are thought to be detrimental.

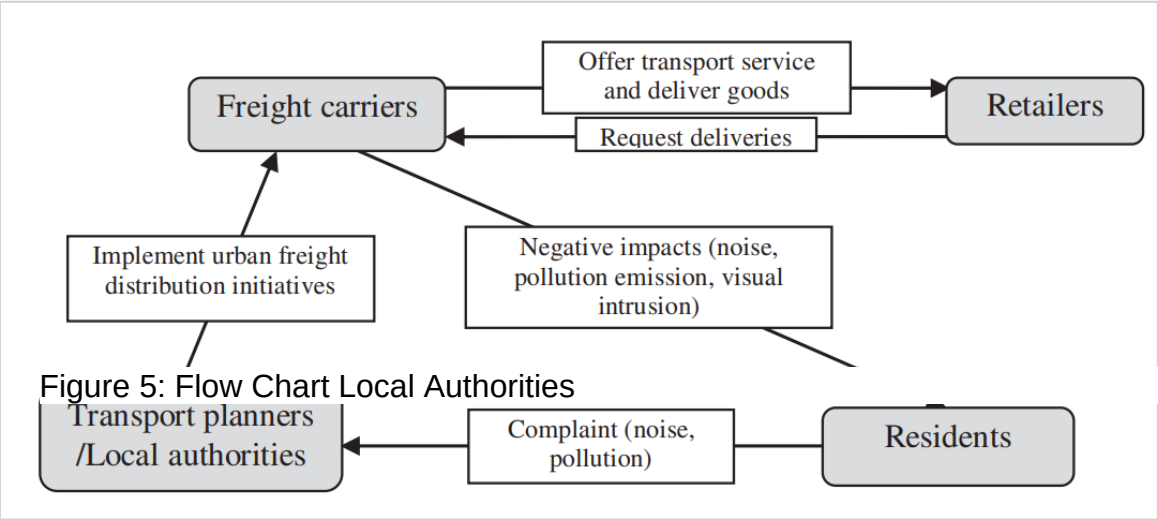


Figure 5: Flow Chart Local Authorities

2.15 Infrastructural and Planning

Issues with freight LML should be viewed as challenges in both urban planning and logistics. The built environment, which includes features like population density, planning control, which handles parking, loading, and unloading, and transport control, which handles speed limits, traffic lights, bus lanes, railroad crossings, etc., are the three main aspects of urban planning that have an impact on LML's efficiency.

The physical layout and composition of a city have an impact on LML activities since urban environments present challenges with regard to distance, access, and space. Geographical challenges, historical hubs, population density, and truck transportation limitations all create obstacles. The performance of LML systems is impacted by issues with urban tight streets, stringent rules, and a lack of facilities for quick loading and unloading.

A number of creative fixes have been proposed and put to the test to deal with issues with urban freight distribution. Nevertheless, no single fix exists for every issue pertaining to freight LML services in various cities. Certain models can be duplicated in other locations, but action protocols tailored to the logistical

environment must be developed beforehand. Urban freight LML is defined by dynamic, uncertain conditions that make it challenging for supply chain participants to coordinate. However, depending on the available transport capacity, delivery window, order volume, and order value, online retailers may have to decline some delivery orders in order to remain profitable. Consumers are calling for a decrease in emissions as their understanding of the effects on the environment has grown in many nations.

2.15.1 Cost-Related Challenges

LML transport is associated with traditional and external costs. It accounts for approximately 28% of the total shipping cost of the product. Key cost drivers for LML include consumer service levels, type of delivery and security, geographic region and market penetration, technology and fleet management, consumer awareness, and environmental and social impacts of LML services. Delivery charges are affected by factors such as service time, service area (from DC), driver fees and investment costs. Since electric cargo bikes require more driving time, driver fees can affect delivery costs. Another aspect of the complexity of LML services is that while customers expect higher service quality, the growth of e-commerce has resulted in lower profit margins for companies. For some companies, electric vehicles used for LML have higher purchase and operating costs.

2.15.2 Opportunities for Improving the Sustainability Performance of LML.

It was stated that LML is not sustainable for urban transport and more innovative solutions are needed. LML's innovative solutions include innovative vehicles, proximity stations, participatory and collaborative urban logistics, optimization of route and transport management, and policy-related innovations. At a holistic level, the sustainability of a product or system can be evaluated from economic, environmental, and social perspectives. Each aspect has its own sustainability indicators. The main sustainability indicators in the LML sustainability assessment include the environment (air emissions, energy consumption, land use). Economical (product quality, cost efficiency, time efficiency). and social (voice disorder, health issues, employee satisfaction, customer satisfaction).

2.15.3 Opportunities for Improving Environmental Sustainability.

In urban LML services, small improvements can have a large long-term impact, as urban delivery services are a recurring activity. There are also geographical influences. This means that small improvements in small areas (for example, reducing greenhouse gas emissions) can lead to large benefits in large areas of cities or other cities. Effective logistics management is a key element to the success of an e-commerce business. For example, in OC businesses, consumers order from almost anywhere. In such cases, OC service centres may be able to increase customer loyalty and satisfaction by implementing digital multimedia for customer convenience. OC retailers use traditional and online channels and integrate and share data across all channels [6]. In some cases, it is not easy to obtain accurate and relevant data on LML operations and related effects [20, 40]. To overcome such problems, it is possible to evaluate using predictive (estimated) data and scenario-based analysis. Delivery services can be improved by introducing innovative policies, reducing the distance traveled by road vehicles, and changing their speed.

2.15.4 Opportunities for Improving Economic Sustainability

Urban freight transport has a major role in economic and social development. In the LML logistics process, the characteristics of the city and the characteristics of the final receiver are the variables that affect the cost-effectiveness. Therefore, companies should use these features to evaluate performance in the context and scope of LML services. Stop time, distance from warehouse, distance between stops, travel speed, vehicle and maintenance costs, and warehouse costs are variables that affect logistics costs. Although electric cars are expensive, they have lower running costs compared to conventional cars. If your delivery area is close to DC, has high density and few deliveries per location, electric cargo bikes may be more cost-effective. Delivery trucks are more economical if the delivery area is large and the volume of deliveries per stop is high. Electric cargo bikes have lower depreciation costs than diesel vans, and their operating costs are also relatively low due to reduced energy consumption. Bicycles, tricycles, and light vehicles allow flexible delivery times, reduce traffic congestion and reduce costs and

resources. Unlike cars, bicycles need little time to find a parking space. On average, vehicles spend a significant amount of time searching for on-street parking. For example, in Seattle it takes about 9 minutes, while in New York it takes about 15 minutes. Some companies are implementing sharing economy business models to overcome the logistical challenges associated with the growing demand for freight transportation. For example, a scheduled delivery scheme such as drone delivery can reduce delivery costs by about a third compared to manned delivery with a two-hour delivery window.

2.15.5 Sustainable Urban Transport Index for Asian Cities

Provision of sustainable urban transport is becoming a major issue due to rapid urban development worldwide, including in the Asia-Pacific region. The adoption of the 2030 Agenda for Sustainable Development with its 17 Sustainable Development Goals provides new impetus to address the world's global development challenges, including transportation in urban areas. Additionally, Sustainable Development Goals (SDG) target 11.2 focuses on improving accessibility for all with an emphasis on public transport. Other recent and emerging global and regional commitments such as the Habitat III Summit and its outcome New Urban Agenda and Ministerial Declaration on Sustainable Transport Connectivity in Asia and the Pacific further emphasize the urgent need to address urban transport challenges. Improving urban mobility, achieving SDG target 11.2 as well as increasing the overall sustainability of urban transport systems and services will require new commitments from Asian countries and cities.

In the absence of a comprehensive standard framework and tools for measuring the state of urban transport systems in the Asian context, UNESCAP has developed the Sustainable Urban Transport Index (SUTI) with 10 key urban transport indicators. SUTI is based on ten key urban transport indicators that represent environmental, social and economic dimensions of transport system sustainability. The outcome of the evaluation can support urban policy makers to create evidence-based policies and measures to improve urban mobility. This increasing vehicle ownership led to traffic congestion which led to many negative externalities such as economic losses in urban areas, increased energy consumption and air pollution. In 2016, among Asian cities, Bangkok (61 percent), Jakarta (58 percent) and Chongqing (52) experienced severe traffic congestion,

ranging from 30 to 50 percent (increase in overall travel time compared to free-flow conditions). percent) had the worst traffic jams.

Motorcyclists, cyclists, and pedestrians are among the vulnerable road users who suffer road fatalities; in the area, urban road safety is an issue. Fifty-five percent of all road traffic fatalities are caused by vulnerable road users.

Cities account for more than two-thirds of energy consumption and greenhouse gas emissions. Lost time and transportation costs due to road congestion result in economic costs of 2-5% of the region's GDP each year. Another key issue facing Asian cities is the prospect of an aging population, which will add more challenges to urban areas and urban life. Transport planning and demand for more urban space, accessible public transport and pedestrian facilities. New concepts for planning and designing liveable cities are emerging that promote active mobility and sustainable access and provide more vibrant public spaces. Cities account for more than two-thirds of energy consumption and greenhouse gas emissions. Lost time and transportation costs due to road congestion result in economic costs of 2 to 5 percent of the region's GDP each year. Another key issue facing Asian cities is the prospect of an aging population, which will add more challenges to urban areas and urban life—transport planning and demand for more urban space, accessible public transport, and pedestrian facilities. New concepts for planning and designing liveable cities are emerging that promote active mobility and sustainable access and provide more vibrant public spaces.

CHAPTER 3 STUDY AREA

3.1 About Bhopal

Bhopal one of the most beautiful state capitals of the country called as city of lakes. In the 21st century, city is experiencing all round development. It is a city with very optimistic growth prospects. Bhopal is the state's socioeconomic and political nerve centre, as well as a symbol of the world's most beautiful metropolis. Surrounded by lakes, hills, forests and agricultural land. Bhopal city's varled topography gives it a distinct personality and unique urban setting. Bhopal, the second largest city of Madhya Pradesh was made the state capital in 1956. The city has consistently grown in importance as a commercial and educational centre of the region Under the increasing strain of up-gradation and densification of activity. Bhopal, Madhya Pradesh's lake capital city. is losing its charm and elegance. It is well connected by rail, road and air to all parts of the country. The area of Bhopal metropolis is 285.88 sq km.

Wil average density of 6,288 persons km.q. Km. (Indian Census, 2011)

Its aim is to make significant improvements in urban transportation services and infrastructure by planning for people rather than automobiles, ensuring that all citizens nave access to jobs, education, social services, and recreation at a reasonable cost and in a timely manner.

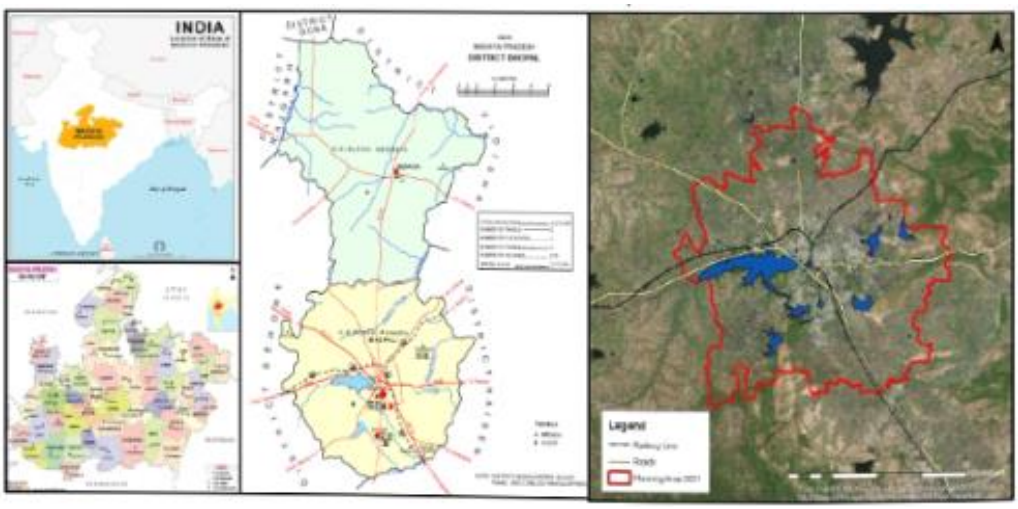


Figure 6: Source: Census Handbook, Google Image

3.2 Regional Setting and Linkages

Bhopal is in the process of becoming a multifunctional regional growth centre. The supremacy of the city in the state will always be maintained as one of the nerve centres of sociopolitical and economic activity. The city's planning cannot be limited to lis planned area. (Mehta And Associates, Indore)

The socio-economiclinkages are continuously changing and evolving in the settlements system around Bhopal. Agricultural, forest, mineral and other production supported by the State Capital Region, population holding capacity of the natural resource base of the sub region, national transport network and accessibility levels defining the role of Bhopal, in its regional and sub-regional context. The regional Growth Centers of significant dependence and influence on Bhopal city (and vice versa) are Indore, Berasia, Bairagarh, Hoshangabad. Vidisha, and Narsingarh

The employment opportunities offered by the state capital as well as similar opportunities which can be pre-empted through various fiscal policy measures for economic development in various nearby cities and sub-cities like Sehore, Raisen, Vidisha, Hoshangabad and Itarsi around the mother city, Bhopal would determine the future distribution of population in and around Bhopal. (Association For Intelligent Transport System, India)

National Highway 12 (Beora - Jabalpur road), which links the city to many large cities in the north-west and the south-east. State Hignways connect Indore and Sagar. The city is connected by the broad gauge railway line to Nagpur, Chennai, Delhi and Mumbai The city is also served by regular air services to Mumbai, Delhi and Indore.

3.3 Growth Pattern Land use pattern of Bhopal

After 1956 Bhopal has grown extensively in almost all directions except in the west. The growth has been very fast in the south-easter direction because of better roads and rail transportation facilities and close location of Mandideep industrial centre. The new city has expanded over the agriculturally rich black soils of the Malwa plateau. he expansion of Bhopal in terms of its planning area is discernible. However each area has its own peculiar geographical characteristic, which makes it difficult to make a genenc strategy for the city as a whole. The Hoshangabad

Road has seen the most increase in the southeast direction. The citys southerty expansion is attributed to the city's level land, ease of transportation, and proximity to the Habibganj Railway station. Bhopal being the State Capital IS growing relatively at a rapid pace and is likely to promote increasing urbanization in and around it. The rapid growth in Bhopal due to increasing migration not only from within the state but also from neighbouring seven states, calls for more pragmatic policies to absoro the population flow in a balanced manner. It is also necessary to channelize the growth into other neighboring cities and sub cities to maintain the quality of life in the region as a long-term measure. The grow of Bhopal is towards Misrod along NH-12, which passes through Mandideep. Misrod lies in the center of Mandideep and Bhopal it is major proposed sub city of Bhopal. which will have more than 3 lacs population. Misrod is the transitional link between Bhopal and Mandideep, which has better-existing infrastructure facilities that can be very well utilized. Mandi deep being located on national transportation and communication network can emerge as a major strategic centre in the national context.

3.4 Economic Base

Bhopal, in addition to being the state capital, has a wide hinterland that spans six districts. Bhopal serves a wide geographical area since the nearest large city. Indore. is about 180 kilometres away. It has expanded as a separate township comprising the ancient city and its environs, BHEL township, T T Capital Township: Bairagar (Army cantonment location), and some other new places, rather than as a single city nearby are two industrial estates: Mandi deep, which has 32 large and 252 small and medium-sized businesses, and Pilukhedi, which has 6 large and 3 small and medium-sized businesses. dominating. The service sector is becoming Increasingly relevant in Bhopal, and it now employs most of the population. There are approximately 200 banks and insurance agencies, 36 hotels and restaurants 100 hospitals, over 1500 educational institutions, and 32.212 stores Bhopal. like many other cities, has seen the decline of traditional industries in recent years, especially engineering support and component manufacturers that grew up around Bharat Heavy Electricals Limited (BHEL) BHEL, India's largest public sector engineering firm, was founded in the 1960s, attracting additional investment and providing a large source of employment in Bhopal. According to the market survey,

over-reliance on BHEL is one of the key reasons for the closure and sickness of small and medium-scale industrial units in Bhopal. Housing, banking and insurance, and education are among the sectors stated to be rising rapidly in Bhopal, Bhopal is to be established as a centre for education, according to the state's economic development strategy. A large number of schools training centers, and colleges have been founded in the last few years, resulting in the AL concentration of educational establishments at all levels. Businesses from four distinct categories were surveyed, industries outside the Urban area, Industries within the urban area, private sector services, and public sector services.

3.5 Existing Scenario of the Road Transport System in Bhopal

Bhopal is one of the exploding cities of India. Like other citles, Bhopal also faces phenomena of urbanization leading to an increase in population and vehicle growth. Also the amount of growing economic activities in and around Bnopal contributes to the travel demand. Bhopal is on the verge of facing the intensities of the traffic and transport issues arising due to rise in transport demand, which exists in most of the megacities and metros in India. In Bhopal, the vehicle growth is approximately 50% in 4 years (2003-04 to 2007-08). City authorities in Bhopal are addressing these issues primarily with an ambitious road construction program and the construction of BRTS Corridor.

The growth rate from actual data of 2005 to extrapolated data for 2008 has been assumed at around 8.5% as evident from table below. The table referred has been sourced from Bhopal Master Plan Draft for 2021. The population of two wheelers on the road is the highest followed by cars. This has also lead to the increase in the chance of accidents on road. Also maximum number of accidents involves two wheelers as they are maximum used mode of transport in the city. the vehicular population of Registered Vehicles in Bhopal between December 2010-2011, as per information collected from the office of the Transport Authority, is 91,471.215% is constituted of registered cars and 79.5% is that of two wheelers.

3.6 Regional Setting

Bhopal plays a dominant role in the Bhopal Capital Region, which comprises of the districts of Bhopal, Rajgarh, Sehore, Raisen, Shajapur and Agar Malwa. The city is surrounded by a network of market towns of Berasia, Vidisha, Raisen, Obedullaganj, and Sehore. These towns are well-connected by regional roads with the city of Bhopal but are poorly connected. Consequently, the city acts as a nodal center of trade and commerce of regional importance. Furthermore, the city is relatively accomplished in various services and facilities acts as a major service centre of the region.

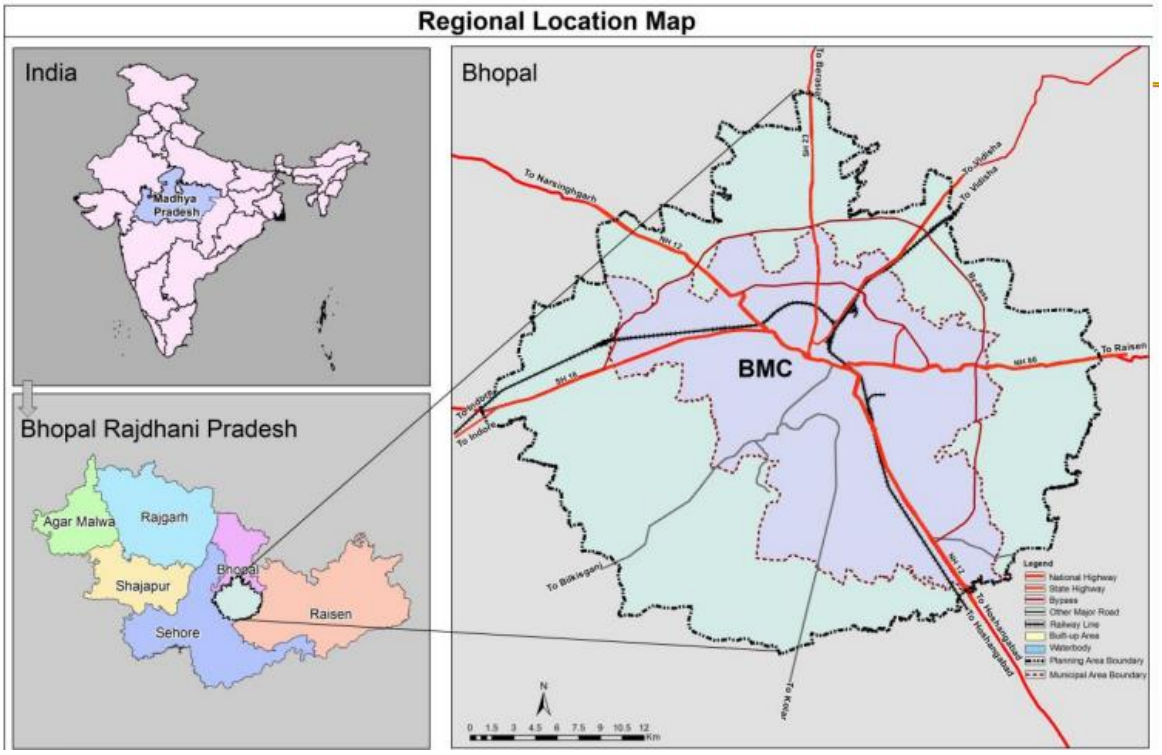


Figure 7: Regional Location Bhopal

In addition to these market towns other nearby small and medium-sized towns such as Hoshangabad, Sehore, Obedullaganj, Mandideep, Salkanpur, Rehti, Budhni, Itarsi, Ganj Basoda, Narsinghgarh, Badi Bareli, Berasia, Raisen, Shajapur, Sanchi, Nasrullaganj, Sultanpur, Vidisha, and Ichchawar are also largely dependent on Bhopal. Major agriculture produce of the region is comprised of wheat, soybean and grams and horticulture produce like Amla, mango, orange and Flowers, etc. In this region, Sehore, Vidisha, Budhni, Mandideep, Obedullaganj, and Sanchi etc. are connected with railways. Apart from this national highway NH-69, 12 and 34 passes

through Budhni, Obedullaganj, Mandideep, Raisen and Shyampur. Similarly, state Highway SH-23, and SH-19 also pass through the region.

