

Urban Sprawl Modelling and Commuting Pattern- Delhi Gurgaon Corridor: A Sustainable Growth

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ABSTRACT

The Paper is based on findings of the Minor Research Project entitled "Urban Sprawl Modelling & Commuting Pattern- Delhi Gurgaon Corridor: A Sustainable Growth" sanctioned by Research & Innovation Cell, Shivaji College, University of Delhi, India (March 2023 to March 2024). It has been completed under the supervision of Dr. Lalita Rana, Department of Geography, Shivaji College and Dr. Rashmi Singh, Department of Geography, Miranda House, University of Delhi. The project is a collective endeavour, also involving seven Student members from B.A. Hons., Second Year, Department of Geography, Shivaji College, viz. Anish Tiwary, Nivedita, Jhilmil Verma, Inika Garg, Kajal Chaudhary, Dildar Ali and Srishti Maini.

Plate-0.1: The Project Team

The Project is based largely on the primary data gathered through Structured Questionnaire, covering 121 Respondents. The information used from Secondary sources is duly acknowledged in the work.

A sincere appreciation is on record for Delhi Metro Rail Corporation (DMRC), National Social Science Documentation Centre (NASSDOC), National Highways Authority of India (NHAI), Delhi Transport Corporation (DTC), Rattan Tata Library (RTL) and the offices of several Metro Stations for laying at disposal the relevant information and data and bibliography required for the Project.

The Paper is presented in Seven Chapters. The First chapter is introductory focusing on Statement of the Problem, Research Objectives, Research Methodology, Conceptual Framework and Literature Review. The Second deals with the Study Area, its Location & Physical Setting, Socio-Economic Characteristics and Major Corridors of Movement. The Third chapter highlights

the nature of Commuters on Delhi- Gurgaon Corridor in terms of Age, Gender, Marital Status, Qualification, Place of Residence, Occupation and Location of Workplace. The emphasis of Fourth chapter is on Commuting Pattern studied on the basis of Distance between Place of Work and Residence, Transport Network Used, Mode of Commuting, Frequency of Trips, Time Involved in Travel and Expenditure on Travel. Subsequent sections of this analysis delve into the plausible implications of the findings, exploring contributing factors to these discerned patterns and examining the broader ramifications for transportation planning and service provisioning within the surveyed areas. Various Environmental, Socio-Economic and Administrative challenges and remedies related to commuting are identified in Fifth chapter. It is followed by a discussion on Future Prospects, and lastly the Conclusion.



CHAPTER 1

INTRODUCTION

Delhi, the capital of India, has been ceaselessly growing after Independence. The increased concentration of people and activities here has led to the formulation of several successive Master Plans and a National Capital Regional Plan for it. According to the National Capital Region Planning Board Act 1985, the National Capital Territory of Delhi and a number of Satellite Towns from the adjoining states of Uttar Pradesh, Haryana and Rajasthan comprise of the National Capital Region (NCR) of India. Besides Delhi, they include, for instance, Faridabad,

Gurugram (Gurgaon), Nuh, Rohtak, Sonapat, Rewari, Jhajjar, Gurugram, Panipat, Palwal, Bhiwani, Charkhi Dadri, Mahendragarh, Jind and Karnal.

The project examines the relationship between Urban Sprawl and Commuting pattern on an urban corridor formed between Delhi and Gurgaon, and accounts for the different attributes of Vehicular Commuting in a part of the Metropolitan region of Delhi. Particularly the Reverse Commuting from Delhi to Gurgaon is under the study. The present project explores the issues related to urban sprawl and commuting in Delhi-Gurgaon corridor of NCT of Delhi considering Delhi as the Point of Origin and Gurgaon as that of Destination. The observations are based on 121 Respondents.

This study will help to evaluate the urban development policy tools in terms of commuters' behaviour. The proposed study of Delhi-Gurgaon Corridor would illustrate the spatial dimensions of this process of land use change and resultant mobility (commuting), with the partial fulfilment of the objectives of Sustainable Development Goal.

Statement of Problem

Urban sprawl has become a remarkable characteristic of urban development in the last few decades. The major elements of urban sprawl are metropolitan expansion and work facilities in suburban areas. Resultantly, present-day cities are pushing out their original boundaries by way of spatial spread geographically. This is followed by the linear development of transport routes linking the city with its surrounding region, thus forming a corridor of movement. Such urban corridors are experiencing the fastest growth rates and the most rapid urban transformation. Urban sprawl is the uncontrolled expansion of urban areas. It is a multi-faceted concept centred on the expansion of auto-oriented, low-density development. With the massive expansion of suburbs over the past few decades, it is becoming an increasingly common phenomenon throughout the developed and developing worlds alike. The nations are facing new challenges as their cities grow in size and in population. Delhi, the capital of India, ceaselessly growing after Independence with the increased concentration of people and activities, is not an exception.

Conceptual Framework

Urban sprawl is a temporal and spatial (geographical) dimension of the process of land use transformation. There is an interrelationship between the urban sprawl and patterns of commuting to the city, facilitating particularly the journey to work. Urban sprawl has become a remarkable characteristic of urban development in the last few decades. The major elements of urban sprawl are metropolitan expansion and work facilities in suburban areas. Resultantly, present-day cities are pushing out their original boundaries by way of spatial spread geographically. This is followed by the linear development of transport routes linking the city

with its surrounding region, thus forming a corridor of movement. Such urban corridors are experiencing the fastest growth rates and the most rapid urban transformation. The nations are facing new challenges as their cities grow in size and in population. This reflects in the Agenda for Sustainable Development, and the goals (SDG 11) contained within it. Sustainable Development Goal-11 aims to renew and plan cities and other human settlements in a way that offers opportunities for all, with access to basic services, energy, housing, transportation and green public spaces, while reducing resource use and environmental impact. Transportation is a key development issue and Target 11.2 is important to achieve safe, resilient, and sustainable cities.

Urban Sprawl not only involves the commuting from the suburb to the main city, but also the 'Reverse Commuting' to suburbs. Both the forms of commuting, Pedestrian and Vehicular, have appeared in the scene. However, the urban growth largely exhibits a high dependency on automobiles for transportation, a condition known as automobile-dependency. Because, the sprawling patterns create large distances between dwelling units and workplaces, segregating different land uses, the residents are forced to rely on automobiles at the cost of alternate means of transportation. The automobile dependency, in turn, is closely associated to job- sprawl, i.e., geographically spread-out patterns of employment, when the majority of jobs in a given metropolitan area are located outside the main city, and increasingly in the suburban periphery.