3.6.1 Regional Study Area

The total area of the region is 30144.80 Sq. Km, the Development Plans of Sehore, Berasia, Sanchi, Vidisha, Raisen, Rajgarh, Salkanpur- Rehti and Mandideep are prepared by T&CP and adopted by the State Government. The Planning Area of Ashta and Obedullaganj have been delineated and the Draft Development Plan is under preparation.

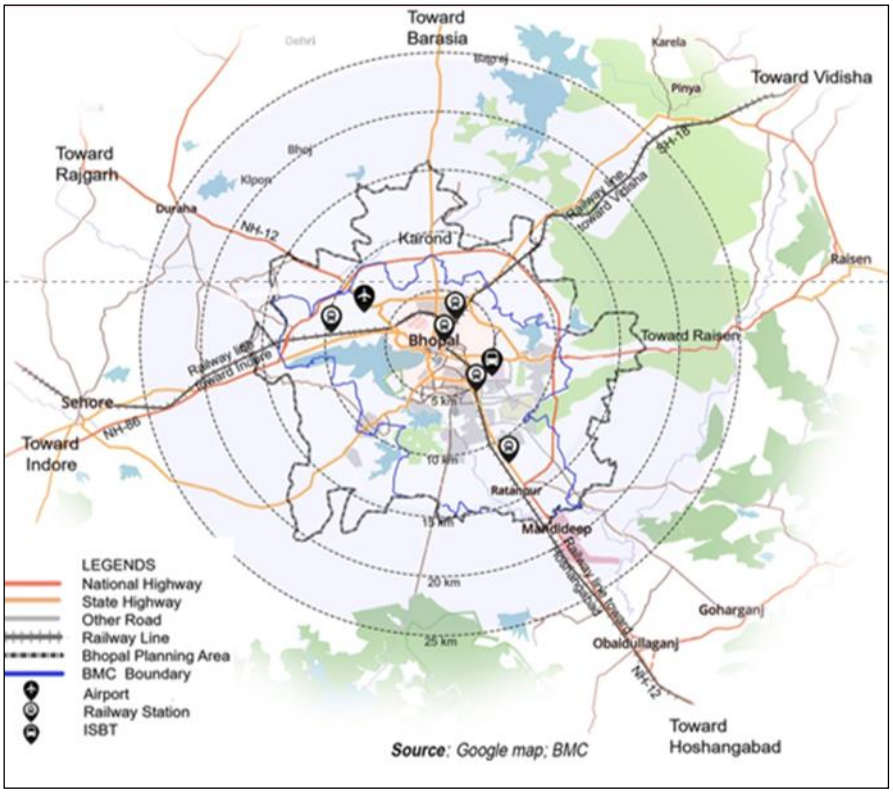


Figure 8: Regional setting

The surrounding areas have the potential for economic development, by incorporating the towns like Sehore, Vidisha, Hoshangabad and Itarsi. In the region the population can be distributed by providing employment opportunities in present as well as for future. The development of the Bhopal city will depend upon the incorporation of the sprawl in the planning area. Thus, it becomes necessary to balance the population growth and its flow within the region by way of implementation of effective policies. Looking into the prospects.

3.6.2 Natural Water Distribution

Depending on the natural drainage pattern, an easy flow of water discharge possible. Water discharge in the northeast region in the Halili River and the southeast region it is in the kaliyasot River. Similarly, in the southeastern part water discharge through several small drains and the Kolar River, takes place in the Narmada River. Also, the Northwest flows into the Parvati River. This confluence site is in the lower of the water treatment center of the Vidisa town. Kaliyasot River carries the flow of the southeastern area of the Bhopal city, which meets the Betwa River in Bhojpur of Raisen district. The major quantity of rain water is collected from maximum parts of Sehore and nearby areas which flows into Bhojtal Lake through the Kolans River. The catchment area is quite sensitive due to the importance of the Bhojtal Lake in the context of the city and its use as a drinking water source. The water supply of Bhopal city is done through the Kolar reservoir and Narmada River beside Bhojtal Lake. Kolar reservoir water is transported to Bhopal city parallel to Kolar Road. Similarly, water is being supplied to the Narmada River from the Shahpur Intake well through the transport line installed parallel to the National Highway- 12. In the case of water scarcity, water can be supplied through Ghora Pachaad water reservoir and Kerwa Reservoir. It will be necessary to use other rivers and reservoirs located in the region to fulfill the need for increased water supply of the capital in the future. Considering the future water requirement, it is important to include groundwater prospects, water reservoirs, and rivers in the water management plan to sustain for the next 20 years.

3.6.3 Traffic and Transportation at Regional Level

Bhopal Planning area is well connected by National Highway, State Highway and another district road with Raisen, Sehore, Rajgarh, Vidisha, Narsinghgarh and Hoshangabad town.

3.6.4 Economic System and Development Area

Mandi deep is located in the south part of the city, and the Govindpura area is located in the central part of the city, considered to be the major industrial area. The city has more than 1000 small and medium-scale companies. HEG (Hindustan Electro Graphite), various Laboratories, Eicher Tractor, Action Group of Company, and BHEL (Bharat Heavy Electricals Ltd.) are among the major companies in the city. Bhopal is famous for Medicinal Goods, Electrical Goods, Jewellery and Chemicals. Apart from

these Cotton mills, Floor Mills, Cloth weaving mills, paint factories, matchbox industry, sealing wax, sports equipment, etc. also contribute to the economy. The handicraft industry is well established in the city where the local people make zardozi work and Wallet Embroidery. The work of embroidery is also popular among tourists.

3.6.5 Employment

The number of units and employment is increasing in small scale industries of Bhopal district. Bhopal is also a major centre for wholesale products and recently software and computer-based industries are also developing here. Govindpura industrial area serves as an ancillary industrial unit of BHEL, which acts as supporting economic growth center and employment generation hub. Bagroda and Tamoot are major upcoming industrial areas that will generate employment and help in the economic development of the region.

3.6.6 Income Profile

The per capita income of Bhopal as a city grew substantially from 36,855 to 80,784 INR in 2013. The average per capita income of the Bhopal Region is 50,000-60,000 INR per annum. Average household income varies greatly among different income groups and spending patterns. It will be necessary to understand the expenditure pattern of EWS and other families along with the percentage of monthly expenditure patterns of average household income percentage of Below Poverty Line (BPL) families with household income in all income groups per month. The economic base of Bhopal city mainly depends on the industrial area. While the service sector is becoming more important which is providing most of the employment in Bhopal as it is the state capital.

3.7 Bhopal city Profile

3.7.1 Demographic Profile

Bhopal is the second largest city of Madhya Pradesh with population of 18,86,100 as per census 2011. The city has experienced natural growth and expansion of its limit due to which the municipal limit was expanded. In 1950, the population of Bhopal was 100,258. Population of Bhopal for the current year is estimated as 2,333,106. Bhopal has grown by 224,619 since 2015, which represents a 2.56% annual change. These

estimates represent the Urban agglomeration of Bhopal, which typically includes Bhopal's population in addition to adjacent suburban areas.

3.7.2 Population Growth

Bhopal was made the capital of Madhya Pradesh on 1ST November 1956. During the same period BHEL was established thereby augmenting the employment opportunities in the city. The city, which was thus limited to the old walled city until 1956, expanded in all directions to accommodate increasing activities and the functions that it served. These events prompted rapid population growth in the city, resulting into nearly 120% decadal population growth during the period 1951-61, and this momentum continued in the following decades as well. In the decade of 1971-1981 the city boundary was increased to bring BHEL Township and Bairagarh within the BMC limits. During the same decade, Mandi's deep industrial area was established. With the heavy growth in industrial and commercial activities together with the expansion of Government services, the decade of 1971-81 witnessed a phenomenal 75% decadal population growth. In 1984, Bhopal witnessed one of the worst industrial disasters of the World, the Bhopal Gas Tragedy, which resulted in a decline in industrial activities in the city, thereby resulting into a decline in the population growth rate during the decade of 1981-91. This event severely impacted the preferred destination status of Bhopal as an industrial center and could be one predominant reason for a comparatively lower decadal growth rate of 58%. In the year 2000, the state of Chhattisgarh was separated from Madhya Pradesh, prompting the migration of many Government employees to the newly formed state. It is interesting to note that nearly 10.16 % of the total population of Bhopal was engaged in Category – 9 (Other Service, both Private sector and Government services) as per the census of India, 1991, and nearly 28% of the Government Servants migrated to Raipur after bifurcation of the state. The decade, therefore, reported a population of 18.86 Lakh in the year 2011. The present decadal growth rate is 29% at this rate and it is assumed that the population will grow about 36 Lakhs by 2031.

Table 1: Population Growth Rate

Year	Population In lakh	Decadal Growth Rate
1951	1.02	
1961	2.23	117.87

1971	3.85	72.62
1981	6.71	74.35
1991	10.62	58.04
2001	14.54	36.99
2011	18.86	29.72

3.7.3 Sex Ratio

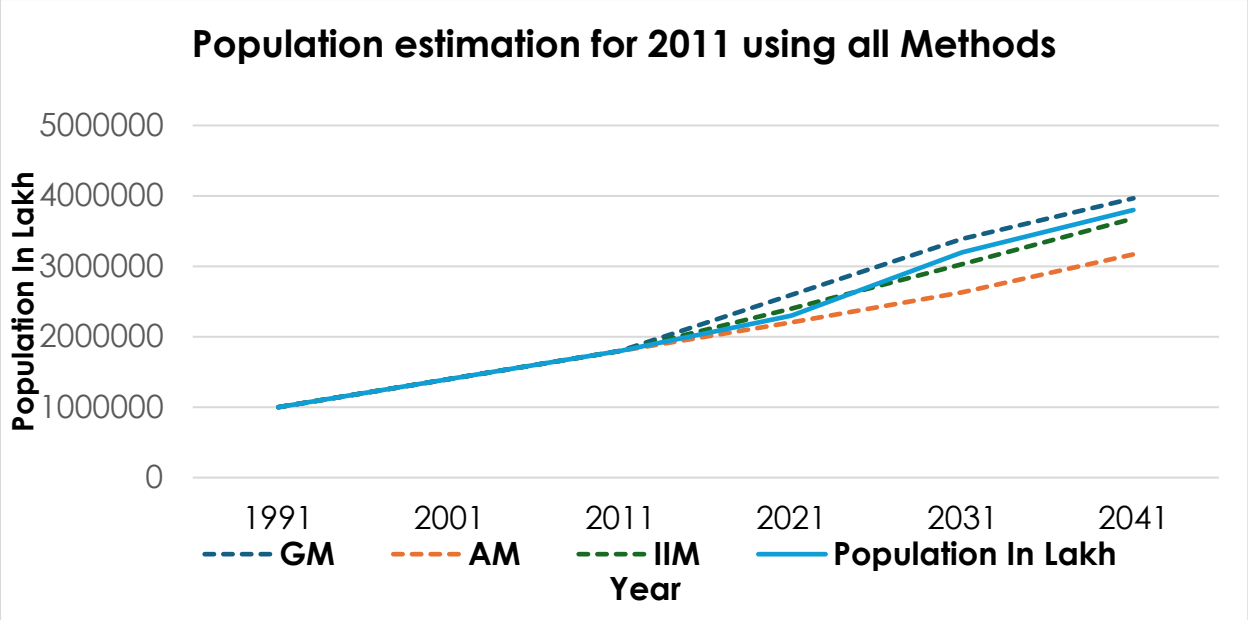
The sex ratio of Bhopal is 918 females per 1000 males as per census 2011. This ratio is equal to the sex ratio of the state of Madhya Pradesh however it is less when compared to the other cities of the same category. Balanced sex ratio represents the stable social structure, a low proportion of females indicate a lack of housing facility in the city. Migrant workers have a tendency to live alone in cities as employees leaving their families in their native place due to high rent or non-availability of houses. The social and cultural life of the city can be improved by fulfilling the housing demand.

3.7.4 Methods for Population Projection

Population projection for BDP 2031 shall be calculated out using the following methods: (Annexure IV)

1. Arithmetic Method
2. Geometric Method
3. Incremental Increase Method

A preliminary analysis of these methods suggests that the estimated population for BDP 2031 lies in the range of 28 lakh to 36 lakh1. However, the population estimates mentioned below are based on preliminary numbers which will have to be reviewed and recalculated by T&CP. The population estimated using incremental increase method which is 35.39 (say 36) Lakhs has been considered as the basis for planning.



The use of different methods for population projections presents a range of projected population for the Master plan. The liberal approach towards preparation of a Master plan would require consideration of the population on the higher side of the projected range. The projected range of the population is based on past trends and presents a Business as Usual (BAU) scenario. However, a robust Development plan would be flexible enough to endure fluctuations and cater to a population higher than the Business as Usual (BAU) scenario. Dynamic parameters like an industrial and commercial investment and employment generations in the past 5-10 years, new large-scale projects which bring large employment shall be evaluated for population estimates. If the current growth trends continues, the total population in the Planning area is expected to go up to 26 Lakhs by 2021 and 35.39 Lakhs by the year 2031. This growth will require additional infrastructure, services and facilities to cater to the needs of the future population and to facilitate a high quality of life within the city.

3.7.5 Urbanization and Growth of the City

MP has a large and growing urban population, with nearly 27 per cent of the state's population, approximately 16 million people, living in towns of over 100000 people (Class I towns). The high growth rate is expected to continue, with the urban population rising by a further 50 per cent to over 25 million people living in the towns having more

Figure 9: Population Estimation

than 1 lakh population by 2021. Bhopal is most urbanized amongst the divisions of the state. As per Census 2011, 80.85 percent of the total population is urban.

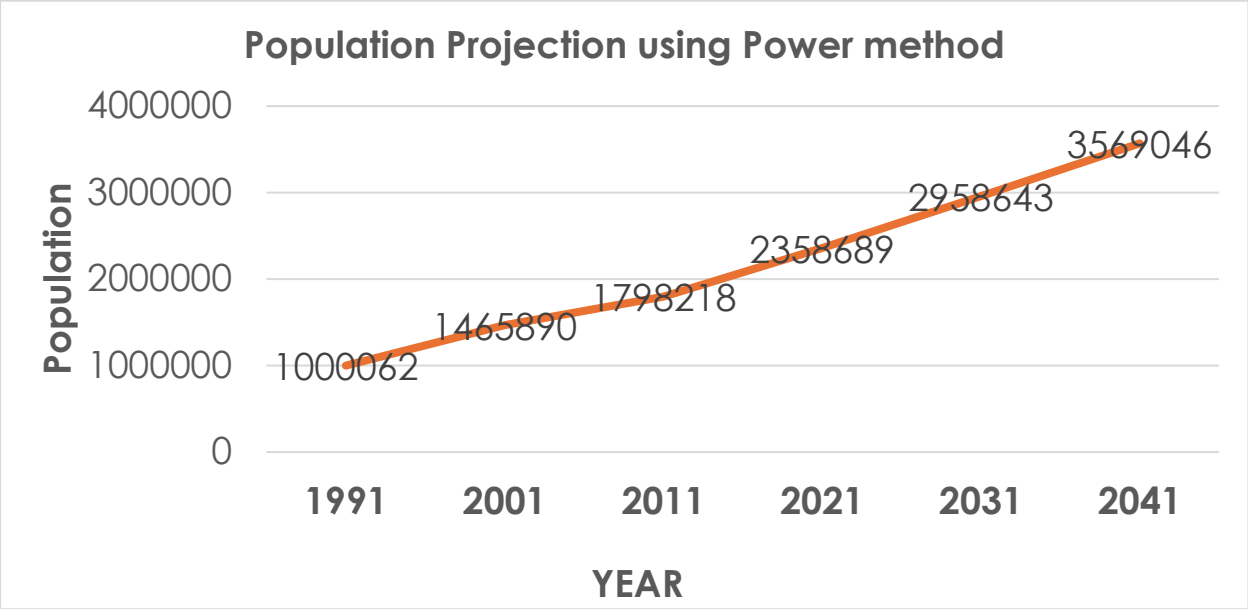


Figure 10: Population Projection

3.8 3.3 State Wise commodity Supply.

Every day, residents of Bhopal eagerly await the arrival of fresh fruits and vegetables from various states across India. These essential commodities play a vital role in the daily lives of people in Bhopal, not just as ingredients for meals but also as a symbol of health and well-being.

Bhopal, the capital city of Madhya Pradesh, is known for its rich cultural heritage and vibrant community life. However, when it comes to fresh produce, the city relies on the agricultural bounty of neighbouring states. The geographical location of Bhopal makes it strategically situated to receive fruits and vegetables from several states, ensuring a diverse and plentiful supply throughout the year.

One of the primary sources of fruits and vegetables for Bhopal is Maharashtra. Known as the "Granary of India," Maharashtra boasts a diverse agro-climatic zone that enables the cultivation of a wide range of fruits and vegetables. From the lush orchards of Nashik to the fertile fields of Pune, Maharashtra supplies Bhopal with a bounty of

mangoes, bananas, grapes, tomatoes, onions, and more. The bustling wholesale markets of Mumbai serve as a hub for the distribution of these fresh produce items to cities like Bhopal.

Additionally, neighboring states like Gujarat and Rajasthan contribute significantly to Bhopal's fresh produce supply. Gujarat, with its extensive coastline and fertile plains, produces an abundance of fruits such as papayas, guavas, and citrus fruits, along with vegetables like potatoes, carrots, and bell peppers. Rajasthan, despite its arid climate, utilizes innovative agricultural practices such as drip irrigation to grow fruits like pomegranates, grapes, and melons, along with vegetables like spinach, okra, and eggplants. These states rely on efficient transportation networks to ensure timely delivery of their produce to Bhopal's markets.

Uttar Pradesh, another neighboring state, also plays a crucial role in supplying fruits and vegetables to Bhopal. The fertile plains of Uttar Pradesh yield a variety of fruits like mangoes, bananas, and lychees, as well as vegetables such as cauliflowers, cabbage, and radishes. The bustling wholesale markets of cities like Agra, Kanpur, and Lucknow serve as distribution centers for these fresh produce items, which eventually find their way to Bhopal's markets through well-established transportation routes.

Furthermore, states in Eastern India, such as West Bengal, Bihar, and Odisha, contribute their share to Bhopal's fresh produce supply. West Bengal, known for its cultivation of fruits like mangoes, pineapples, and bananas, along with vegetables like potatoes, onions, and leafy greens, provides Bhopal with a taste of Eastern flavors. Similarly, Bihar and Odisha, with their fertile plains and favourable climate, produce a variety of fruits and vegetables that add to the diversity of options available in Bhopal's markets.

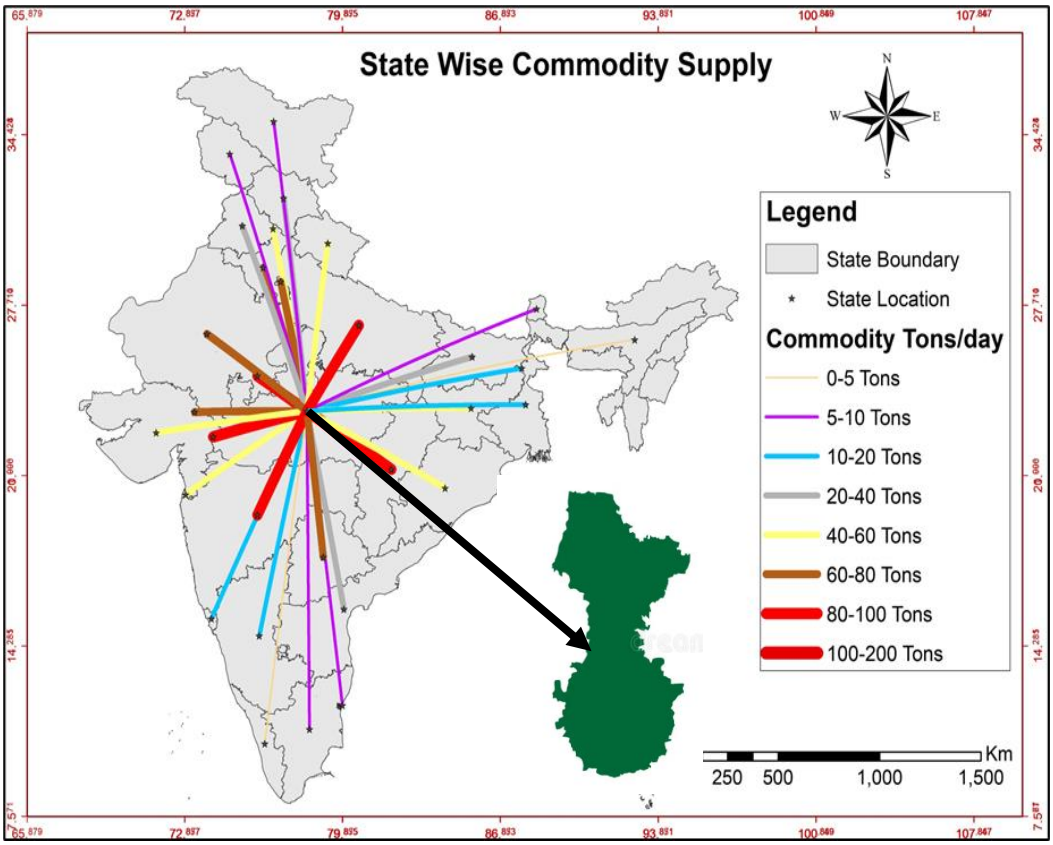


Figure 11: Commodity Supply

3.8.1 Vehicle Register in Bhopal

The data from the Regional Transport Office (RTO) in Bhopal indicates a significant increase in the number of goods vehicles in recent years. In 2015, out of a total of 896 registered vehicles, a staggering 657 were classified as goods vehicles. This figure highlights a substantial portion of the registered vehicles being dedicated to the transportation of goods within and possibly beyond the city limits.

Such a surge in goods vehicles can be indicative of various factors contributing to increased economic activity and trade within the region. It suggests a growing demand for the movement of goods, potentially driven by factors such as industrial development, commercial expansion, and increased consumerism.

The rise in goods vehicles also underscores the importance of efficient logistics and transportation infrastructure to support the burgeoning economic activities in Bhopal. It emphasizes the need for adequate road networks, logistics hubs, and transportation policies to ensure smooth and timely delivery of goods, thereby facilitating economic growth and development in the region.

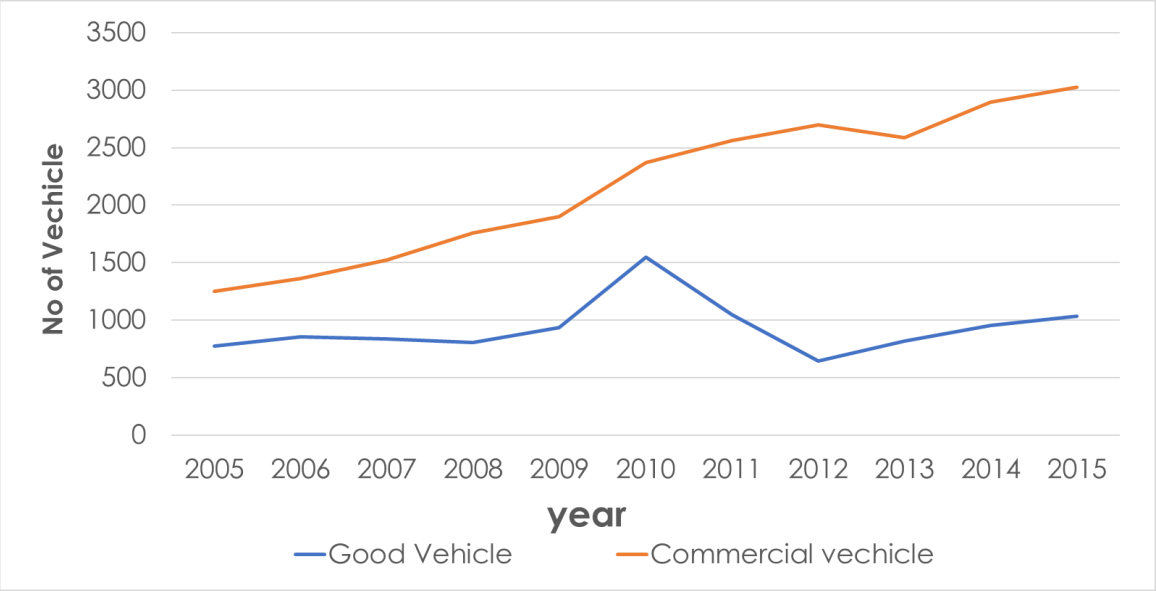


Figure 12: Goods Vehicle Registration

CHAPTER 4 DATA COLLECTION/ PRIMARY SURVEY

4.1 Market Identified

Out of 18, registered weekly markets of Bhopal, 8 markets of Bhopal Municipal Corporation (BMC) and 4 markets of Bharat Heavy Electrical Limited (BHEL) markets have been identified for this study based on the following markets.

Figure 13: Existing Market in Bhopal Mandi

Table 2: Location of Mandi

S.N	Market in Bhopal city	S.N	Market in Bhopal city	S.N	Market in Bhopal city
1	Karond	8	Bhopal Takiz	15	Kotra Sultanabad
2	New market	9	Azad Market	16	Nehru Nagar
3	Bittan Market	10	Bharkheda	17	Kamla Nagar
4	Habib Ganj Mandi	11	Raisen Mandi	18	Kolar Sabji mandi
5	Gandhi Nagar	12	Piplani		
6	Sant Haridas Nagar	13	Bagh Sewaniya		
7	Nadra Sabji Mandi	14	Ashoka Garden		

The bustling fruits and vegetable markets of Bhopal are scattered across various neighborhoods, each offering its unique charm. Prominent markets include the bustling 10 Number Market in Area Colony, where locals flock for fresh produce, and the historic karond Mandi, Habibaganj, nadra mandi, kamal nagar mandi Bhital market, renowned for its vibrant atmosphere and traditional offerings. Additionally, Bairagarh Market stands out for its extensive selection of fruits and vegetables sourced directly from nearby farms. These markets not only provide essential groceries but also serve as cultural hubs, reflecting the diverse Flavors and traditions of Bhopal's culinary landscape.

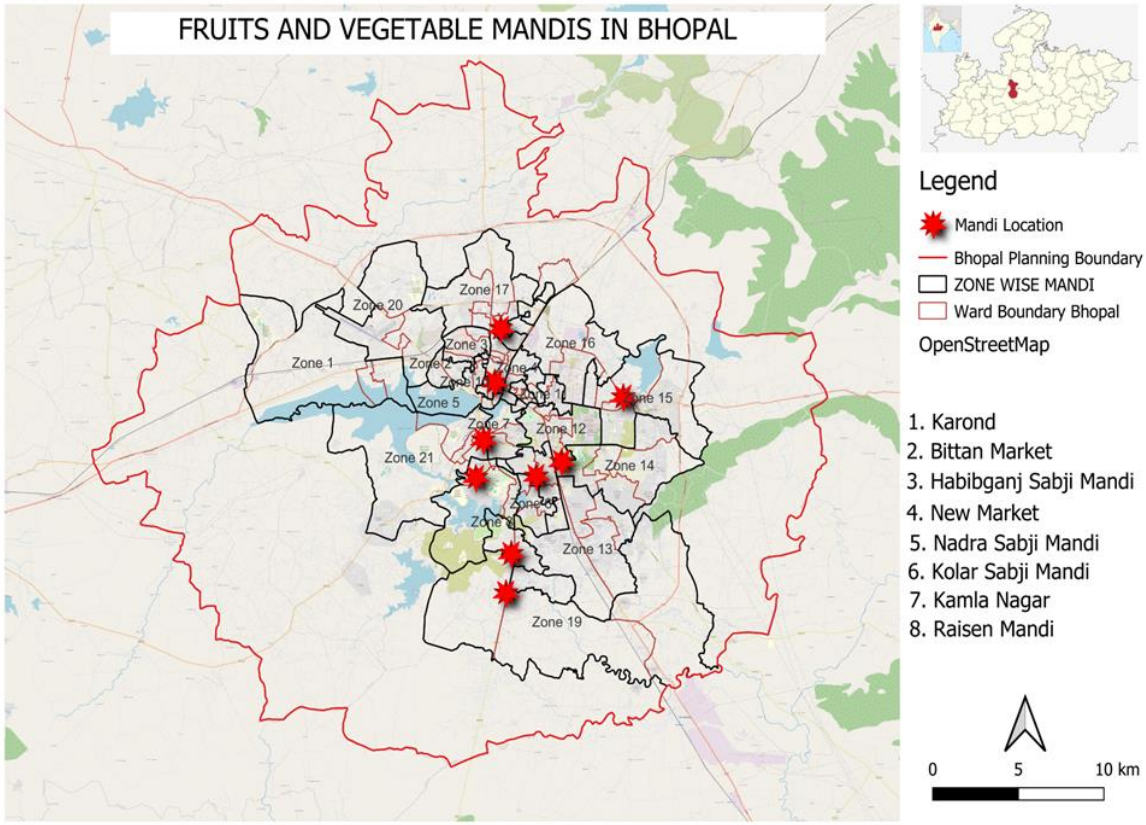


Figure 14: Location of Bhopal Mandi

4.2 Location of Fruits and Vegetable Mandi

Fruits and vegetables sourced from different markets in Bhopal are distributed daily from the mandi to local vendors and shops across various areas. However, a shortage of parking space near the mandi persists. The tonnage flow of Karond mandi amounts

to 6714 tons per day. This substantial flow underscores the significance of Karond mandi as a pivotal hub in Bhopal's agricultural supply chain. Despite its crucial role, the challenge of limited parking space poses logistical difficulties for vendors and transporters alike. Trucks transporting fresh produce often face congestion and delays due to the lack of adequate parking facilities, hindering the efficient distribution of goods. Addressing this issue is imperative to ensure the smooth operation of the supply chain and to support the livelihoods of countless individuals dependent on the trade of fruits and vegetables in Bhopal. Efforts to alleviate the parking shortage must be prioritized to sustain the seamless flow of goods and to foster the continued growth of Bhopal's agricultural economy.

Figure 15: Karondh Mandi Bhopal

- Entry of Unloading vehicles: Start at 11 pm and then at 4 am.
- Entry of Loading vehicle: 4 am -7 am.

Table 3: Location wise tonnage flow

Markets	No of Sample	Area(Ha)	Est no of Shops	Shops density shops /ha)	Jobs	Tonnage Inflow Daily 2024	Tonnage handled per ha
Karond	65	25	380	15	375	6714	268
Bittan Market	38	1.34	80	59	160	260	194
Habibganj	25	1.64	40	24	120	1200	731
Nadra sabzi ma	30	0.6	30	50	90	452	753
Nehru Nagar	15	0.17	25	147	105	60	352
New Mamrket	23	0.84	60	71	120	50	59
Kolar Sabji Man	12	0.62	40	62	120	90	140
Raisen mandi	10	0.54	25	46	75	125	231
Total	**218**	**30.75**	**680**	**474**	**1165**	**8951**	**2728**

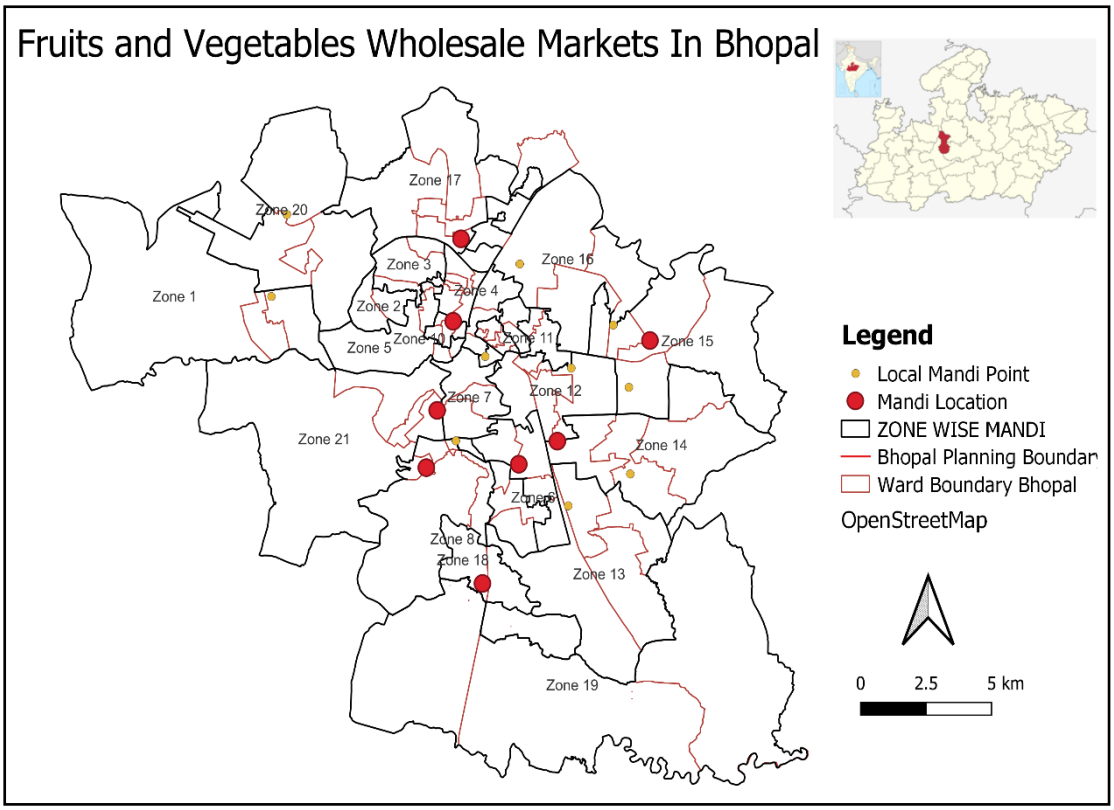


Figure 16: Local Mandi of Bhopal

The mandi in Bhopal is in Karond, serving as a central hub for the distribution of fruits and vegetables across the city. Despite its pivotal role, the mandi faces challenges due to a shortage of parking space, impacting the smooth flow of goods.

4.3 Facility of Mandi

The mandi provides essential facilities to ensure convenience and safety for vendors and customers. These include well-maintained toilets and drinking water facilities for hygiene. Shaded parking spaces are available to accommodate vehicles, protecting goods from harsh weather conditions. Additionally, a police officer chowki is stationed within the mandi premises to maintain law and order, ensuring the security of traders and visitors. These amenities collectively contribute to a conducive environment for smooth operations and transactions within the mandi, promoting efficiency and facilitating a positive trading experience for all stakeholders involved.

Facility	Availabilty
Drinking water	Yes
Toilet	No
Cover sheds	yes
Police Chowki	No
ATM	No
Post office	No
Medical Facility	No
Parking restrictions	yes
Cold Storage	No

Figure 17: Public facility.

4.4 Commodity distribution

Bhopal district consumes 40% of fruits and vegetables, with the remaining 60% being distributed to nearby districts such as Vidisha, Sanchi, Hoshangabad, Sehore, and other cities close to Bhopal. This distribution network ensures a steady supply of fresh produce to surrounding areas.

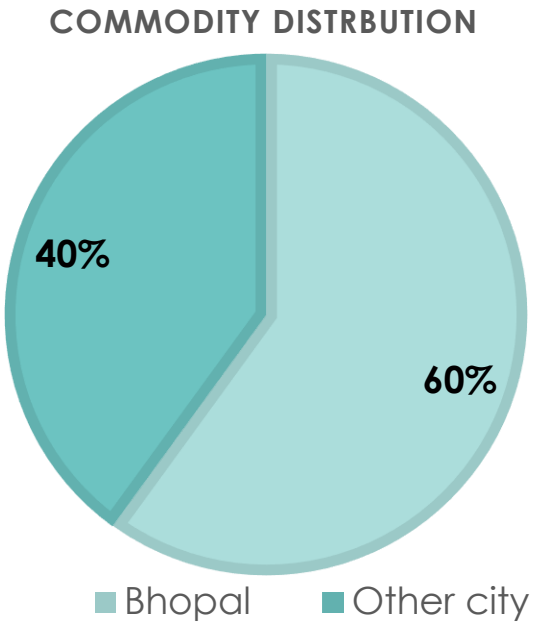


Figure 18: Commodity distribution

4.5 Journey of a Commodity from the farmer to the customer

The journey of fruits and vegetables from the farmer to the customer is a fascinating process that involves multiple steps to ensure freshness and quality. It all begins at the farm, where dedicated farmers carefully cultivate and harvest the produce, often adhering to strict agricultural practices to maintain high Standards.

Once harvested, the fruits and vegetables are sorted and packaged at the farm or at nearby processing facilities. Packaging plays a crucial role in protecting the produce during transportation and storage, helping to preserve its freshness and extend its shelf life. After packaging, the produce is transported to wholesale markets or directly to retailers. This transportation phase involves various modes of transport, including trucks, refrigerated vans, and sometimes even air freight for long-distance shipments. At wholesale markets, the fruits and vegetables are purchased by traders or distributors who then sell them to retailers such as supermarkets, grocery stores, and local markets. Retailers display the produce prominently, often arranging them aesthetically to attract customers. Customers visit these retail outlets to select the fruits and vegetables they desire, considering factors such as freshness, appearance, and price. Once purchased, the produce is taken home by the customer for consumption.

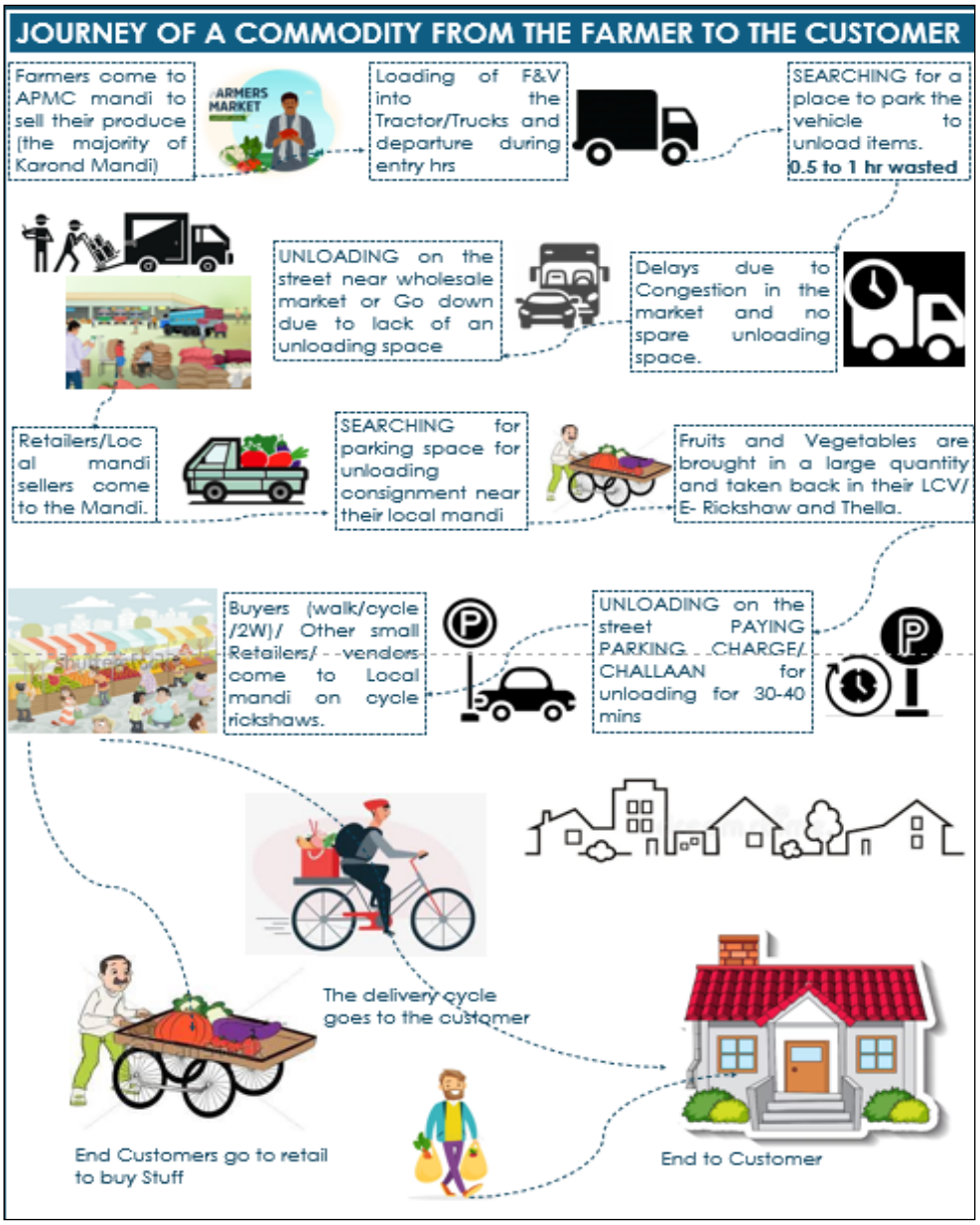


Figure 19: Flow of Commodity farmer to Customers.