Research Objectives

Objectives of Study:

- Development of an insight into the commuting behaviour of the users of corridor;
- Determination of the limits of sprawl on Delhi-Gurgaon corridor on the basis of physical extent of commuting;
- Mapping the limits of urban sprawl on the basis of Reverse Commuting from the city to its periphery
- Measuring the Density Gradient outward from the city centre;
- Identification of major transit routes on Delhi-Gurgaon Corridor;
- Identification of the purpose, forms and means of commuting between the city (Delhi) and the suburb (Gurgaon);
- Studying the impact of commuting on the commuters' day-to-day life;
- Assessing the socio- economic impacts of commuting;

- Modelling the development based on urban sprawl and commuting behaviour, and
- Offering possible solutions projecting development on sustainable basis, in the light of SDG-11.

Research Methodology

Following are the action steps in the sequence needed to complete this project.

1. Review of Literature and creation of Bibliography;
2. Procuring data on Commuters from the point of Origin, Delhi, from the secondary sources'
3. Preparation of Questionnaire for Field Survey;
4. Representation of Data using Maps and various Cartographic Techniques as Pie-Charts, Line Graphs, Bar Diagrams, etc supported by Tables, Satellite Imageries and Photographs.
5. Data Processing & Analysis; and
6. Report Writing



Plate- 1.1: Collecting information from commuters

- The findings of Project are derived mainly from the primary sources of information, which include empirical observation and questionnaires-based interviews (Personal/ Telephonic/E-mail).



Plate- 1.2: Collecting information at IFFCO Chowk Metro Station

- The behavioural responses of commuters between the Place of origin and destination have been studied on the basis of the parameters like: Flow-Network, Mode-Choice, Travel-Distance, Time, Cost and Frequency determine the Urban Communication. The data for these have been derived from primary and secondary sources both.
- The Respondents have been divided in two categories, viz. the Commuters, and the Officials (employed with Corporate Sector Enterprises/Transport Planning Authorities at both the ends). This information has been derived on the basis of the following queries:
 1. Respondent: Name, Category (commuter/official), Age, Sex, Qualification, Place of Residence, Place of Work.
 2. Causes of Relocation in the periphery
 3. Mode of Commuting (Journey): Private/Public
 4. Commuting: Purpose, Involved Time/ Distance / cost, Number of Trips per Day/Week/Month,
 5. Level of satisfaction in terms of journey, and the problems encountered: Jams and delays, wear and tear of vehicle, freedom of mobility, etc.; and
 6. Possible solutions.
 7. Awareness towards Sustainable Development Goal, particularly SDG-11.



Plate- 1.3: Extracting highlights from Delhi Masterplan 2021

Literature Review

A significant increase in reverse commuting with residents from metropolitan core commuting towards peripheral municipalities and it even underscore the traditional commuting has been discovered. The public transport system in Gurgaon, India, mainly consists of auto rickshaws and buses. Several field studies have been conducted to understand and improve the public transport system, including surveys on bus stops, passenger boarding and alighting, auto rickshaw operators, and user attitudes (Sanjay (Gupta & Sujata Savant, 2008). The low reliability, comfort, safety, and security of Indian public transport services is leading to a shift towards private car use. To combat this, Bus Rapid Transit Systems (BRTs) have been planned in various Indian cities over the past decade. (Geetam Tiwari and Deepty Jain, 2010). Short trips are common in urban areas with a high share of minorities and illiteracy rates, while intermediate and long trips are prevalent in rural areas. Long trips are undertaken by public transport, while intermediate trips are by two-wheelers and buses, and short trips are on foot and by bicycle. It is recommended to reduce long commuting distances by promoting public transport and establishing a unified regional transportation authority (Manisha Jain & Robert Hecht (Dec, 2019).

The studies reveal several problems, including poor travel conditions, faulty auto route networks, high transport expenditure, limited public transport operation, and overcrowding. These problems result in spatial inequities in public transport provision, which lead to increased use of personalized modes of travel, fuel consumption, and congestion. The increasing vehicle growth in Haryana state due to rising population and migration has created excessive burden on the road

network and infrastructure, leading to pollution, energy consumption, congestion, and accidents. Public transport is an important solution to this problem, but poor service quality has led to a decline in ridership. Passengers' perceptions of service quality, including reliability, frequency, safety, comfort, staff behaviour, and cost, are important factors in attracting riders to public transport. The success of public transport policy depends on ensuring public benefits before its implementation. Upgrading transport infrastructure and providing reliable, efficient, and affordable public transport are essential steps (Seema Jain, Dec, 2021). To address these issues, several measures are suggested, such as reorganizing auto rickshaw operations, bringing auto rickshaws under cooperatives, rationalizing auto rickshaw route networks, and incentivizing auto rickshaw operators to replace their vehicles with standard/mini buses on major travel corridors. The National Urban Transport Policy in India has been criticized for its shortcomings, including land use planning not allowing lower-income groups to live closer to work, road use being dominated by private vehicles, and insufficient funding for pedestrian and bicyclist facilities. It is suggested to maintain 70% non-personal transport share as incomes increase, requiring safer walking and bicycling, and making public transport more attractive (Dinesh Mohan, November, 30, 2013).

The importance of meeting the needs of non-motorized traffic in urban areas for sustainable transport systems has been recognised (Dinesh Mohan and Geetam Tiwari, (Jun. 19-25, 1999, pp. 1589-1596). Redesigning existing roads can provide a safer environment, improved vehicle efficiency, and improved mobility on the corridor, thereby enhancing the overall transport capacity.

Delhi's roads are facing increasing pressure, necessitating curbing private vehicle use and promoting public transport. Importing traffic-restraint policies could help, while a policy package focusing on ring railway expansion is being considered (Sanjay Mishra, Jun. 10-16, 2000).

The 3D dynamic geo-visualisation models help understand urban land changes and contribute to spatiotemporal representation of land use processes. They integrate temporal, spatial, and geographic dimensions, facilitating understanding of urbanization and land use transformations. These models are crucial for land management, planning, and monitoring future needs (Sébastien Gadal, Stéphane Fournier and Emeric Prouteau 2009).

The significance of Delhi and Gurgaon as key metropolitan centres and the major roads routes that connect them are also covered in the Delhi master plan (**Delhi Master Plan, 2021, chapter 12**). It contains get insights of all the policy and objectives and set forth and managed to carry out by the city government, as well as the obstacles encountered in carrying out the policies.

CHAPTER -2

STUDY AREA

Two Cities, namely, Delhi and Gurgaon, constitute the Study Area, both being part of a bigger region, NCR (National Capital Region). This chapter talks about the physical setting (topography, natural surroundings), and socioeconomic characteristics of Delhi and Gurgaon. Also included in discussion is the significance of Delhi and Gurgaon as key metropolitan centres and major corridors of movement between the two. The Land Use and Land Cover of the region has shown a remarkable extension and change over the years (Plates 1 and 2).