4.6 Karond Mandi Commodity Distribution

Karond Mandi stands as a pivotal hub for Bhopal's fruits and vegetables, receiving a substantial flow of 6714 tons per day. From here, the commodities disperse to various local mandis across the city. These local markets serve as crucial distribution points, ensuring accessibility to fresh produce for residents in different neighborhoods. Each mandi caters to the specific needs and preferences of its surrounding community, contributing to the vibrant tapestry of Bhopal's culinary landscape. Through this network, the city's residents benefit from a consistent supply of high-quality fruits and vegetables, sourced from both local farms and broader markets.

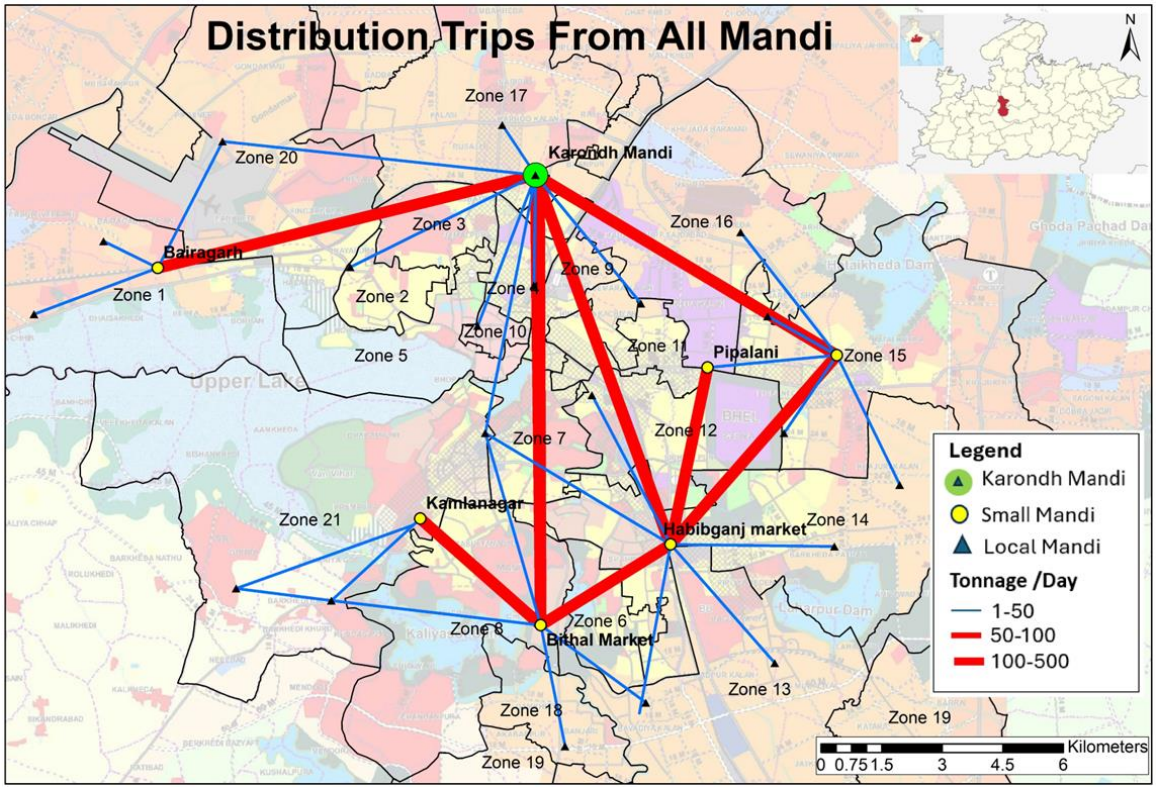


Figure 20: Distribution trips from all mandi

4.7 Planning Issue

The Bhopal Mandi faces several planning issues, including limited social amenities such as toilets and drinking water facilities. Additionally, there is a shortage of cold storage facilities, impacting the preservation of perishable goods. The mandi also lacks sufficient unloading space, causing congestion during peak hours. Moreover, the availability of goods vehicles for transportation remains a concern, affecting the timely distribution of produce. Addressing these challenges is crucial to ensure efficient operations and meet the needs of vendors and customers in Bhopal's mandi.

Table 4: Planning Issue

Location	Availability of social amenities	Availability of Cold storage	Availability of Unloading space	Availability of Goods vehicle parking
Karond	No	No	Yes	No
Habib Ganj	No	No	No	No
Bitten	Yes	No	No	No
Nadra Bus stand	No	No	No	No

4.8 Physical Characteristics

4.8.1 Establishment Density

Nehru Nagar boasts a high establishment density of 32%, reflecting a concentration of businesses and vendors. Conversely, Karond Mandi exhibits the lowest density at 4%. This density underscores vibrant commercial activity and a diverse range of goods and services, fostering competition and promoting economic growth within the market environment.

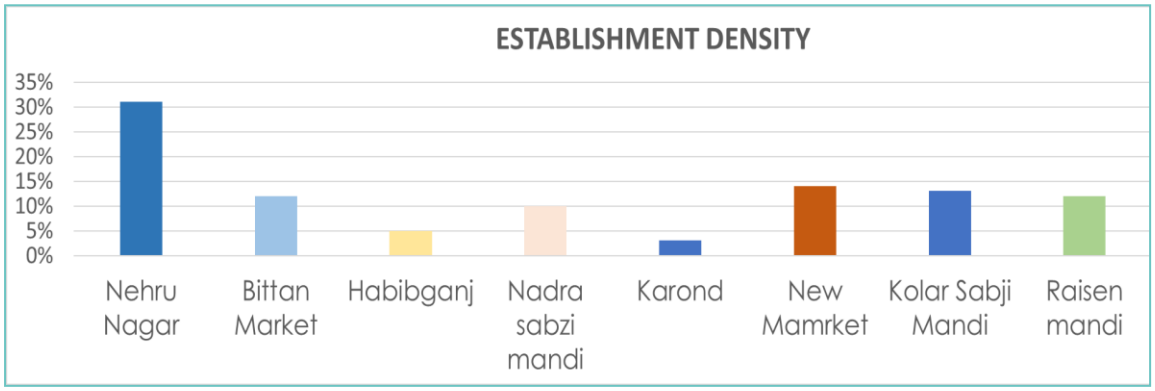


Figure 21: Establishment Density

4.8.2 Tonnage Generate Per Day

Karond Mandi exhibits a high tonnage generation of 6714 tons per day, highlighting its significant role in the agricultural trade. In contrast, Habib Ganj Mandi generates 1200 tons per day. These figures underscore the substantial volume of goods flowing through these markets daily, supporting local and regional commerce.

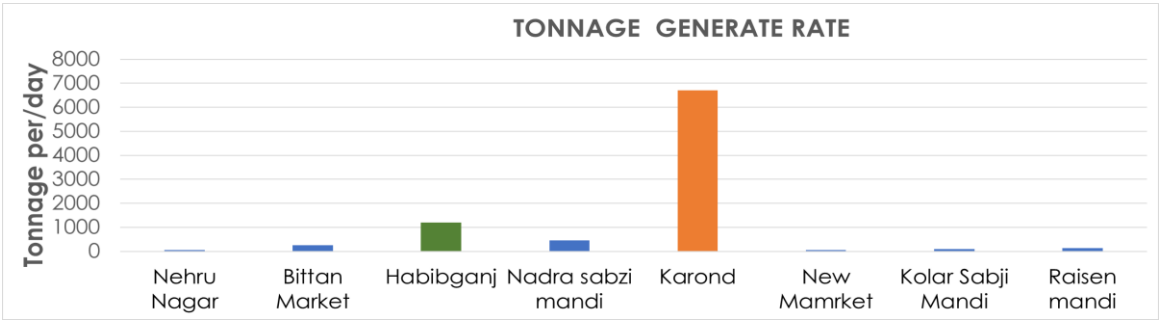


Figure 22 : Tonnage generate.

4.8.3 Urban Freight Operation Issue

Major issues resulting from urban operations include pollution (80%), traffic congestion (60%), noise pollution (40%), inadequate parking (45%), poor road quality (40%), encroachment (40%), and safety concerns (50%). These challenges impact the daily lives of many residents, necessitating effective urban planning and management strategies to address them comprehensively.

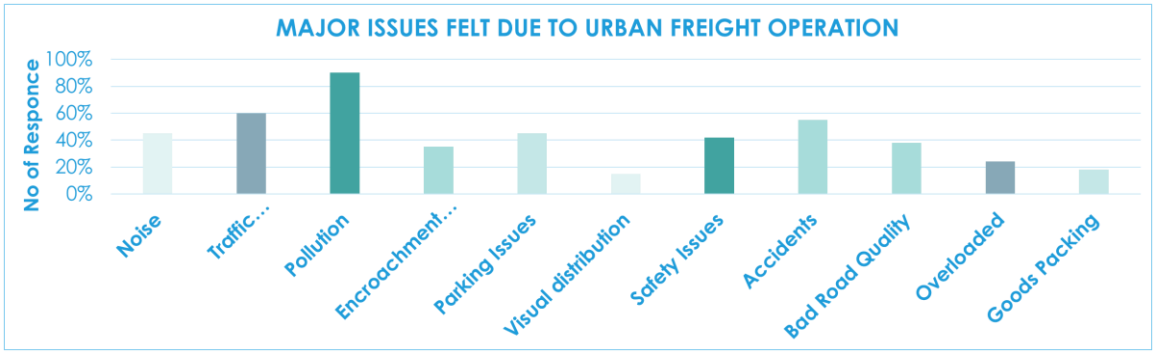


Figure 23: Urban Freight Issue

4.8.4 Impact of Urban Freight Operational on Quality of Life

The impact of urban freight operations on the quality of life was surveyed around mandis and vegetable markets. The findings reveal that 85% of respondents perceive a moderate impact, while 40% report severe consequences. Additionally, 30% identify the impact as major, followed by 28% who consider it significant, and 10% find it insignificant. These results underscore the varied perceptions and experiences of individuals regarding the effects of urban freight operations on their daily lives. Addressing these concerns is crucial for enhancing the overall well-being of affected communities.

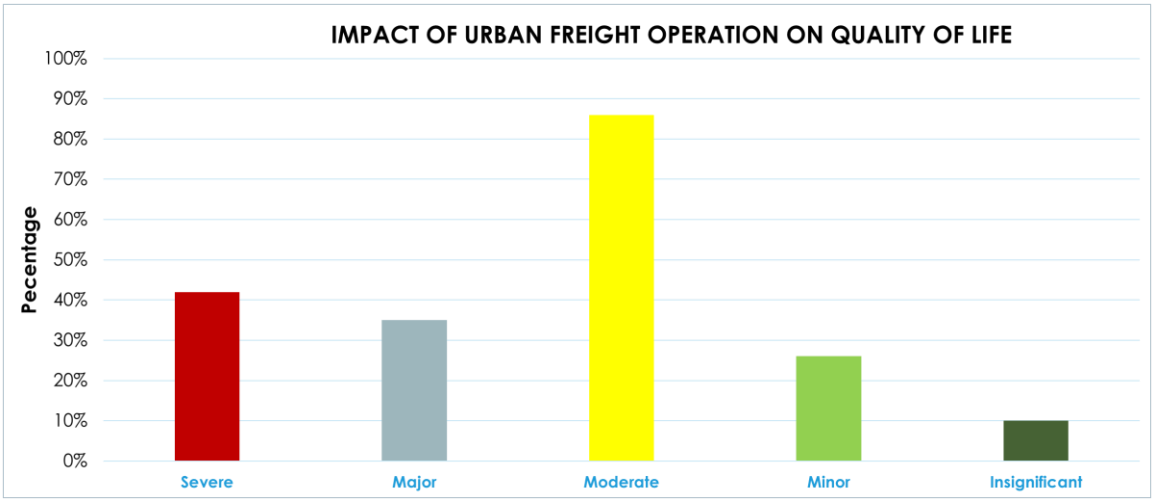


Figure 24: Impact of urban freight.

4.9 Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) is a decision-making technique developed by Thomas L. Saaty in the 1970s. It's designed to help individuals or groups make complex decisions by breaking them down into a hierarchical structure of criteria and alternatives, then systematically evaluating and comparing them based on pairwise comparisons and judgments.

The process begins with identifying the main goal or objective, followed by breaking it down into a series of criteria that contribute to achieving that goal. Each criterion is then further decomposed into sub-criteria if necessary, creating a hierarchical structure.

Next, decision-makers compare each pair of criteria and sub-criteria, determining their relative importance using a scale that reflects their preferences or priorities. These pairwise comparisons are typically done using Saaty's fundamental scale, which ranges from 1 to 9, with 1 representing equal importance and 9 indicating extreme importance.

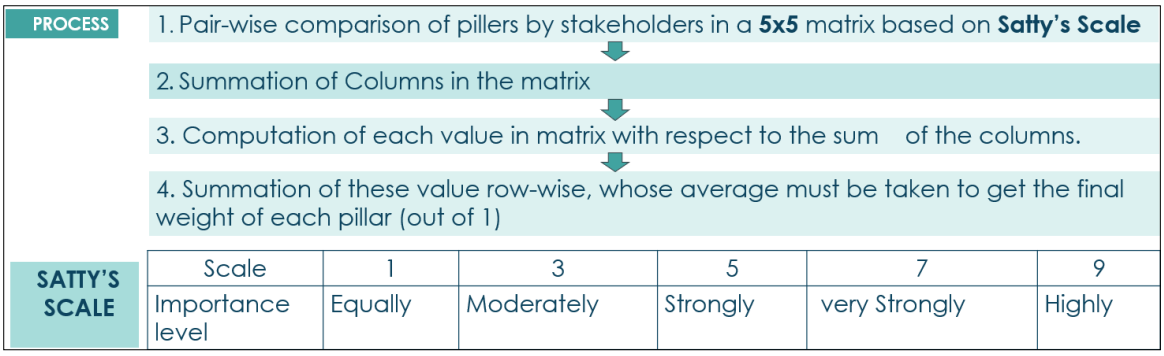


Figure 25: Satty's Scale

Once all pairwise comparisons are made, mathematical algorithms are applied to derive priority weights for each criterion and alternative. These weights are then used to calculate a final ranking or score for each alternative, helping decision-makers to make informed choices based on a systematic and structured approach. AHP is widely used in various fields, including business, engineering, project management, and healthcare, to address complex decision-making scenarios.

4.9.1 Application of AHP In the Study

In the study, the Analytical Hierarchy Process (AHP) was applied to facilitate decision-making processes. A crucial step in implementing AHP is consulting stakeholders to gather insights and preferences relevant to the decision context. The primary survey data collected revealed a diverse set of stakeholders consulted, including Academic Experts (40%), Wholesalers (17%), Corporation Office Representatives (8%), Town Planners (8%), Students (17%), and Development Authority Officials (8%).

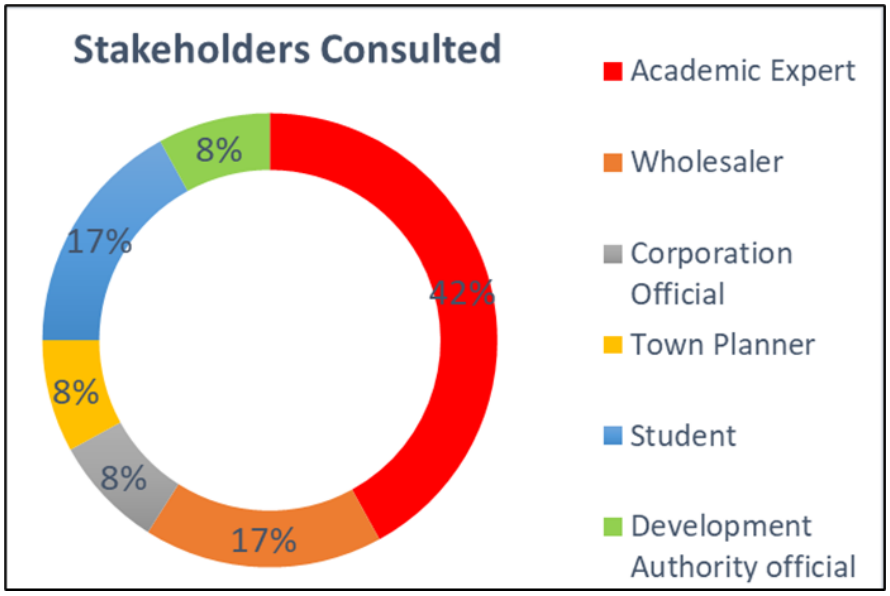


Figure 26: Stakeholders Consulted

4.10 Normalized Value Each Piller

In the Analytical Hierarchy Process (AHP), normalizing the values of each pillar involves ensuring that the weights assigned to each criterion are consistent and comparable. This process is crucial for accurately assessing the relative importance of different criteria in decision-making.

Normalization typically involves dividing the raw scores obtained from pairwise comparisons by their respective column totals. This transformation ensures that the weights of all criteria sum up to 1, reflecting their relative importance to each other.

Normalized Matrix

Parameters	Environme	Economy	Social	Planning	Policy	Weights	AW	Lamda	CI	RI	CR
Environment	0.45	0.53	0.48	0.47	0.25	0.44	2.35428	5.39025	0.065191	1.12	0.058207
Economy	0.15	0.18	0.29	0.16	0.25	0.20	1.094204	5.355374			
Social	0.09	0.06	0.10	0.16	0.17	0.11	0.593159	5.207422			
Planning	0.15	0.18	0.10	0.16	0.25	0.17	0.866391	5.212201			
Policy	0.15	0.06	0.05	0.05	0.08	0.08	0.404841	5.138582			
								5.260766			

Figure 27: Normalized Matrix Value

A comparison matrix is a tabular representation used in decision-making processes, particularly within the Analytical Hierarchy Process (AHP). It systematically captures pairwise comparisons between criteria or alternatives, facilitating the assessment of their relative importance or performance. Each cell in the matrix contains a value representing the preference or priority of one option over another, typically assessed

using a numerical scale. Comparison matrices are essential for structuring complex decision problems, providing a clear visual representation of decision factors and enabling decision-makers to derive priority weights or rankings through mathematical algorithms like eigenvector analysis.

Study Outcomes Comparison Matrix (A)

Parameters	Environment	Economy	Social	Planning	Policy
Environment	1	1/3	5	1/3	1/3
Economy	3	1	3	1	3
Social	1/7	1/3	1	4	1/5
Planning	3	1	7	1	1/3
Policy	3	1/3	5	3	1

Figure 28: Comparison Matrix

CHAPTER 5 SUMMARY OF SUSTAINABILITY ISSUES

5.1 Environmental Issues

Overall, there are many sustainability issues related to all market levels. Approximately, 1924 tons of greenhouse gas emissions are emitted into the atmosphere every month due to the fruits and vegetables related freight movement to and away from these markets. Daily, 30 thousand vehicle kilometers, and 90 Lakh tonnage kilometres are travelled by the fruits and vegetable-based transport, suggesting a higher ton-km, vehicle- km, indicating over-utilization of vehicles, additionally, 3122 Liters of fuel (mostly diesel) is consumed daily for the fruits and vegetable related freight movement in the study area.