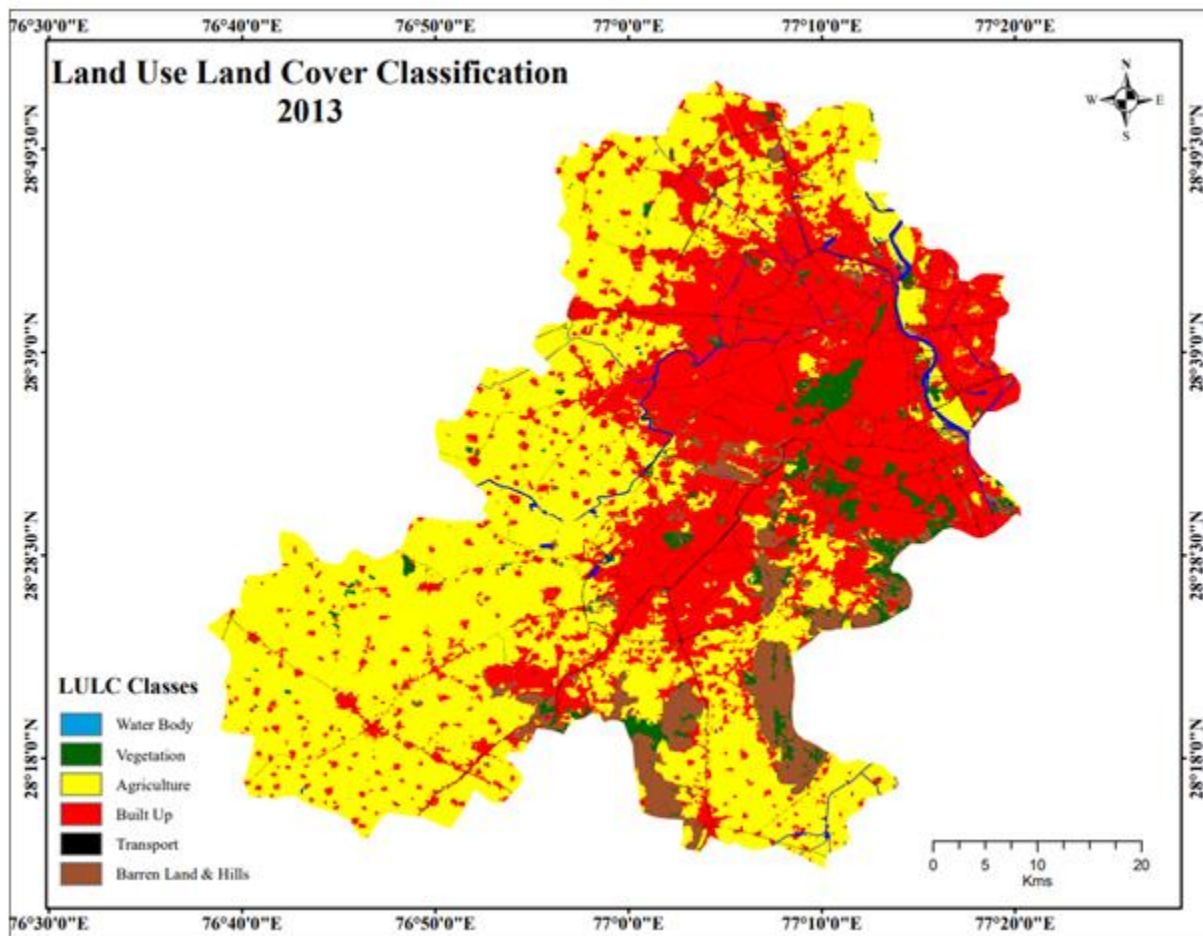


Plate-2.1: Delhi-Gurgaon: Land use land cover classification (2013)

According to the figure, the region comprising Delhi and Gurugram depicts a significant blend of agricultural and urban features. Approximately half of the area is dedicated to agriculture, primarily in the western sector covering much of Gurugram. Gurugram experienced substantial

agricultural activity until 2013, as it was still developing within the NCR (National Capital Region), with agriculture serving as a primary economic driver. The transport network looks well connected and dense. Natural vegetation is scattered in patches across the middle and eastern portions of the region, particularly in the lower reaches of Delhi. Also, the lower areas of Delhi and the south eastern region of Gurugram display barren land and hills, interspersed with smaller patches of natural vegetation. Additionally, a drain can be observed in the central part of the region, influencing its hydrology and land use patterns.

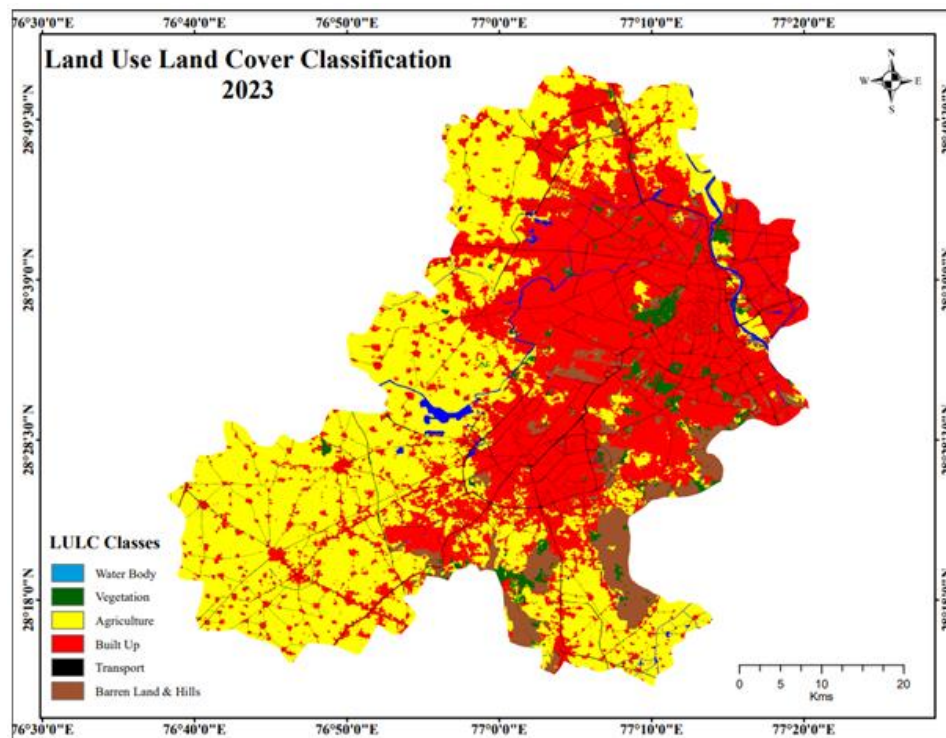


Plate-2.2: Land use land cover classification (2023)

The fundamental landscape of Delhi and Gurugram appears to have remained largely consistent with that of 2013, as indicated by the imagery. A little less than 50% of the total area is still dedicated to agricultural use, while noticeable changes have occurred in urban features. Plate 2.2, depicting the situation in 2023, suggests an expansion and enhancement of built-up areas, particularly in Gurugram, which has experienced rapid development over the past decade. Similarly, the transportation network appears denser compared to 2013, indicating infrastructural growth. These developments have led to a reduction in the size of vegetative patches, with the area drained appearing thicker in the western part of the region. There seems to be little to no change in the distribution of barren land and hills.

Location & Physical Setting

Gurgaon, officially known as Gurugram, is a satellite city located in the North Indian state of Haryana. It is situated in the National Capital Region (NCR) and is a part of the larger metropolitan area of Delhi. Gurgaon is India's 2nd largest information technology hub and 3rd largest financial and banking hub. Gurgaon is also home to one of India's largest medical tourism industries.

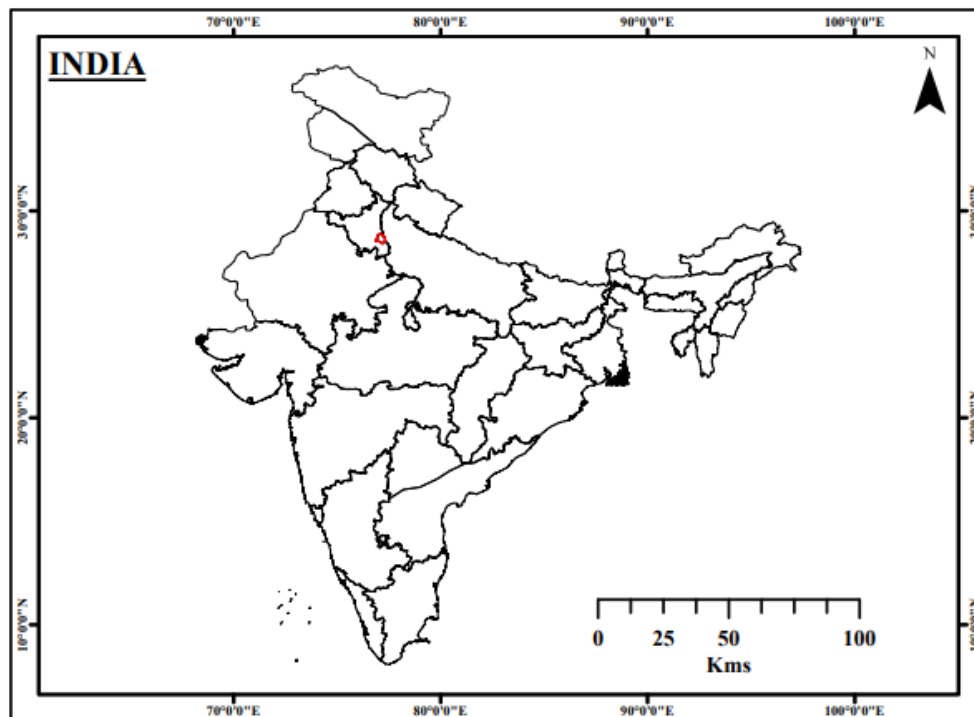


Figure 2.1: Location of Study Area in National Context

Gurgaon is located in Gurgaon district in the Indian state of Haryana and is situated in the south-eastern part of the state. Characterised by a relatively flat topography with some undulating terrain. The city is part of the fertile plains of the Yamuna River. Gurgaon is bounded by the district Jhajjar and New Delhi in North, Faridabad in its east side, and shares the district boundaries with the Mewat District, Rajasthan, on its south. Gurgaon is situated on the northern edge of Aravali Mountain range. Gurgaon district is further divided into 3 sub-divisions: Gurgaon North, Gurgaon South, and Pataudi.

Gurgaon is located in India with the GPS coordinates of 28° 26' 20.076" N and 77° 0' 21.312 E. It is precisely mapped in the UTM coordinate system, located in zone 43R. Its UTM Northing coordinate is 3156045.8003609, and the UTM Easting coordinate is 990529.23952453,

providing a detailed and specific location within the global grid. Gurgaon experiences a climate typical of the Indian subcontinent, with hot summers, monsoon rains during the months of July to September, and cool winters. Summers can be quite hot, with temperatures often exceeding 40 degrees Celsius (104 degrees Fahrenheit), while winters are relatively mild and cool. The mean yearly temperature observed in Gurgaon is recorded to be 24.9 degree Celsius. Precipitation here is about 670mm. The natural vegetation in and around Gurgaon is influenced by its location in the arid to semi-arid region. The region has some native shrubs and grasses, but urbanisation and development have significantly altered the natural landscape. It also consists of Aravali Biodiversity Park, Gurgaon which spreads over 153.7 hectares. The natural vegetation falls within the Northern Tropical Dry deciduous forest and Northern Tropical Thorn Forest. Species including, *Anogeissus pendula* and *Boswellia*. The fauna includes golden jackal, Indian hare, common palm civet, and Indian grey mongoose.

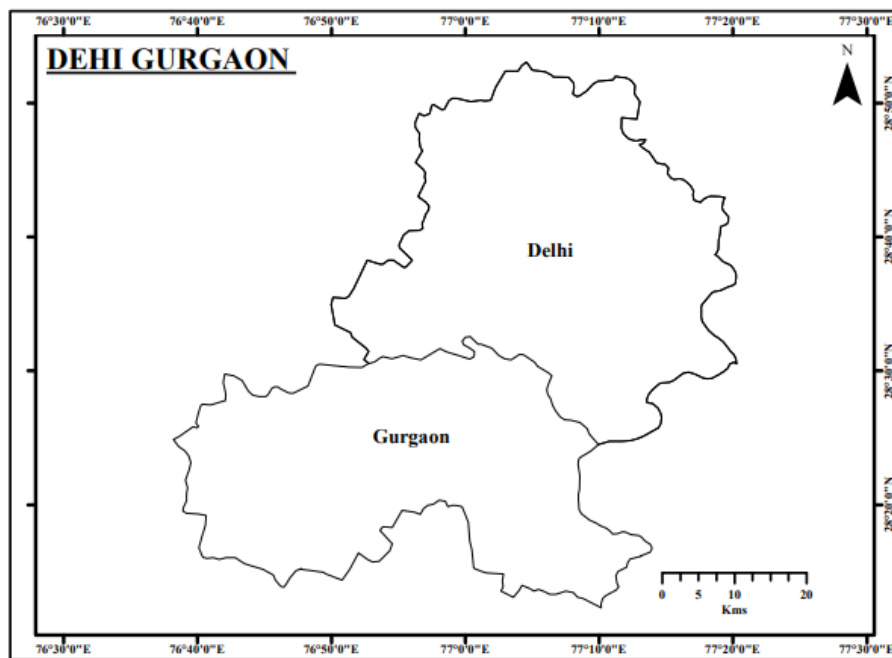


Figure 2.2: Delhi-Gurgaon Region

Socio-Economic Characteristics

Delhi

Delhi is known for its cultural and ethnic diversity. People from different parts of India and the world have migrated to Delhi, creating a cosmopolitan society. The national capital ranks third in terms of per capita income behind Sikkim and Goa, according to the Economic Survey of Delhi

2021-22. Delhi's per capita income grew 16.81% year-on-year to Rs 4, 01,982 in fiscal 2021-22 as against Rs 3, 44,136 during 2020-21. The bulk of Delhi's working population is engaged in trade, finance, public administration, professional services, and various community, personal, and social services. Indeed, for many centuries Old Delhi has been a dominant trading and commercial centre in northern India. Since the 1990s New Delhi has emerged as an important node in the international corporate and financial network. Nested in different layers of administrative and planning regions, Delhi consists of both the urban agglomeration and more than 200 villages distributed mostly across the Delhi and Mehrauli *tehsils* (sub-districts) of the territory. At the macro level, Delhi is part of the National Capital Region (NCR), a planning region carved out in 1971 by the Town and Country Planning Organisation to guide future growth around Delhi. The NCR comprises not only Delhi but also the bordering *tehsils* in the states of Haryana, UP, and Rajasthan.