Table 5: Environment Indicators

Environment			
Indicators	**Value**	**Min**	**Max**
AQI	112	0	115
Noise	76	80	50
GHG	1924	3682.06	0
Fuel - Consumption	30	70	15
Total	**2142**	**3832.06**	**180**

5.2 Economic Issue

Maintaining and operating these markets is a big economic affair because almost 3.56 crores are spent in operating mandis, Particularly Moving the produce from the farmer to the end customers. Moreover, freight economics is time-sensitive, and there are about 50-60 minutes of delays in and around these markets, which are lost in waiting for an unloading space or searching for a safe parking spot for the vehicle.

Table 6: Economic Indicators

Economy			
Indicators	**Value**	**Min**	**Max**
Tonnage Gen, rate	600	800	300
Establishment	40	40	80
Average Speed around Market	14	25	30
Average Dwell time	28	10	0
Street Parking Space	60	20	10
Total	**728**	**895**	**420**

5.3 Social issue

Urban freight is a provider of employment to many people, meaning many people are benefiting from daily operations. On the contrary, there are some other social issues due to the mandi operations too. Based on the primary survey, 55% of citizens feel that there has been an impact on their quality of life, particularly due to the daily noise and pollution due to the mandi activities.

In addition, 40% of citizens feel unsafe around large freight vehicles, indicating a safety issue too. Moreover, access of the mandi workers and drivers to basic amenities is a problem across mandis of all levels. There is a shortage of these basic facilities, implying non-inclusive market planning.

Table 7: Social Indicators

Social			
Indicators	**Value**	**Min**	**Max**
Jobs	280	0	1500
Health impact	2	1	5
Impact on Quality of Life	3	1	5
Freight related Accidents	13.46	10.59	0
Social Amenities	1	0	5
Total	**299.46**	**12.59**	**1515**

5.4 Planning Issue

Concerning planning, there are a lot of issues, as most of these markets are unorganized and unplanned. Besides having poor circulation, these markets lack basic facilities. The lack of a cold storage facility has led to the daily wastage of a large quantity of leftover fruits and vegetables.

Additionally, these markets do not have proper unloading or loading spaces for the goods vehicles, which is one of the reasons for delays in and around mandi premises. Also, the lack of proper parking space and availability of certain services within the market cause delays and inconvenience to all.

Table 8: Planning Indicators

Planning			
Indicators	**Value**	**Min**	**Max**
Availability of parking Space for freight Vehicles	3	0	5
Loading and Unloading Spaces	0	0	5
Market is Planned /unplanned	3	0	5
Available of Cold Storage area	0	0	5
Total	**6**	**0**	**20**

5.5 Policy Issue

Policy issues revolve around the absence of a regulatory body for each market, because of which there is no coordination among the various dealers within the market. Moreover, there is a very little contribution of the municipal body in ensuring the cleanliness and sanitation of the markets. Additionally, it is related to the unawareness of the population, concerning the initiatives related to the sustainability of the urban freight system.

Table 9: Policy Indicators

Policy			
Indicators	**Value**	**Min**	**Max**
Regulatory Body	5	0	5
Action taken by Municipal Body	1	0	5
Coordinate among Stakeholders	0	0	5
Presence of Sustainability strategy Policy	0	0	5
Total	**6**	**0**	**20**

5.6 Sustainability Index for all markets

The Index has been calculated for all the mandis, based on the same Procedure. The Process for Karond Mandi, along with all mathematical formula has been Show in the table.

Parameters	Normalized value
Environment	0.54
Economy	0.64
Social	0.8
Planning	0.7
Policy	0.7

Weighted Mean Method

Parameters	Weight (Overall)	Index
Environment	15%	15%*0.54 + 32%*0.64+ 5%*0.8+ 21%*0.7+ 27%*0.7= 0.6
Economy	32%	
Social	5%	
Planning	21%	
Policy	27%	

Table: Normalized value

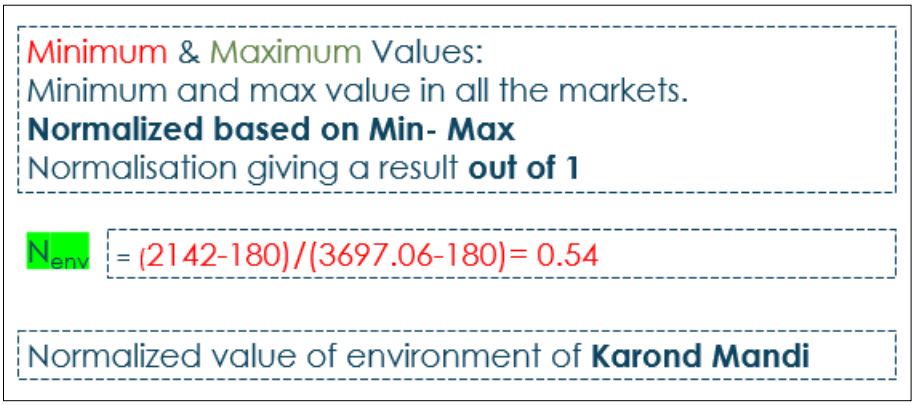
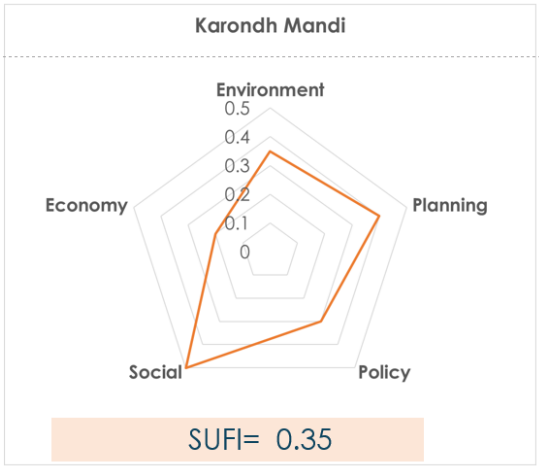
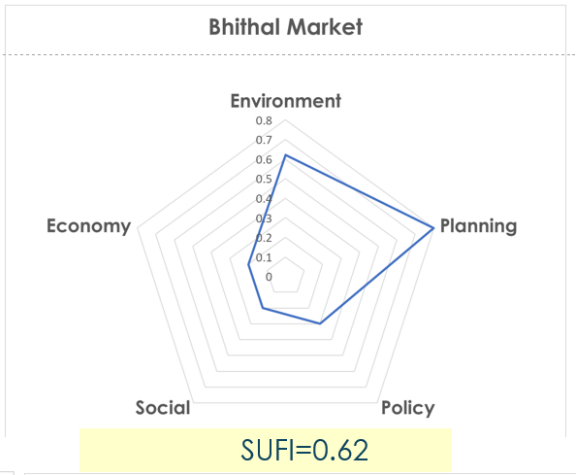
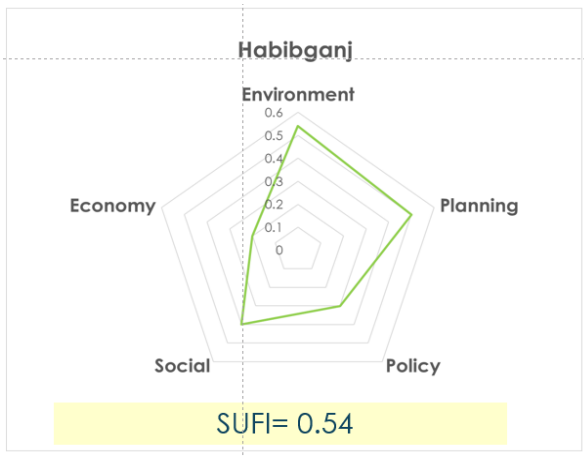


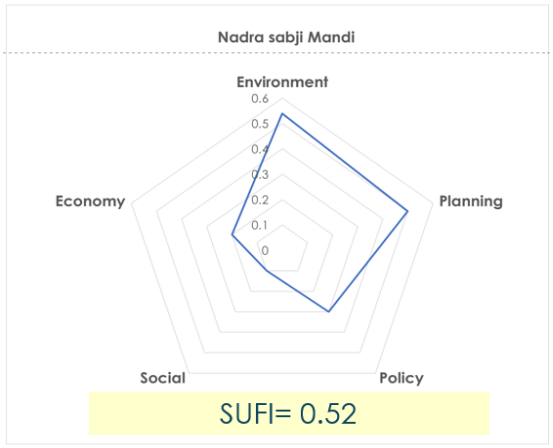
Table 10 : Index Value

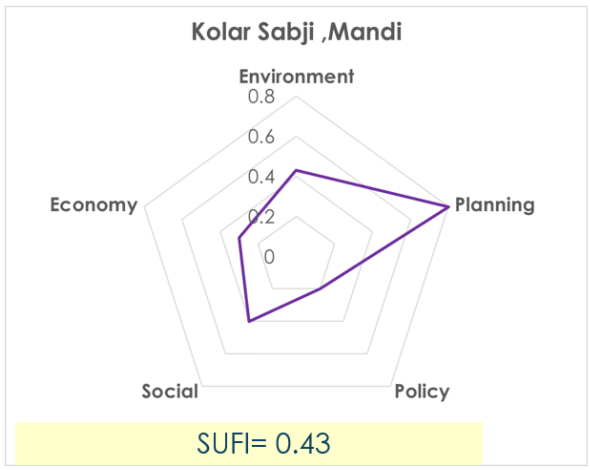
Index Interpretation (Given by Author)	
SUFI Value	Interpretation
<0.2	Worst
0.2-0.4	Bad
0.4-0.6	Satisfactory
0.6-0.8	Good
0.8-1	Best

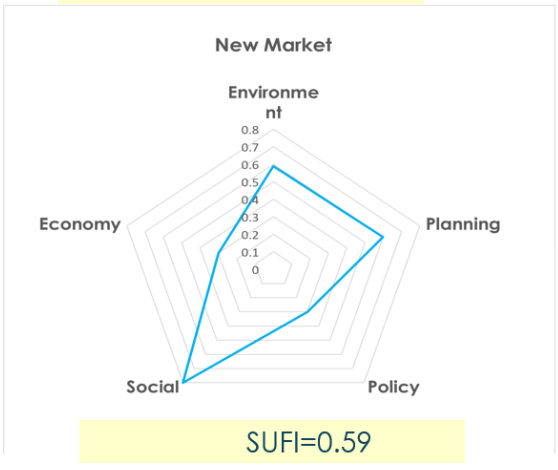

Karondh Mandi
Environment
0.5
0.4
0.3
0.2
0.1
0
Economy
Planning
Social
Policy
SUFI= 0.35

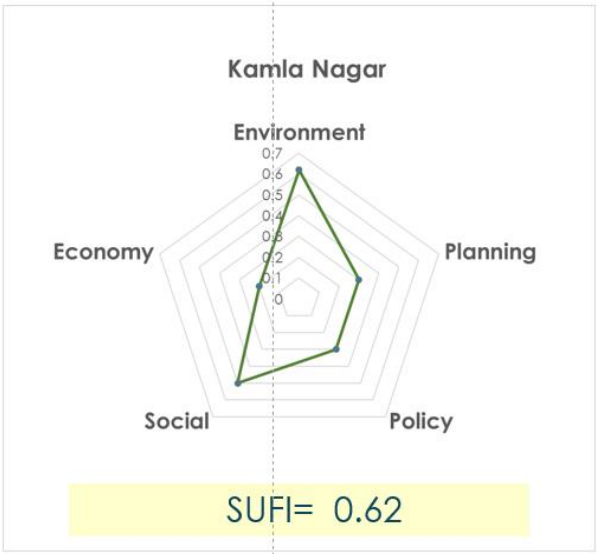

Bhithal Market
Environment
Economy
Planning
Social
Policy
SUFI=0.62

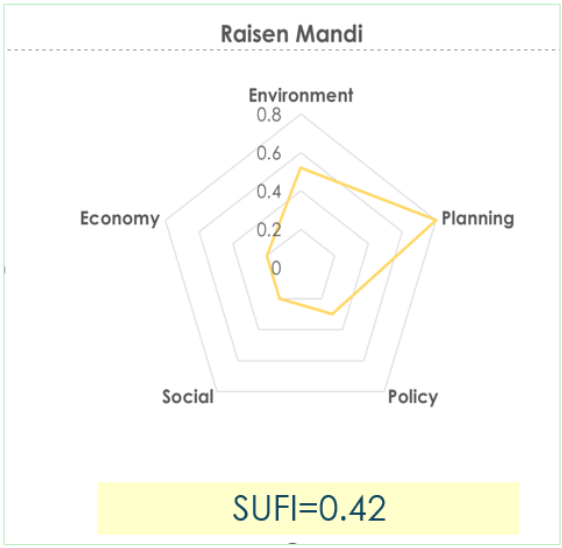

Habibganj
Environment
0.6
0.5
0.4
0.3
0.2
0.1
0
Economy
Planning
Social
Policy
SUFI= 0.54


Nadra sabji Mandi
Environment
Economy
Planning
Social
Policy
SUFI= 0.52


Kolar Sabji ,Mandi
Environment
0.8
0.6
0.4
0.2
0
Economy
Planning
Social
Policy
SUFI= 0.43


New Market
Environme
nt
Economy
Planning
Social
Policy
SUFI=0.59





5.7 5.3 Comparison of All scenarios

To decide for sustainably planning the markets, a comparison of the Sustainable Urban Freight Index across all the scenarios has been done to find out the best working scenario for the future.

From the following table, it can be inferred that the SUFI category of all the markets has improved, and almost all of them fall in the "Good Sustainability Category' in the ' Long Term' Scenario, indicating the best sustainable scenario for the future. However, all of the scenarios have a positive outcome, with an improvement in the SUFI value of each fruit and vegetable market. Although, the short-term strategies have a very less impact on the SUFI value of the markets, both medium term and long-term scenarios prove quite successful in enhancing the market sustainability. The overall SUFI in 2041 (BAU) has improved from a mere 0.53 to a very good 0.86 sustainability category.

Table 11: Urban Freight Index

Market	SUFI			
	BAU 2041	Short Term 2029	Medium Term 2035	Long Term 2041
Karond	0.35	0.58	0.63	0.81
Bitten Market	0.62	0.59	0.65	0.93
New Market	0.59	0.54	0.72	0.84
Habibganj Market	0.54	0.56	0.71	0.81
Nadra Mandi	0.42	0.59	0.66	0.86
Kamla Nagar	0.62	0.51	0.65	0.91
Raisen Mandi	0.52	0.54	0.68	0.95
Kolar Mandi	0.43	0.53	0.71	0.87

It can be concluded that the maximum positive change is expected to occur in all the markets in the long- term strategy scenario. Therefore, all the Proposals Planning norms, and guidelines have been given in the next Chapter, In line with this Scenario.

CHAPTER 6 PROPOSAL/RECOMMENDATION

6.1 FINDING

6.1.1 Issues Related to the Sustainability of Markets

Sustainability of fruits and vegetable markets of various tires is a function of the tone-Kilometres travelled daily, the number of motorized vehicles plying into and out from these markets, the planning layout of these markets, the impact of these markets on the neighbouring residential areas and so on. In addition to the requirement of sustainable operations. each market's plan must be sustainable and efficient too. Efficient layout plans ensure parking spaces for both passenger and goods vehicle unloading and loading spaces and a better circulation system. helping in reducing the dwell time of the goods vehicles. Additionally, the presence of all facilities and special amenities ensured in a planned market, further augmenting its sustainability. Additionally, the usage of green and non-motorized modes is also a detriment to sustainable market operations. Consequently, a market where all the shopkeepers interact with each other to maintain their markets or consolidate deliveries and are regulated under a market body proves to be more sustainable. Finally, a market that does not impact the residents around then (in terms of pollution waste disposal, noise. and congestion) is socially sustainable.

6.1.2 Salient Findings

Through this intensive research and analysis, it has been found that there is a gap in the availability of literature concerning the evaluation of the sustainability of fruits and vegetable markets, Further, it has been found that unsustainable operations are significantly higher at the higher hierarchy, while it is significantly lower at the lower-level retail markets These issues have been identified based on the calculated Sustainable Urban freight index. This index i a basis for identifying issues in a market and can be used to find out which strategy works best Also, certain strategies can help in enhancing the SUFI value by certain percentages, thereby augmenting market sustainability.

6.1.3 Application of Sustainable urban Freight Index (SUFI)

This study was an attempt to formulate a mathematical tool for quantifying the Sustainability of the market, based on an intensive literature review. It is for the first time that such kind of a mechanism has been developed for urban freight, which is limited to fruit and vegetable Markets, in this study, the SL I has been used as a means to decide on the best choice for the proposal. It is a novel technique to assess the impact of a proposal on the overall sustainability of the fruit and vegetable markets. Further, a categorization has also been done to find the level of sustainability of these fruits and vegetable markets. Additionally, such an index can be utilized in markets of other commodities as well to assess and evaluate the level of the market Sustainability. This is a new contribution to the sector of freight planning and must be made a part of Freight Action Plans for the urban areas. Such an attempt can be made very year to assess the level of.

6.1.4 Market planning Principles

6.1.4.1 **Locations Attributes**

Different types of markets have different needs which makes it essential to define contain locational and siting guidelines for these markets. These locational attributes have been referred for various reports and past studies done in the domain of market planning. Following are some of the key points:

6.1.4.2 **Urban Wholesale Markets**

Wholesale markets located in the urban areas receive huge vehicles from the adjoining states and require good accessibility to the arterial network or the highways, In addition, to reduce the outflow leads, the land uses adjacent to the wholesale markets should be compatible enough. For instance, if it is a fruits and vegetables wholesale market, then the adjoining land uses could be a truck terminal, a big restaurant hub, catteries, caterers, etc**.**

6.1.4.3 **Retails Markets**

Customers generally buy their produce from a regional retail market (like a mall or a commercial complex) or a local retail shop in their neighborhood. Therefore, the first principle of locating such shops is that the location must be convenient for the customers, i.e., at a walkable distance from their residence, Additionally, regional retail must be well accessible by bus, metro, or walk, to reduce the emissions due to private vehicles**.**

6.1.4.4 **Principal for Efficient Markets Layouts.**

There are certain principles and considerations to be kept in mind while planning a wholesale or retail market. These have been explained below.

1. Market Circulation: A market receives a plethora of goods vehicles daily and a good circulation network would ensure an efficient movement of trucks: Therefore, each market should have enough space allocated for the circulation of the goods vehicle.
2. Adequate Parking: Each market should have sufficient parking space for both goods vehicles as well as passenger vehicles. The parking space required by each market depends on the number of shops in each market, along with the frequency of the arrival of goods vehicles. Also, a lot of research depicts that almost 40-50% of the market plot area should be allocated for Parking and Circulation.
3. Display Arrangement: Display arrangement is crucial in attracting customers to buy stuff from the market, whether it is a wholesale market or a retail shop. Along with the display of the produce, cleanliness, and organization of the market is equally important.
4. Adequate Storage Space: A market is supposed to always keep extra stock to fulfill the unforeseen stocks required on any given day. For separate commodities, separate types of storage spaces are required. For instance, fruits and vegetables are perishable commodities and require cold storage for the storage of their produce.

6.1.4.5 **Proposed for New Mandi**

Based on the above-mentioned location attributes and hierarchy, the new mandi has been in the unserved area, i.e. the area which doesn’t come within a buffer of 10-15 km.