Gurgaon

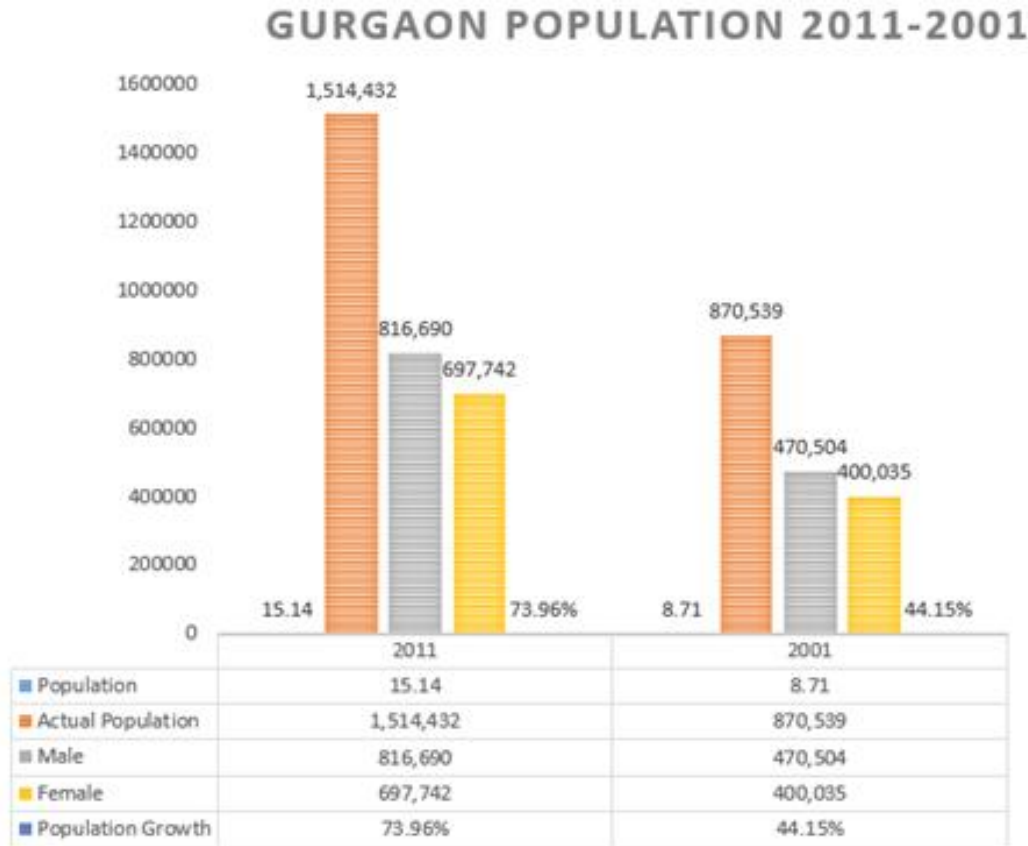
Gurgaon district, of which Gurgaon is an important city, merged as a separate district in the map of Haryana state on 15th August, 1979. Geographically, the district has a total 1,258 sq. km. area and occupies the rank 19th in State and 585th in India on the bases of this size. It lies at 28°44'N latitude, 76°99'E longitude and 220 m altitude. In the year 202, a total of 9.04% was covered by the forests out of the total geographical area. It is bordered by the district of Jhajjar and the Union Territory of Delhi. It is surrounded by Faridabad district on the East, Palwal and Mewat district on the south and Rewari district on the West. The climate of the district remains extremely hot in the summer and fairly cold in the winter. Administration wise, the district is divided into 5 sub-districts, 9 towns and 242 villages. Hindi is its official language.

Demographically, according to the 2011 census, the district has a total number of 3, 20,642 households with a total of 15, 14,432 persons comprising 8, 16,690 are males and 6, 97,742 are females which causing it to rank 4th in the State and 328th in India. The sex ratio is pegged at 854 females for every 1000 males while the child ratio stands at 830 females per 1000 males. The scheduled caste population of the district is recorded as 1, 97,937 including 1, 04,332 males and 93,605 females. The population growth rate during the period 2001 to 2011 was 73.96% of which 73.58% were males and 74.42% were females. The population density in the district is 1,204 persons per sq. km. In the year 2020 the number of live births in the district was 41,438 out of which 21,664 were males and 19,771 were females. In the same year the number of deaths in the district was 13,618 out of which 8,896 were males and 4,722 were females. As per 2011 census the major religion in the district is Hindu with 93.03% of the total population. According to the 2001 census the principal languages in the district are Hindi and Punjabi with 91.91% and 2.35%.

Table-2.1: Demographic Profile, Gurgaon

Description	2011	2001
Population	15.14 Lakhs	8.71 Lakhs
Actual Population	1,514,432	870,539
Male	816,690	470,504
Female	697,742	400,035
Population Growth	73.96%	44.15%
Area Sq. Km	1258	1215
Density/km ²	1204	716
Proportion to Haryana Population	5.97%	4.12%
Sex Ratio (Per 1000)	854	850
Child Sex Ratio (0-6 Age)	830	806
Average Literacy	84.70	78.50
Male Literacy	90.46	88.00
Female Literacy	77.98	67.50
Total Child Population (0-6 Age)	202602	144640
Child Proportion (0-6 Age)	13.38%	16.61%

Figure-2.3: Demographic profile



(Data is according to 2011 census)

Economically, the district is dependent on industries primarily. The district consists of a large number of industries and offices. A number of Multinational Companies (MNC) are also located in Gurgaon city, on Manesar and Sohna Road. Education wise, according to the 2011 census, the literacy rate is 84.7% out of which 90, 46% are males and 77.98% are females. The total literate population of the district was 11, 11,116 including 6, 38,666 are males and 4, 72,450 are females. Ansal Institute of Technology, ikIndian Institute of Learning and Advanced Development (INLEAD), ITM University, Management Development Institute (MDI). School of Inspired Leadership (SOIL) and BML Munjal University are main management institutes here. Kendriya Vidyalaya AFS, American Montessori Public School, Amity International School. Aravali Public School, Blue Bells Public School and DAV Public School are one of the most famous schools of this region. A number of colleges are also available here which offer B.A., M.A., B.Ed. and M.Ed. courses. Gurgaon has witnessed rapid urbanisation and development over

the years. It is known for its modern infrastructure, including high-rise buildings, shopping malls, IT parks, and residential complexes.

Major Attractions for Commuters:

The Delhi-Gurgaon corridor hosts several industrial areas and special economic zones (SEZs) that serve as major employment hubs along and at destinations. Being most accessible, the region boasts commercial centres, shopping malls, and business districts, with Cyber City and Golf Course Road being prime examples. Besides, there are several others, such as the Aero-city, Huda City Centre, Ambience Mall, Udyog Vihar and various Industrial Zones that generate large-scale commuting between Delhi and Gurgaon. Gurgaon, especially, has witnessed significant growth in its commercial landscape. The Cyber city here is a commercial district, housing several top Gurgaon's IT and business hubs with numerous multinational companies and corporate offices. The area has been also termed as the “futuristic commercial hub”. Delhi's Aero-city is known for its luxury hotels, restaurants, stores, and even its modern architecture. Built near the Indira Gandhi International Airport, it serves mostly travellers, or people with endless layovers. Huda City Centre, also known as ‘The Millennium City Centre’ of Gurugram, is a major metro and transportation hub in Gurgaon connecting various parts of the city. Ambience Mall is one of the prominent shopping centres attracting visitors from both Delhi and Gurgaon. Udyog Vihar in Gurgaon is a SEZ (Special Economic Zone) earmarked to promote investments, export-oriented manufacturing, and improve the ease of doing business. Business units in these zones receive special fiscal incentives such as tax exemptions, duty-free exports and infrastructure investments, among others.

Transportation Infrastructure

The space between Delhi and Gurgaon includes extensive transportation infrastructure. This encompasses major highways like NH-48 (formerly known as NH-8) and the Delhi-Gurgaon Expressway, as well as the Delhi Metro and suburban railway networks that facilitate commuting between the two cities.

Major corridors of Movements:

The National capital region of Delhi (NCR) is the 6th largest urban area in the world with the population of about 16.5 million people. The major corridors connecting Delhi to Gurgaon play a crucial role in the transportation and connectivity between these two important urban centres. Here is some key road- corridors:

NH48: The Delhi–Gurugram Expressway on NH-48 is a 27.7 km (17.2 mi) six to eight lane expressway connecting the national capital, Delhi and the Millennium city of Gurugram,

Haryana in the National Capital Region of India. The expressway is a part of the Golden Quadrilateral project, which itself is a part of the National Highway Development Project. This expressway is the busiest intercity route in India and handles more than 180,000 PCUs daily. It starts at Dhaula Kuan in Delhi and terminates on the outskirts of Gurugram. Gurugram City is located at both sides of this Expressway.

M.G. Road (Mehrauli-Gurgaon Road): M.G. Road is a significant arterial road in Gurgaon that connects to Delhi. This road is known for its commercial and business establishments and is an important route for daily commuters. It starts from the Mehrauli area in the southern part of the city and later connects with NH48, before which it connects with a golf-course extension road. The road is a gateway to key business districts and commercial hubs in Gurugram, making it a vital route for daily commuters, businesses, and visitors.

Sohna Road: Sohna Road is another important corridor that connects Delhi to Gurgaon. It has witnessed significant real estate development and is a crucial route for residential and commercial connectivity. Sohna Road typically starts from the southern parts of Delhi, serving as a major road that extends towards the southwest. Further, this road connects with NH48. It is known for its proximity to residential and commercial developments, making it an important route for daily commuters.

Dwarka Expressway (Northern Peripheral Road): NH 248-BB, commonly known as Dwarka Expressway is a 27.6 km (17.1 mi) long, under construction, 8-lane (elevated) and 8-lane (service road) expressway connecting Dwarka in Delhi to Kherki Daula Toll Plaza, Gurgaon in Haryana. The expressway takes off from km 20 of NH 48 (old NH 8) at Shiv Murti in Mahipalpur in Delhi and terminates at km 40 of NH 48 near Kherki Daula Toll Plaza in Gurgaon in Haryana. The Dwarka Expressway has been planned as an alternate road link between Delhi and Gurgaon, particularly to new Gurgaon and is expected to ease the traffic situation on the Delhi-Gurgaon Expressway. It supports urban development and infrastructure expansion in this region.

Old Delhi-Gurgaon Road: This historic road has been a traditional route connecting Old Delhi to Gurgaon. Which somewhere meets with NH-48.

NH-44: In the context of Gurgaon and Delhi, NH-44 plays a significant role in providing a direct and efficient road link between these two cities. Within Gurugram, NH-44 may intersect with key roads such as Sohna Road, Golf Course Road, and other minor roads, contributing to the overall connectivity within the city. After crossing Delhi- Gurgaon periphery, it connects through south Delhi, Indira Gandhi international airport, later connects with NPR or Dwarka expressway and then to central Delhi.

Conclusion

The study area encompasses Delhi and Gurugram, integral parts of the National Capital Region (NCR), offering a rich blend of topography, natural surroundings, and socio-economic dynamics. Gurugram, also known as Gurgaon, stands as a prominent satellite city in Haryana, situated amidst the fertile plains of the Yamuna River. Characterised by a relatively flat terrain with undulating features, Gurugram lies at the northern edge of the Aravali Mountain range. Its climate reflects the typical patterns of the Indian subcontinent, with hot summers, monsoon rains from July to September, and mild winters. The region's natural vegetation, influenced by its semi-arid environment, includes native shrubs and grasses, alongside the Aravalli Biodiversity Park, displaying diverse flora and fauna.

Socio-economically, Delhi and Gurugram exhibit distinct characteristics. Delhi, a pot of cultural diversity, ranks among the top in terms of per capita income and is spread across various sectors such as trade, finance, and professional services. Its historical significance, coupled with modern economic aims, has led to its emergence as a global hub. Gurugram, on the other hand, has experienced rapid urbanisation driven by industries and commercial ventures. With a growing population and a flourishing industrial landscape, Gurugram has become a magnet for investment and development. Educationally, both cities boast prestigious institutions and a high literacy rate, contributing to their intellectual human resource.

Furthermore, the transportation infrastructure between Delhi and Gurugram is robust, featuring major highways, expressways, and metro networks facilitating excellent connectivity. The Delhi-Gurugram corridor, featured by arteries like NH-48 and M.G. Road serve as lifelines for both commuters and businesses. These corridors not only enhance connectivity but also drive economic activities and shape the socio-economic landscape of this region. In essence, Delhi and Gurugram stand as vibrant metropolitan centres, symbolising India's socio-economic dynamism and cultural diversity.