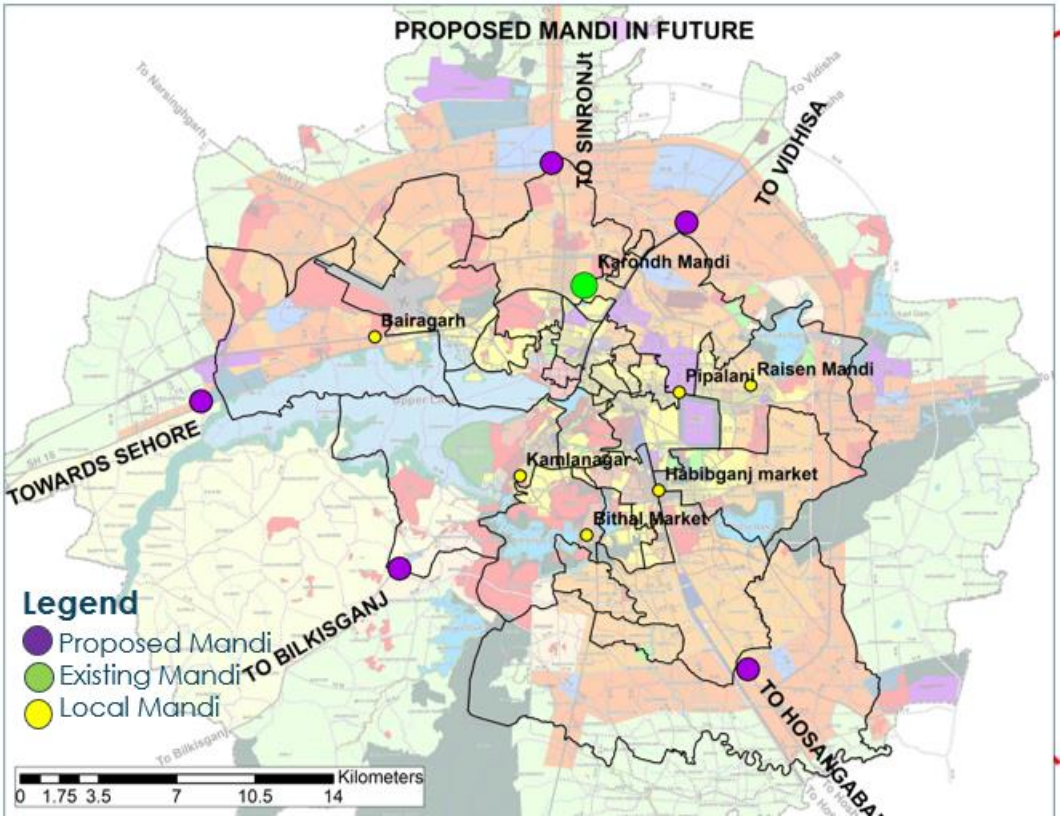


Figure 29: Fruit and Vegetable Mandi In Bhopal

Shows all the major mandis in the city with a catchment of 10km. The green areas are the areas that are served at a sustainable level, i.e., at a 10km catchment from the mandis. while the red areas are the unserved areas, which require another mandi. From Map 1-1, in Zone 19, the western part is relatively unserved and a perfect location for siting a new mandi. Based on the reconnaissance survey and the proposed land use of Bhopal for 2011, the land chosen for the new mandi is government land. Moreover, it is being used for parking trucks and can be utilized better, where parking facilities can be provided in a better manner. It is located close to the Airport and can be utilized for any international fruit and vegetable deliveries as well. Map 1- depicts the location and plot taken for the new mandi.

6.1.4.6 **Facility Guidelines**

The guidelines for the market facility have also been given based on the suitable and most sustainable scenarios discussed above. The following aspects have been studied and included as a part of the facility planning guidelines:

.1. Tonnage generation rate

2. Tonnage handled per shop

3. Establishment size
4. Establishment Density
5. Area for Circulation Space
6. Area for Loading/Unloading
7. Provision of Colgin Storage
8. Buffer around Markets
9. Built form
10. Electric Vehicle Charging Facility
11. Waste to Energy Plant

Figure 30: Proposed Layout For New Mandi

Therefore, most of the literature review has emphasized on the provision of a larger parking and circulation area in the mandi, the provision of certain social amenities, like toilets, food parlor and accommodation. A significant area has also been allocated to warehousing, along with some reserved areas for loading and unloading.

The features of market planning are as follows:

1. Segregating Public Parking from Freight Parking, loading bays
2. Facilities around large mandi space and peripheral major circulation road
3. Gren Buffer area to raise the impact on nebouring area
4. Waste to Energy Plant for reliction of carbon footprint due to wastage
5. Separate entry-exit points for goods vehicles and passenger vehicles.

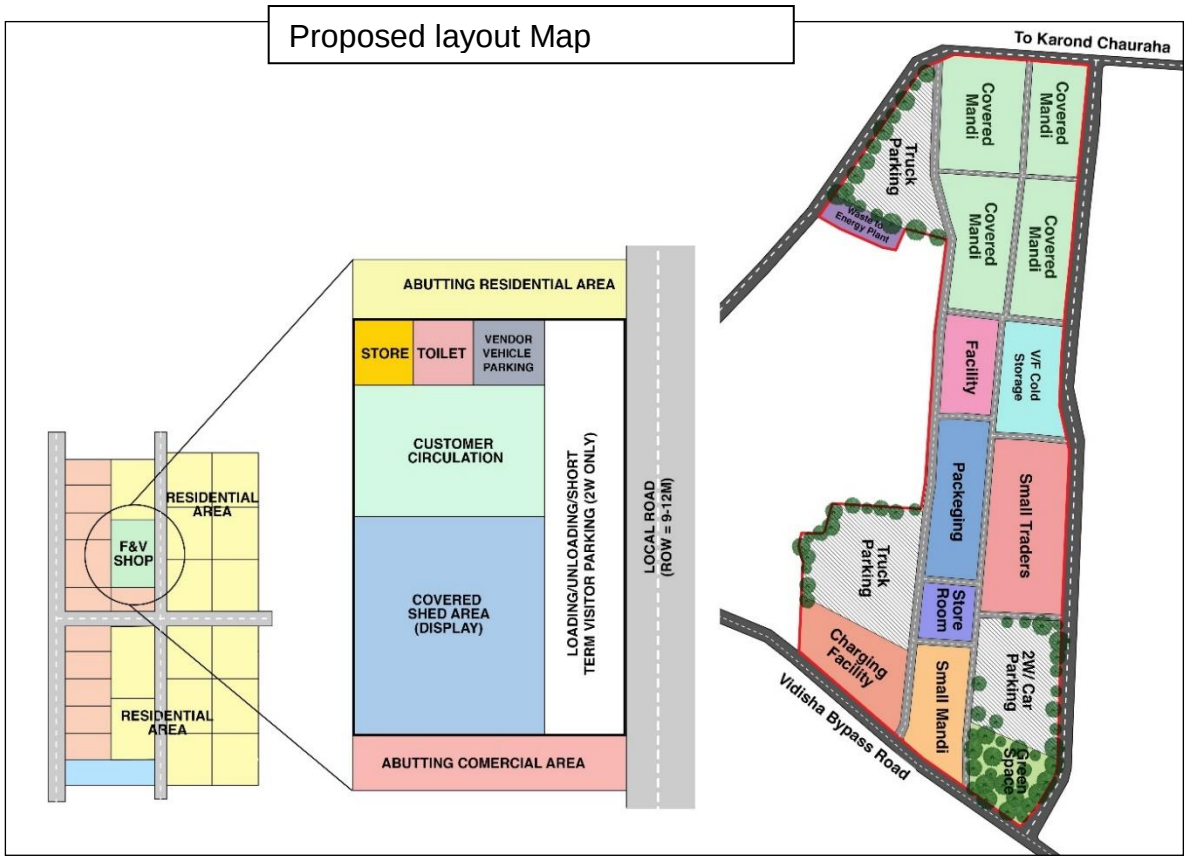


Figure 31: Proposed Layout For shops on Mandi

1. Accessible by walk, cycle
2. Parking for 2W, Cycles
3. Located near a residential area
4. Located on a collect /local road

Furthermore, an area of approximately 30-40 sqm. has been planned as a fruit and vegetable shop. which has a circulation area for the customers, a narrow loading/unloading space, a storage area social amenities like toilets and waste disposal. It is located in a dense area, which can act as an immediate catchment for the shop and help in fulfilling the demand.

6.1.4.7 **Adoption of Electric Vehicle for Distribution**

With the FAME ll Policy in place in India, a hefty subsidy is applicable on the purchase of electric 3-wheelers, along with certain other incentives. Additionally, the Bhopal Electric Vehicle Policy to emphasizes on the uptake of electric vehicles for goods movement and gives an incentive of Rs: 20,000 on the purchase of the first 10,000 E-

Cargo vehicles. In line with these policies, a dire need for the uptake of electric vehicles in the distribution segment has been (elaborated and the associated infrastructure requirement has also been taken up as a part of the guidelines. The financial viability of the electric autos has also been tested through an analysis by (IRI India, 2021). The total cost of ownership (TCO) has been compared based on the distance traveled by each goods auto segment. The electric goods auto with FAME II Subsidy, goods auto without subsidy, CNG goods auto, diesel goods auto and petrol goods auto have been compared in Figure 10-2, and e-goods auto based TCO (Rs/km) is lower for electric goods auto with the subsidy at all the distances. However, the electric goods auto becomes feasible without the subsidy if the minimum daily vehicle kilometers is 100km.

6.2 Mobile Application Based delivery

As the world is moving towards Online delivery, a system to get the fruits and vegetables delivery from the nearest mandi is another plausible solution in reducing the traffic congestion and parking related issues around the mandis. An application has been developed, whereby the catchment area of each mandi is fixed and has been loaded in the application**.**

5.1.4.9 Intelligent Transport System based Interventions

Intelligent Transport System is the all-new solution for solving any management issues in the transport sector. With a lack of data availability for the urban freight movement a new App called, ITS System has been created to enhance the efficiency of the truck movement in and out of the mandi. A system has been devised, whereby the farmer would load the agricultural produce in a truck, owned by the transport operator. The transport operator would Benexate a QR code in his mobile phone and stick the same on his truck as well. The truck driver should download the "APMC" Application on his mobile phone and fill in his details, the vehicle details, and the quantity of produce loaded to book a bay in the raid that he's approaching. The App would track the chicle's location too, and as soul he the muck reaches any toll of Bhopal, the QR code with all details would get scanned and he immediately is sent a message regarding the details of the entry gate, route, Bay number and a pass code. As soon as the vehicle would reach the mind, the truck driver would how his details and enter the passcode on the machine at the entrance. As soon as the truck driver enters the passcode, the

unmanned gate opens, and the boom barrier would automatically open and then close once the vehicle enters the mandi. The truck would go to the allocated loading bay, hassle-free, unload the produce and exit the mandi by showing the same passcode. Further, the information that the truck has exited the mandi would also be saved in the APMC App Data Base and would be passed on to the Traffic Police Database. The information given to the Traffic Police database could then be utilized to manage traffic.

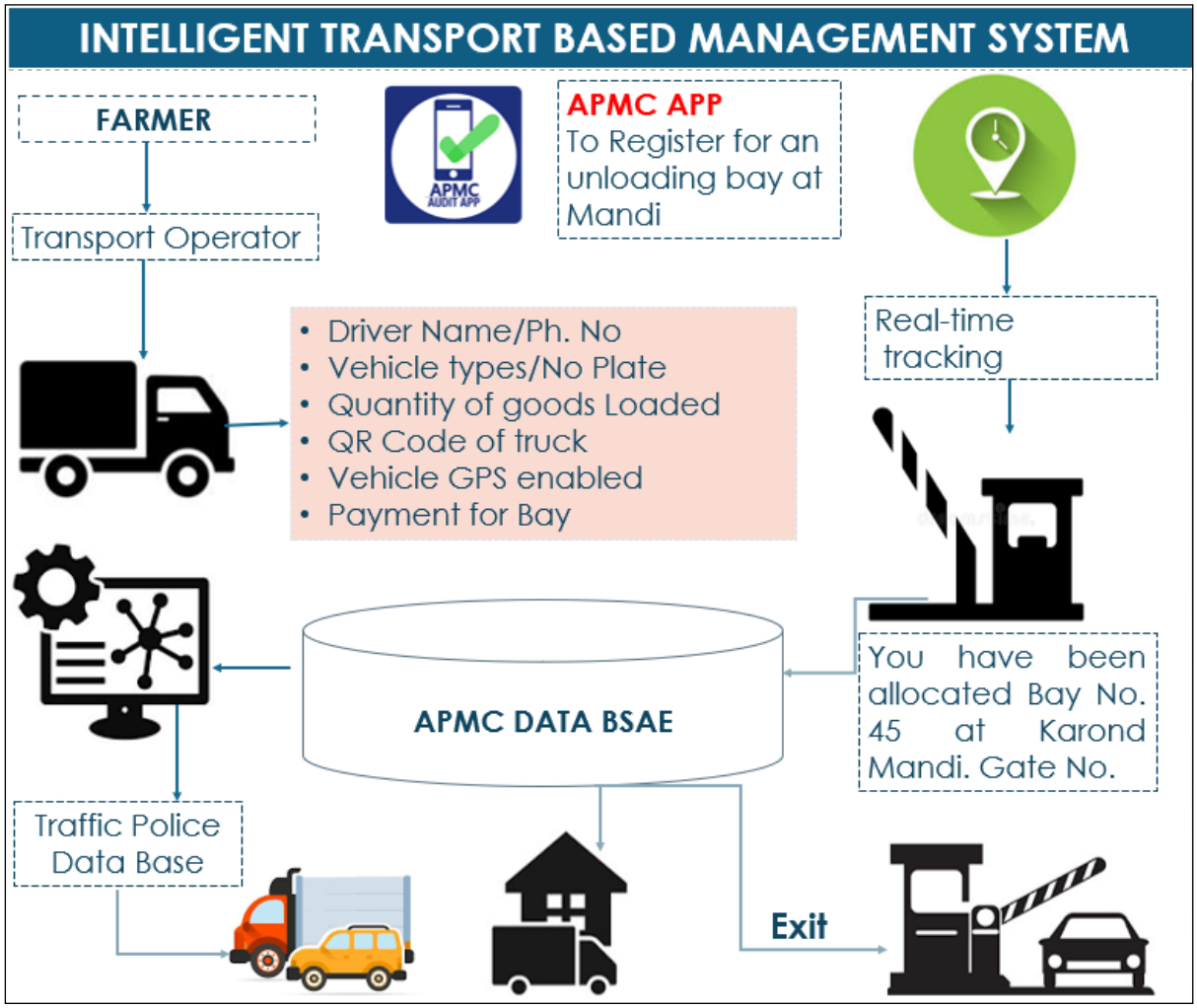


Figure 32: ITS Based Management System

6.3 CONCLUSIONS

The study aimed to develop a Sustainable Urban Freight Index for the mandis and devise sustainable strategies for the same. Based on the intense analysis and the possible strategies sought for each mandi tier. the proposals Have now been Categorised in the Short -medium-and long-term strategies. These have been devised as follows: Therefore, based on all the analysis and proposals, it can, be concluded that there is a dire need of.

- Studying the Urban Freight Characteristics at a disaggregate level instead of an aggregate level.
- A need to formulate a regulatory body for each market type.

6.4 Way Forward

The above study contributes to quantifying the impacts of urban freight movement, with respect. to a single commodity. Since the requirements and characteristics of each commodity type vary, there is a scope of developing a similar index for other commodities as well.

Additionally, there is a need for the development of benchmarks for sustainable urban freight index, which can be taken up in future research. Sustainability aspects of urban freight transport can be included in the Mobility Plans and Master plans of cities across India to propose solutions based on the actual issues.

REFERENCES

- Betanzo-Quezada, E., & Romero, J. A. (2010). An urban freight transport index.
- Lindholm, M. (2013). Urban freight transport from a local authority perspective – a literature review.
- Pan, S., Zhou, W., Pira Muthu, S., Giannikas, V., & Chen, C. (2021). Smart city for sustainable urban freight logistics.
- Decarbonizing Urban Freight in Surat and Bengaluru. (2021). Sustainable Urban Freight Initiative: A Collaborative Approach.
- Behrends, S., Lindholm, M., & Woxenius, J. (2008). The Impact of Urban Freight Transport: A Definition of Sustainability from an Actor's Perspective.
- Sustainability of Urban Freight Transport: Retail Distribution and Local Regulations in Cities (Doctoral dissertation). Erasmus University, Rotterdam, The Netherlands, (2008).
- Sikdar, S. K., Sengupta, D., & Harten, P. (2012). More on aggregating multiple in dictators into a single index for sustainability analyses. Clean Technologies and Environmental Policy.
- Ballantyne, E. E. F., Lindholm, M., & Whiteing, A. (2013). A comparative study of urban freight transport planning: Addressing stakeholder needs.
- Anderson, S., Allen, J., & Browne, M. (2005). Urban logisticseehow can it meet policy makers' sustainability objectives.
- Marsden, G., & Rye, T. (2010). The governance of transport and climate change.
- Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review.
- Timms, P. (2014). Transferability of urban freight transport measures: A case study of cariacica (Brazil). Research in Transportation Business & Management.
- Alexander, M., 2012. Decision-making using the Analytic Hierarchy Process (AHP) and SAS/IML, SESUG.
- Lee, Y., Huang, C., 2007. Sustainability index for Taipei. Environ. Impact Assess.
- Pitot, M., Yigitcanlar, T., Sipe, N., Evans, R., 2006. Land Use & Public Transport Accessibility Index (LUPTAI) tool: The Development and Pilot Application of LUPTAI for the Gold Coast.

- Finnegan C, Finlay H, O'Mahony M, O'Sullivan D. Urban freight in Dublin City Center, Ireland : Survey analysis and strategy evaluation. Transportation Research Record: Journal of the Transportation Research Board 2005.
- Organisation for Economic Co-operation and Development. Delivering the goods -21st century challenges to urban goods transport. Paris: OECD working group on urban freight logistics; 2003.
- Vermie T. ELCIDIS Electric vehicle city distribution final report. The Netherlands: City of Rotterdam; 2002.
- Sinarimbo NG, Takahashi Y, Hyodo T. Search for suitable urban freight distribution measures: the case of horizontal and vertical cooperative delivery system.
- Friesz TL, Holguín-Veras J. Dynamic game-Theoretic models of urban freight: Formulation and solution approach. In: Reggiani A., Schintler LA, editors. Methods and models in transport and telecommunications, Springer Berlin Heidelberg; 2005.
- Blandy R. The size, structure and growth of the City of Adelaide's economy together with prospects and strategic options for the future. City of Adelaide; 2008.
- Davidsson P, Henesey L, Ramstedt L, Tornquist J, Wernstedt F. An analysis of agent-based approaches to transport logistics. Transportation Research Part C 2005.
- Nenni, M.E.; Sforza, A.; Sterle, C. Sustainability-based review of urban freight models. Soft Comput. 2019.
- Visser, J.; Nemoto, T.; Browne, M. Home Delivery and the Impacts on Urban Freight Transport: A Review. Procedia Soc. Behav. Sci. 2014.
- ADB, 2011, Green Cities: Livable and Sustainable Cities in Asia, Manila.
- De Silva, Dimantha, 2017. Sustainable Urban Transport Index. Colombo, Sri Lanka Delhi Metro, 2016, Annual Report, 2015-2016.
- SG High-Level Advisory Group on Sustainable Transport, 2016, Mobilizing Sustainable Transport for Development.
- Methodology and indicator calculation method for sustainable urban mobility. Second Edition. Sustainable Mobility Project 2.
- Central Road Research Institute (1998), Estimation of Short Haul Urban and Suburban Freight Traffic, Study Report, New Delhi.
- Christiao Ambosinia, D. P.-L. (2010). Urban Freight Establishment & Tone Based Survey for Policy.

- Dablanc, L (2009) Freight Transport for Development Toolkit: Urban Freight-Freight Transport, a Key forthe New Urban Economy, World Bank, Washington, DC.