CHAPTER 3

COMMUTERS: DELHI- GURGAON CORRIDOR

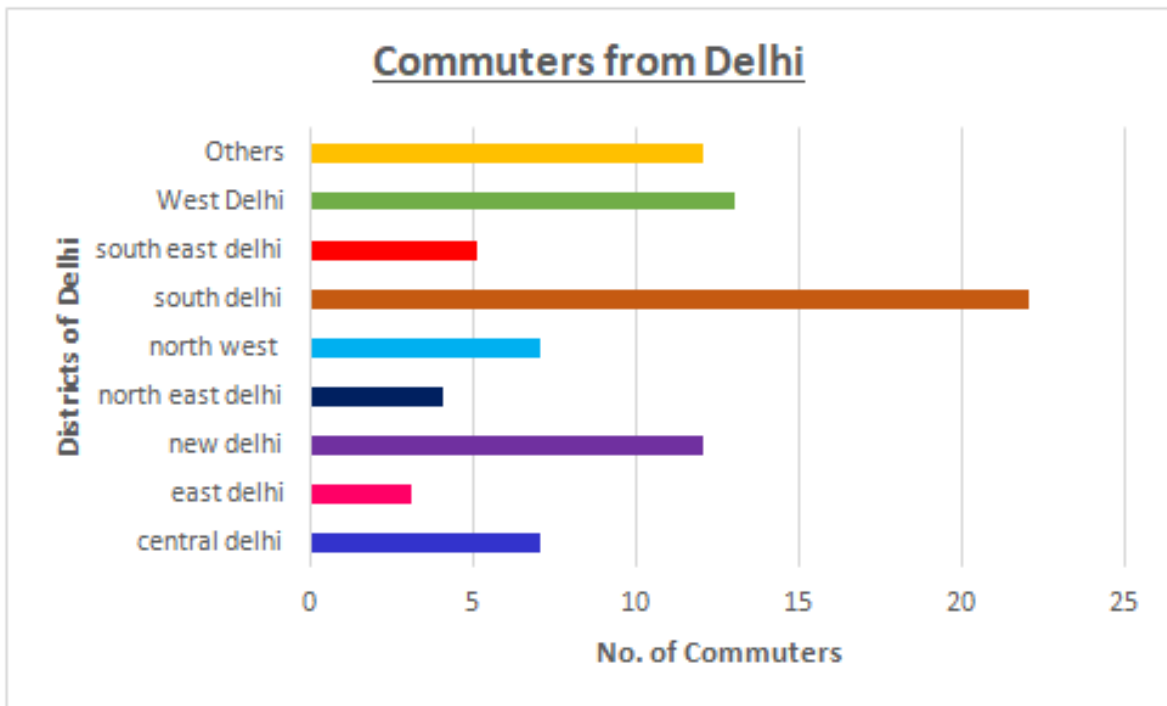
Introduction

The daily commute between Delhi and Gurgaon is a story of millions. It's a testament to the bustling economic corridor that connects India's capital city with its millennial neighbour. This chapter explores the lives of these commuters, the challenges they face, and the unseen aspects of this mass migration that fuels the National Capital Region's growth (Appendix-1).

Table-3.1: Commuters from various Parts of Delhi

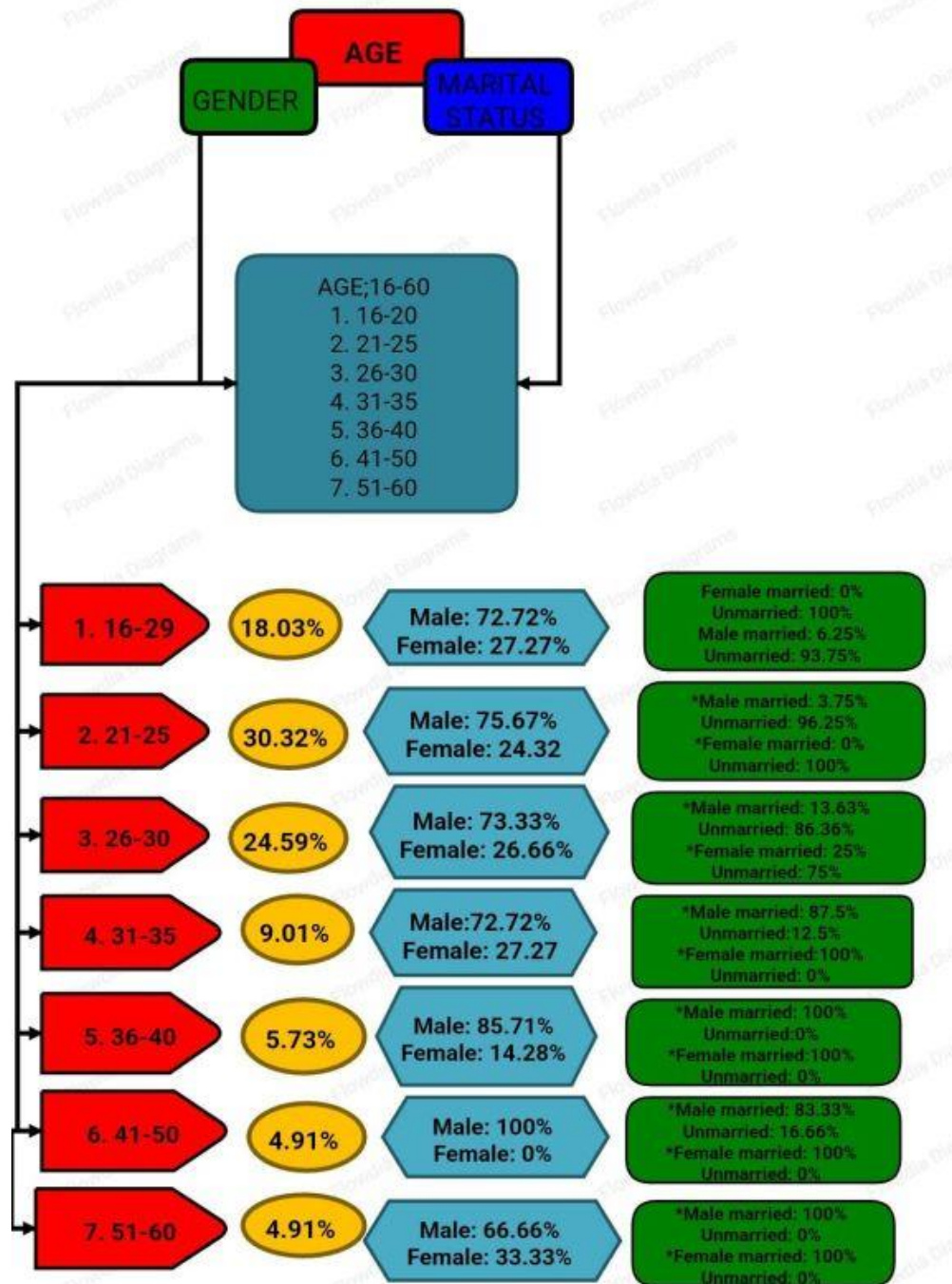
LOCATION IN DELHI	NO. OF OBSERVATIONS
WEST DELHI	13
SOUTH EAST DELHI	5
SOUTH DELHI	22
NORTH WEST DELHI	7
NORTH EAST DELHI	4
NEW DELHI	12
EAST DELHI	3
CENTRAL DELHI	7
OTHERS	12

Figure-3.1: Commuters from Delhi



As evident from the depiction above, the people who travel regularly between Delhi and Gurgaon for work, education, or other purposes largely reside in South and Central Delhi.