ANNEXURES 1

Survey Format

A. Survey Questionnaire for Urban Freight Stakeholders

PERSONAL DETAILS		
1. Your Neighbourhood	2. Profession	Please Tick:
a.	Transport Operator	
b.	Wholesaler	
c.	Retailer	
d.	Academic Expert	
e.	Citizen	
d.	Truck/LCV Driver	
e.	Others	
ATTITUDINAL ASPECTS		
3.	Are you aware about Urban freight (Goods Movement) in your city?	Yes/ No
4.	Are you concerned about the kinds of goods transportation activities that take place in or near your neighbourhood?	Yes/No
5.	How far do you stay from a freight-generating area (like a mandi/bazaar/warehouse/transport Nagar etc)?	<250m 250-500m 500-1km >1 km
6.	What is your perception on the impact of goods movement and deliveries on your quality of life (Rate on a scale of 1 to 5; 1 being worst,5 being best) (Tick one):	1 2 3 4 5
7.	What are the various issues related to urban freight movement in your neighbourhood?	
a.	Noise	

b.	Pollution	
c.	Traffic Congestion	
d.	Visual Distribution	
e.	Parking	
f.	Encroachment of LCVs and Trucks on road space	
g.	Safety Issue	
h.	Accidents	
i.	others	
8.	Are you aware about the concept of Sustainable Urban Transport?	Yes/No
9.	Are you concerned about the Sustainability of these goods' movement-related activities in your neighbourhood or city?	Yes/No
10.	Are you aware about any initiatives that have been taken for ensuring sustainable freight related activities? Are you aware about any initiatives that have been taken for ensuring sustainable freight related activities?	Yes/No
11.	Would you like to suggest any strategies for enhancing the sustainability of freight transport?	Yes/No

B. Survey Questionnaire for Transport Operators and Truck drivers.

PERSONAL DETAILS		
1.	Location of office/Parking area	
2.	Goods vehicle mode operated?	Tick any one
a.	Light Commercial Vehicle	
b.	Goods Rickshaw	
c.	2 Axle Truck	
d.	3 Axle Truck	
e.	Cycle Rickshaw	
f.	Hand Cart	
g.	Other	
3.	Area of Operation wrt. Office Location?	Tick any one
	< 5km	
	5-10km	

	10-15km	
	15-20km	
	>20km	
4.	Place of Parking at Night?	Please tick
	Roadside	
	Dedicated Parking Area	
	Other	
OPERATIONAL DETAILS		
5.	Tonnage carried per vehicle per day(tons)	Please tick
	< 1 ton/day	
	1-3 ton/day	
	3-5 ton/day	
	5-10 ton/day	
	>10 ton/day	
6.	Average distance moved per vehicle per day (km)	Please tick
	< 5km	
	5-10kmn	
	10-20km	
	20-40km	
	>40KM	
7.	Any Parking fees? If yes, how much per hour?	Please tick
8.	Fuel used in vehicle	
	Diesel	
	CNG	
	LPG	
	Electric	
	Other:	
9.	Average fuel consumption per day (litres)?	
10.	Average time taken for a single delivery (hrs)?	
11.	Average cost per trip.?	
12.	Average Idle time per trip?	
13.	Are any roads equipped with an Information system about Pollution (AQI) or Congestion levels?	Yes/No
14.	If yes, what % of roads, approximately?	
	< 5%	
	5-10%	
	10-20%	
	>20%	

ATTITUDINAL ASPECTS		
15.	Are you concerned about the sustainability of the city?	
16	Do you think these vehicles impact the sustainability of the city?	Yes /No
17.	Any issues faced? Please specify:	

C. Survey for Understanding Urban Freight in the Administrative Realm 5 (for Municipal officers, Traffic Police, BDA Officials, Experts)

PERSONAL DETAILS		
1. Profession		Tick any one
a.	Municipal	
b.	Traffic police	
c.	Smart city office Bhopal / BDA	
d.	Academic expert	
e.	Truck/LCV Driver	
f.	Other, Please Specify	
2.	Have you interacted with other people of the same domain to solve any kind of issue related to goods and vehicles? (traffic jams/parking parking-related issues, etc)?	Yes/No
3.	Have you taken up or seen any initiative being taken up for urban freight in the city?	Yes/No
4.	If no, then if such a situation arrives which emergency number will you call?	
5.	Do you have any idea about the budget allocation for urban freight in the Bhopal case? If yes, %?	
6.	Any suggestions to improve urban freight activities in Bhopal	

D. Survey from BMC and Bhopal Development Authority

PERSONAL DETAILS	
1. Profession	Tick any one
2. LAND USE AND INFRASTRUCTURE DETAILS	

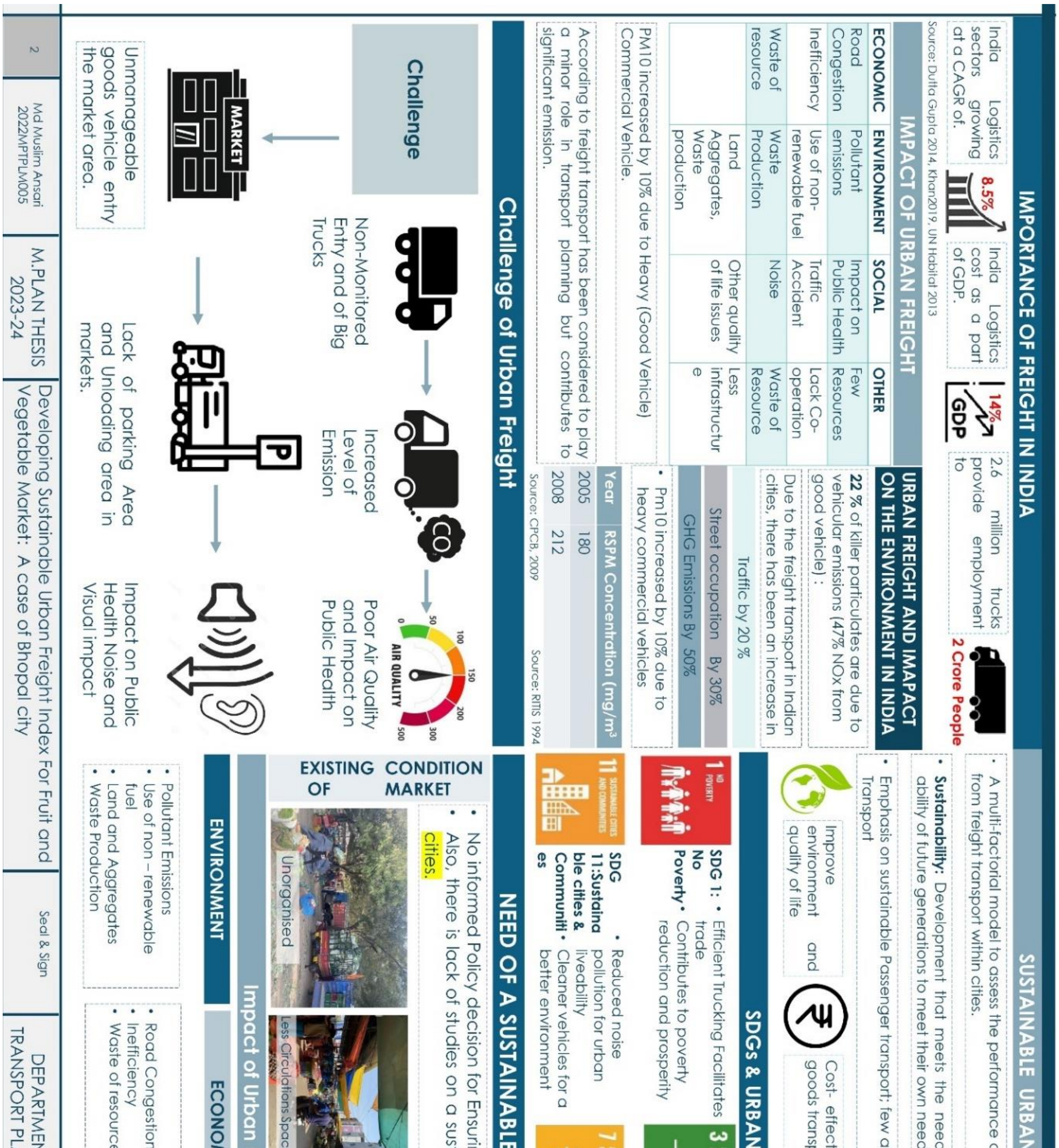
3.	Has Bhopal been planned for urban freight-related aspects?	
4.	Are the following planned, for Bhopal?	
a.	Warehouses	
b.	Wholesale Markets	
c.	Parking for Goods Vehicles	
d.	Consolidation centres	
e.	Loading/Unloading bays	
f.	Other, Please Specify	
g.	Heavy Vehicle Occupancy Lanes	
h.	Transport Nagars	
i.	IFCs	
f.	Night-tine Parking Place	
j.	Any other?	
5.	% Land which has been planned for Urban Freight in Bhopal	
6.	% Total parking in Delhi that is Available for Goods Vehicles in Bhopal?	
7.	Any suggestions to improve urban freight activities in Bhopal?	
8.	Any suggestions to improve urban freight activities in Bhopal	

E. Establishment Survey from Wholesalers/Retailers.

PERSONAL DETAILS		
1.	Commodity dealt with	Tick any one
2.	Location of shop	
3.	No. of employees/shop?	
4.	Modes visited by every day?	
a.	LCV	
b.	Goods Rickshaw	
c.	Cycle Rickshaw	
d.	Cycle Rickshaw	
e.	Hand Cart	
f.	Any other?	
OPERATIONAL DETAILS		
5.	Tonnage handled per day (in tons)	
6.	Do you have a Separate go down?	
7.	Do you have your own Parking Space?	
8.	What are the issues faced by the transport operators who visit you every day?	
a.	Traffic congestion	
b.	Parking issues	
c.	Delays	
d.	Infrastructure deficiency Pertaining to loading and unloading.	
e.	Restricted entry	
f.	Any other?	
9.	Any suggestion for handling goods vehicles in the market?	

Annexure

Annexure 1: Sheets



Annexure 2: Sheets

Literature review

S.N	Title of literature	Year	Author	Takeaway/key learning
1	Sustainable Urban Freight Initiative: A Collaborative Approach	2021	Teri, (EDF)	urban freight cost and emission reduction guidance facility
2	Urban freight transport from a local authority perspective	2013	Maria Lindholm	Freight transport has been considered to play a minor role in transport Planning, but contributes to significant emission
3	The Impact of Urban Freight Transport	2008	sonke behrends, johan woxenius	Freight transport, indicators, an indicator set is developed with the help of a matrix that connects actors and impacts
4	Smart city for sustainable urban freight logistics	2021	Shenle Pan, Wei Zhou, Selwyn Piramuthu	framework; sustainability perspective: social, economic, environmental.
5	An urban freight transport index	2010	José A. Romero	urban logistics, Loading /Unloading
6	Urban Freight Transport planning And Management	-	Dr Sanjay Gupta	On-street loading bays, Low emission zone, night Deliveries
7	Transport and Sustainable Development Goals	2013	Laetitia Dablanc, Genevieve Giuliano,	Truck fleet emission standards, low emission Zones,
8	Sustainability Framework for Assessing Urban Freight Transportation Measures	2018	Eftihia NATHANAIL1, Lambros MITROPOULOS	Safety and security, Living standards, Transportation system
9	A stakeholder-based methodology to enhance the success of urban freight transport measures in a multi-level governance context	2017	Sara Vermined, Koen Mommens,	Urban freight transport Sustainability Policy Stakeholder involvement MAMCA.
10	Developing a conceptual framework for the evaluation of urban freight distribution initiatives	2012	Jintawadee Suksri	Urban freight distribution; sustainability, conceptual framework.
11	Urban Freight Last Mile Logistics—Challenges and Opportunities to Improve Sustainability	2020	Article.	freight last mile logistics, LML sustainability; urban freight flow

Global Practices Sustainable Urban Freight Market

Barcelona, Spain

- Market communication strategies
- Consolidation of deliveries through an online system.

Suceava, Romania

- Usage Electric Vehicles for delivery
- 15 EVs bought and 24 Charging Points installed by Market Area.

East Street Market England

- Electric trolleys to transport goods.
- Time restriction Loading Bays

Lower Marsh Market, England

- Consolidation area for storage and deliveries
- Loading bays
- EV usage by the introduction of charging Point

Torino, Spain

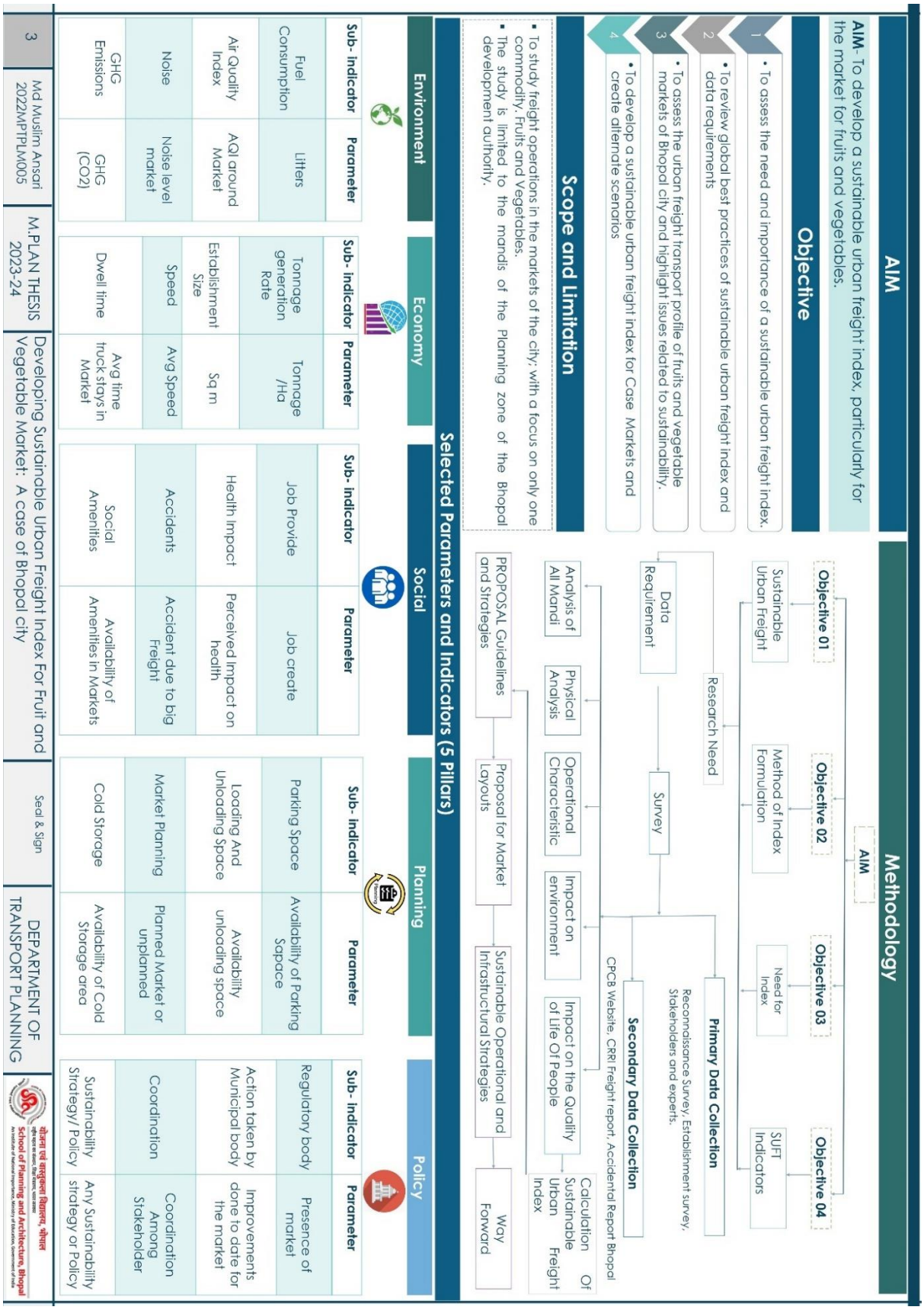
- FA Bene to reduce market waste
- People buy more and donate to LIG.

London, England

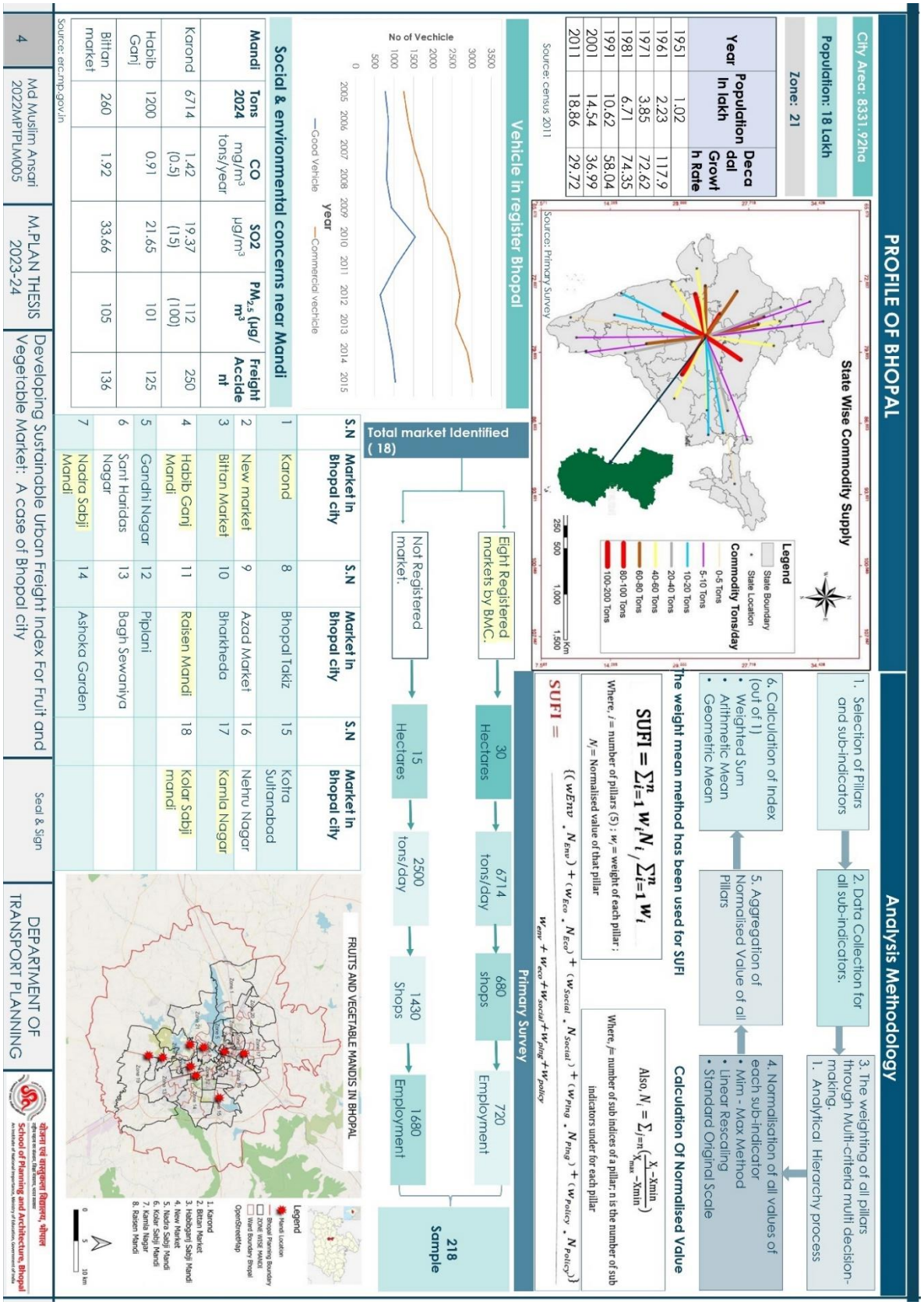
- Recycling and cold storage system
- Reduced carbon footprint due to cycle-based delivery.

2	Md Muslim Ansari 2022MPTPLM005	M.PLAN THESIS 2023-24	Developing Sustainable Urban Freight Index For Fruit and Vegetable Market: A case of Bhopal city	Seal & Sign	DEPARTMENT OF TRANSPORT PLANNING	योजना एवं वास्तुकला विद्यालय, भोपाल School of Planning and Architecture, Bhopal

Annexure 3: Sheets



Annexure 4: Sheets



Annexure 5: Sheets

CHALLENGES RELATED TO FRUIT AND VEGETABLE IN All MANDIS OF BHOPAL

1. **Fragmented Supply** Chain issues
2. Infrastructure issues
3. Packaging Issues
4. **Supply chain** efficiency issues
5. Cold Chain issue
6. Transportation issues
7. Integration issues
8. Technology issues
9. **Information and Communication** issues

Impact efficiency of operation of the mandi

↓

Loss of Fruits and Vegetables due to storage issues

↓

Impact on air quality due to mass movement of **Big Truck**

↓

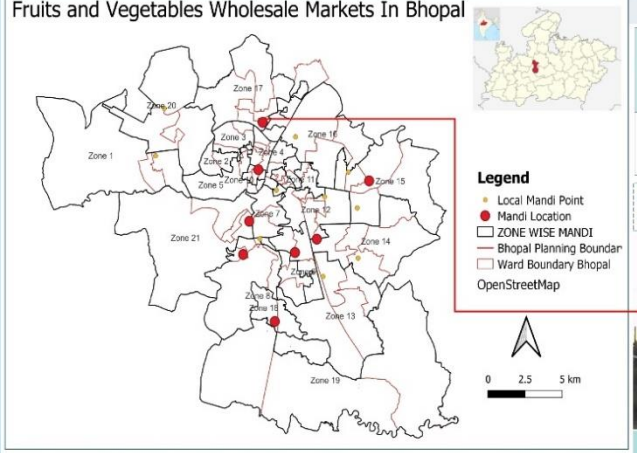
Need to Monitor Mandis impact and ensure Sustainable operations

Source : Multiple reports

Location of fruits and vegetable Mandi

Markets	No of Sample	Area(Ha)	Est no of Shops	Shops density shops /ha)	Jobs	Tonnage Inflow Daily 2024	Tonnage handled per ha
Karond	65	25	380	15	375	6714	268
Bittan Market	38	1.34	80	59	160	260	194
Habibganj	25	1.64	40	24	120	1200	731
Nadra sabzi ma	30	0.6	30	50	90	452	753
Nehru Nagar	15	0.17	25	147	105	60	352
New Mamrket	23	0.84	60	71	120	50	59
Kolar Sabji Man	12	0.62	40	62	120	90	140
Raisen mandi	10	0.54	25	46	75	125	231
Total	**218**	**30.75**	**680**	**474**	**1165**	**8951**	**2728**

Fruits and Vegetables Wholesale Markets In Bhopal

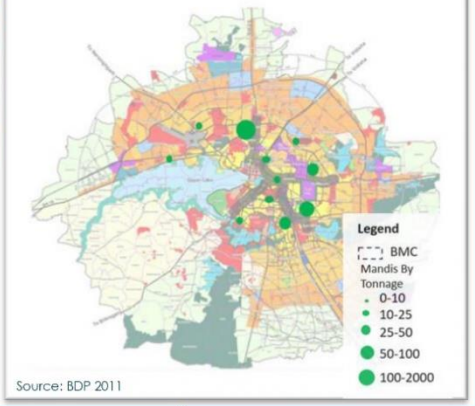


Location of Mandi

Location in Zone 17	Abutting Road	Abutting Residential Area	Daily tonnage inflow (tons)	Operation timings
Karond Mandi	18M	Viskamram Nagar, Janta Nagar	6714	11 pm- 6 am

- Entry of Unloading vehicles: Start at 11 pm and then at 4 am.
- Entry of Loading vehicle: 4 am -7 am.

Market Categorised by Daily Tonnage Inflow(2024)



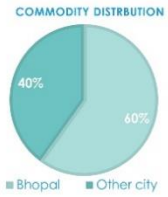
Agricultural Produce Marketing Committees

Functions
- Regulate operations of food-based mandis
- Connect the farmer with the commission agents.

GAP absence of Proper planning of Markets

FACILITY

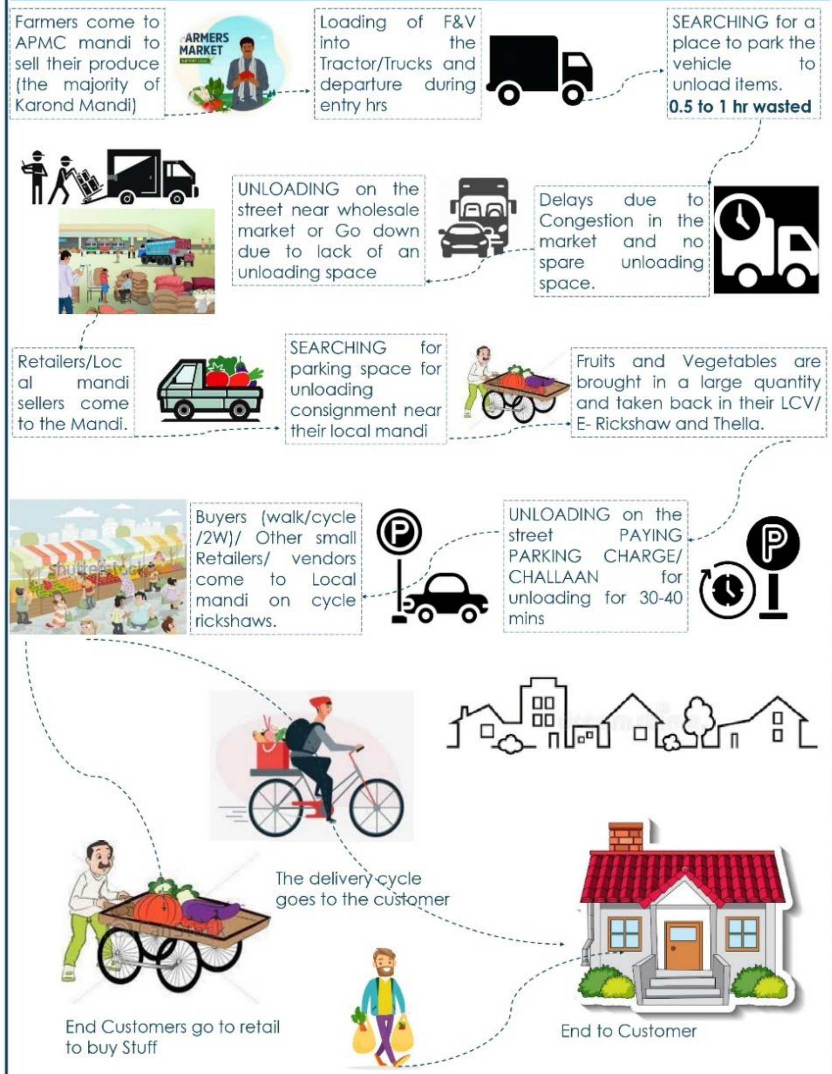
Facility	Availability
Drinking water	Yes
Toilet	No
Cover sheds	yes
Police Chowki	No
ATM	No
Post office	No
Medical Facility	No
Parking restrictions	yes
Cold Storage	No



5	Md Muslim Ansari 2022MPTPLM005	M.PLAN THESIS 2023-24	Developing Sustainable Urban Freight Index For Fruit and Vegetable Market: A case of Bhopal city	Seal & Sign	DEPARTMENT OF TRANSPORT PLANNING	योजना एवं वास्तुकला विद्यालय, भोपाल School of Planning and Architecture, Bhopal

Annexure 6: Sheets

JOURNEY OF A COMMODITY FROM THE FARMER TO THE CUSTOMER



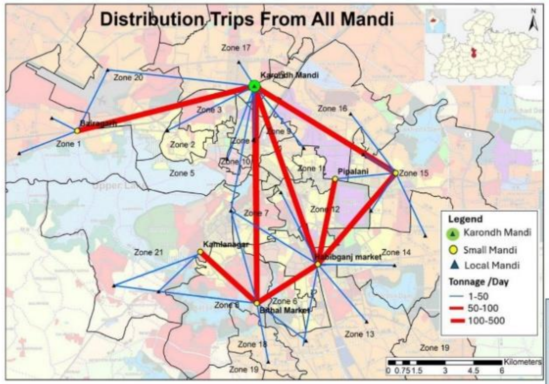
ISSUES FACED AT EACH LEG OF THIS PROCESS

Farmer to city Outer cordon	City outer cordon to wholesaler/ warehouse	Wholesaler/warehouse to retailer	Retailer to End Customers	Government Authorities
• Entry restriction for a heavy vehicle. • Loss of time and money.	• Entry restriction at a certain time. • Entry fees. • Parking fee.	• Freight vehicle movement restrictions • Wasting of time • On-street parking leading to Challans.	• Entry restrictions in residential colonies • Empty vehicle return trip which is cost intensive.	• No system to track goods vehicle movement at various times of the day. • Lack of Vacant govt land to provide for goods vehicle parking

PLANNING ISSUE

Location	Availability of social amenities	Availability of Cold storage	Availability of Unloading space	Availability of Goods vehicle parking
Karond	No	No	Yes	No
Habib Ganj	No	No	No	No
Bitten	Yes	No	No	No
Nadra Bus stand	No	No	No	No

Karondh Mandi Commodity Distribution



- **Karondh Mandi** has the highest catchment area, is as far as 3 Km
- **Habib Ganj mandi** has a smaller catchment (4 Km), and **Bitathal market** has a maximum of up to 2 Km.

Source: Authors

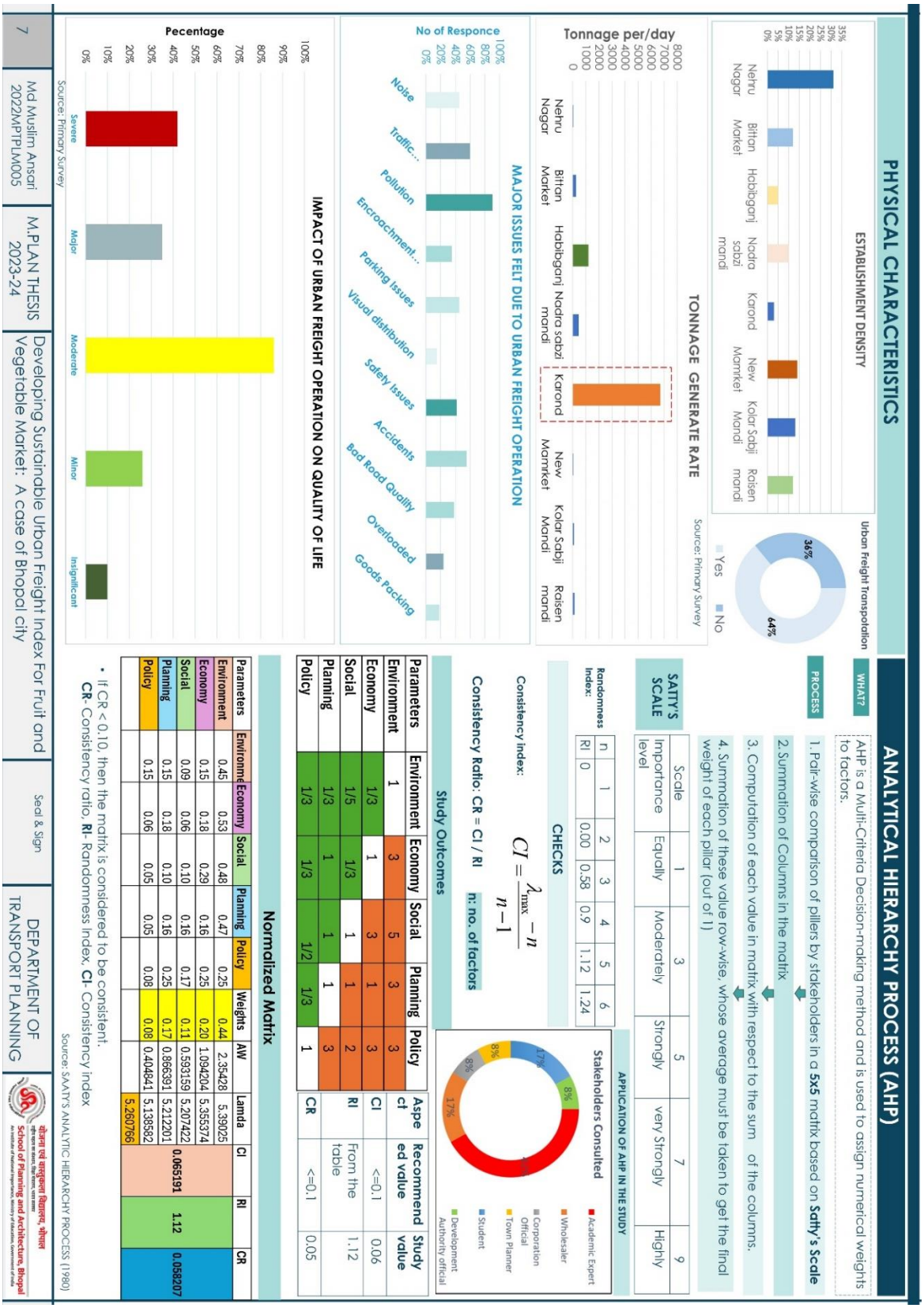
ISSUES (due to distribution Pattern)

- High Vehicle-Km
- Usage of Motorised Mode (as longer leads)
- Increased GHG Emissions
- Increased Fuel Consumption
- Increased Delays

Road types General	Average speed(kmph)	Street Space taken for parking	Delays
Sub Arterial	30	25%	Major
Collector	20	40%	No delay
Local	15	32%	Delay

6	Md Muslim Ansari 2022MPTPLM005	M.PLAN THESIS 2023-24	Developing Sustainable Urban Freight Index For Fruit and Vegetable Market: A case of Bhopal city	Seal & Sign	DEPARTMENT OF TRANSPORT PLANNING	योजना एवं वास्तुकला विद्यालय, भोपाल School of Planning and Architecture, Bhopal

Annexure 7: Sheets



Annexure 8: Sheets

Environment

Indicators	Value	Min	Max
AQI (ug/m3)	112	0	115
Noise(dB)	76	80	50
GHG(MTCO2e)	1924	3682.06	0
Fuel - Consumption(km/L)	30	70	15

Economy

Indicators	Value	Min	Max
Tonnage Gen, rate	600	800	300
Establishment	40	40	80
Average Speed around Market	14	25	30
Average Dwell time	28	10	0
Street Parking Space	60	20	10
Total	**728**	**895**	**420**

Social

Indicators	Value	Min	Max
Jobs	280	0	1500
Health impact	2	1	5
Impact on Quality of Life	3	1	5
Freight related Accidents	13.46	10.59	0
Social Amenities	1	0	5
Total	**299.46**	**12.59**	**1515**

Planning

Indicators	Value	Min	Max
Availability of parking Space for freight Vehicles	3	0	5
Loading and Unloading Spaces	0	0	5
Market is Planned /unplanned	3	0	5
Available of Cold Storage area	0	0	5
Total	**6**	**0**	**20**

Policy

Indicators	Value	Min	Max
Regulatory Body	5	0	5
Action taken by Municipal Body	1	0	5
Coordinate among Stakeholders	0	0	5
Presence of Sustainability strategy Policy	0	0	5
Total	**6**	**0**	**20**

Normalized Value each Pillar

Parameters	Normalized value
Environment	0.54
Economy	0.64
Social	0.8
Planning	0.7
Policy	0.7

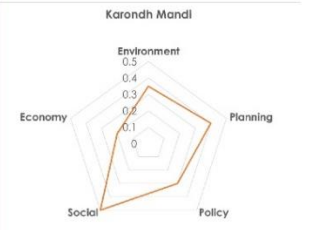
Weighted Mean Method

Parameters	Weight (Overall)	Index
Environment	15%	15%*0.54 + 32%*0.64+ 5%*0.8+ 21%*0.7+ 27%*0.7= 0.6
Economy	32%	
Social	5%	
Planning	21%	
Policy	27%	

Minimum & Maximum Values:
Minimum and max value in all the markets.
Normalized based on Min- Max
Normalisation giving a result **out of 1**

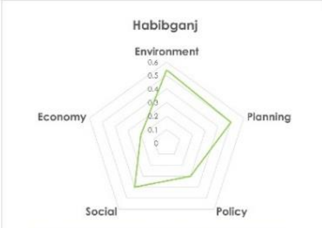
N_{env} = (2142-180)/(3697.06-180)= 0.54

Normalized value of environment of **Karond Mandi**

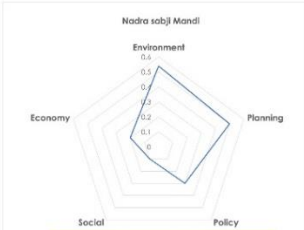


SUFI= 0.35

SUFI=0.62

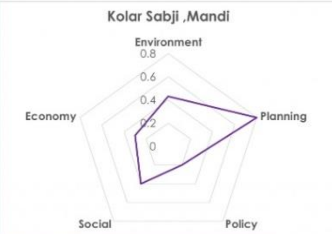


SUFI= 0.54



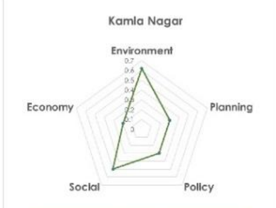
SUFI= 0.52

SUFI=0.42



SUFI= 0.43

SUFI=0.59



SUFI= 0.62

INDEX INTERPRETATION (GIVEN BY AUTHORS)

SUFI Value	Interpretation
<0.2	Worst
0.2-0.4	Bad
0.4-0.6	Satisfactory
0.6-0.8	Good
0.8-1	Best

8	Md Muslim Ansari 2022MPTPLM005	M.PLAN THESIS 2023-24	Developing Sustainable Urban Freight Index For Fruit and Vegetable Market: A case of Bhopal city	Seal & Sign	DEPARTMENT OF TRANSPORT PLANNING	योजना एवं वास्तुकला विद्यालय, भोपाल School of Planning and Architecture, Bhopal

Annexure 9: Sheets

PROPOSAL	
Environment	Excess tonnage arrives in the market
	Noise due to mandi Operations
	Wastage of Fruits and Vegetables
	Polluting incoming vehicle
Economic	Congestion and poor circulation
	Higher tonnage generation rate
	Excess Loading time
	Higher distribution leads
Social	Lack of social amenities
	Safety and security issues
	Impact of quality of life of people near mandi

CONCEPT OF SUSTAINABLE STRATEGIES

TIME	SHORT TERM (<5 YEARS)	MEDIUM TERM (5-10 TERM)	LONG TERM
THEME	GREEN MODES	STORAGE AND AMENITIES	NEW PLANNED MANDI

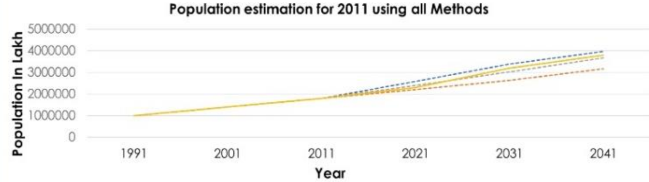
		SHORT	MEDIUM	LONG
Planning	Poor layout design	• Replacement of LCVs by E-LCVs • Change in Modal mix • Change in inflow lead	• Introduction of cold storage facility.	• Introduction of new mandi in unserved area400 tons/ha
	Lack of Proper unloading spaces Parking"	• Green mode-based distribution only • Change in flow lead (inflow only from Mandi)	• Introduction of cold storage facility. • Development of social amenities	• Uptake of sustainable strategies (Charging facility , waste to energy Plant)
Policy	Poor Management Lack of sustainability Lack of proper unloading space &parking space		• Introduction of cold storage facility. • Regulatory Body	• Replacing of shops • Initiatives by ULB

POPULATION PROJECTION METHODS

Method type	Method	Population estimated for 2041	Actual 2011 population in Lakh
Core Method	Arithmetic Method	28,32,503	17,98,218
	Geometric Method	34,89,850	
	Incremental Increased Method	35,29,225	

Market	SUFI			
	BAU 2041	Short Term 2029	Medium Term 2035	Long Term 2041
Karond	0.35	0.58	0.63	0.81
Bitten Market	0.62	0.59	0.65	0.93
New Market	0.59	0.54	0.72	0.84
Habibganj Market	0.54	0.56	0.71	0.81
Nadra Mandi	0.42	0.59	0.66	0.86
Kamla Nagar	0.62	0.51	0.65	0.91
Raisen Mandi	0.52	0.54	0.68	0.95
Kolar Mandi	0.43	0.53	0.71	0.87

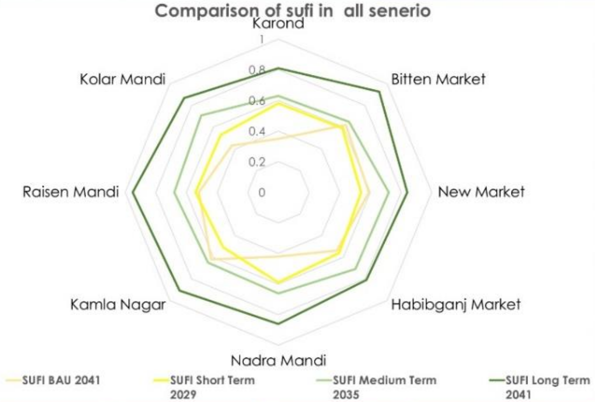
Population estimation for 2011 using all Methods



Source : BDP 2005

Year	Population	AVAILABLE		REQUIRED		GAP	
		No of Mandis Available as of 2023	Area (ha)	No of mandis required	Area (ha)	No of mandis	Area (ha)
2021	2358689	8	30	8	35	2	5
2031	2958643	8	30	12	40	4	10
2041	3569046	8	30	14	45	6	15

Comparison of sufi in all senerio



Inferences

- Lack /of Literature of the development of a sustainable Urban freight Index for Fruits and vegetable markets.

Alternate Scenarios.

- Short-term Strategies: 8 %
- Medium Term Strategies: 25%
- Long term strategies: 60%

- Short-term Strategies are beneficial for mandis handling huge quantum of tonnage.
- Medium-term strategies are beneficial for all mandis.
- Long Term Strategies benefit all the mandis Sustainable by more than 50%.

9	Md Muslim Ansari 2022MPTPLM005	M.PLAN THESIS 2023-24	Developing Sustainable Urban Freight Index For Fruit and Vegetable Market: A case of Bhopal city	Seal & Sign	DEPARTMENT OF TRANSPORT PLANNING	योजना एवं वास्तुकला विद्यालय, भोपाल School of Planning and Architecture, Bhopal

Annexure 10: Sheets