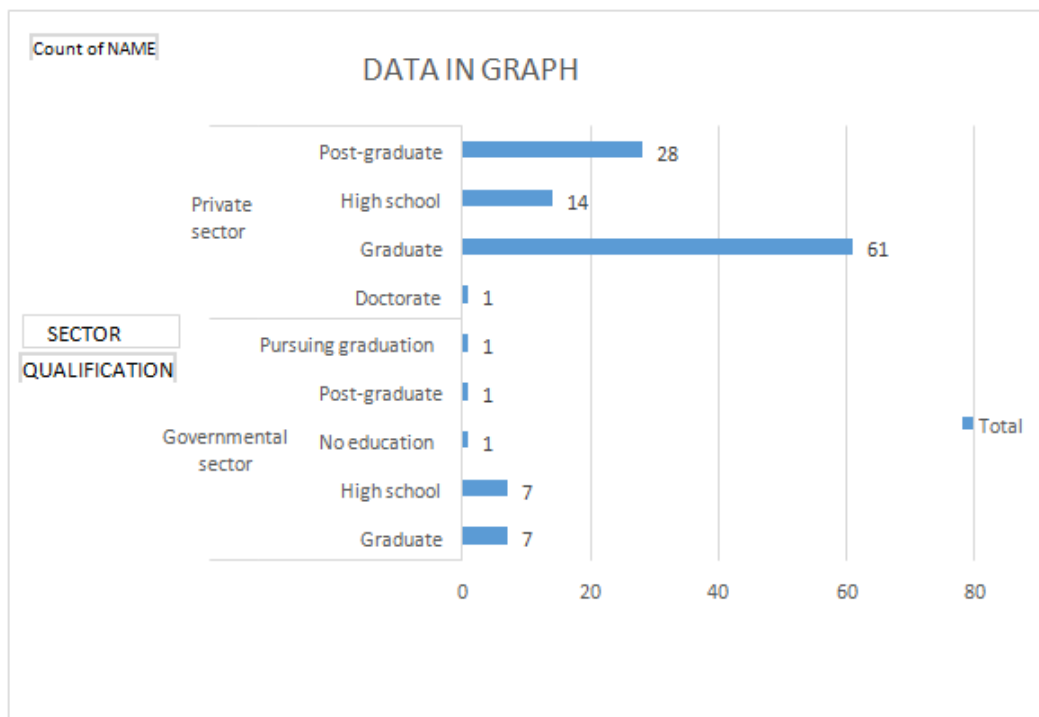
Figure-3.2: Age, Gender & Marital Status of Commuters



Out of total 100% respondents, male 76.22% and female 23.77%. Out of which married 31.14% and Unmarried 68.85%. Out of this, Female married 48.27% and female Unmarried 51.72% and

Male married 32.25% and Unmarried 67.74%. If we look at age, gender and marital status, we find that people between the ages of 21-25 and 26-30 mostly travel for their business. The rest of the people in the age group of 16-20 travel for their education or any skills. Travel for work. But married people are the least among these three categories, and we know how much youth are needed for the economic development of any country. These youth are also behind the development of the corridor from Delhi to Gurugram because the youth need employment and Gurugram provides employment to these youth. Work is being provided in various areas. Like in different types of factories, offices, multiple buildings and multiple works.

Figure-3.4: Qualification Status of Commuters



According to the data

- **Private Sector**

1. Graduates has the majority in commuters that means the basic qualification if fulfilled in private sector
2. Post graduates and high school takes the 2nd and 3rd position respectively, accomplishing the requirement of basic education in almost every individual working in private sector

3. The least percent is of doctorate accounting for less number of highly educated individuals.
- **Governmental Sector**
 1. The highest level of education is of graduates that too 7 being the highest number
 2. This signifies the level of education is less and there is a lack of high educated individuals in government sector
 3. Post graduate being at the top level has only 1 individual whereas doctors are at 0
 4. There are still individuals pursuing education which means educational necessities are less
 5. There is also an individual with 0 education again signifying less or no education in government sector.
 - Private sector **has more educated individuals** working as compared to government sector.

Conclusion

Commuters between Delhi and Gurgaon are a varied bunch - professionals, students, daily wage earners - united by their daily trek. Public transport (metro, buses) is common, but traffic congestion is a major hurdle. Long commutes and air pollution take a toll on well-being. Solutions include improved public options, promoting cycling/carpooling, and flexible work arrangements to ease congestion and improve work-life balance.

Addressing the Delhi-Gurgaon commute requires a multi-pronged approach. Collaborative efforts between government agencies, businesses, and commuters are essential. By prioritizing public transport, promoting sustainable practices, and encouraging innovative solutions, this critical corridor can transform into a model of efficient urban mobility. The success of these efforts will have far-reaching implications for the overall well-being of residents and the economic prosperity of the region.

CHAPTER 4

COMMUTING PATTERN

Introduction:

In the bustling urban landscape of the Delhi-Gurgaon corridor, the nexus between the place of work and residence forms the cornerstone of daily life for thousands of individuals. This chapter delves into the intricate dynamics of commuting behaviours, expenditure patterns, and time

investments. As we navigate through the various facets of commuting dynamics, from distance travelled to modes of transportation, frequency of trips to expenditure patterns, a tapestry of urban mobility begins to unfold.

Distance Between Place of Work & Residence

1. Workplace:

A workplace or place of employment is a location where people perform tasks, jobs, and projects for their employer. The observation makes it evident that the bulk of commuters work at the Gurgaon Cyber hub. This might be due to different reasons, as follow:

- a) Corporate Presence- Gurgaon, which is officially known as Gurugram, has witnessed a significant spike in corporate development over the years. Many Multinational Companies and corporate offices have established their presence in and around Cyber Hub, making it a central business district.
- b) Commercial and Entertainment Hub- Cyber Hub is not only a business district but also a booming commercial and entertainment hub. It hosts a variety of restaurants, eateries, cafes, and retail outlets. This combination of work and leisure options makes it an attractive destination for professionals.
- c) Infrastructure and Amenities- The area around Cyber Hub is well-developed with modern infrastructure and amenities. This includes well-maintained office spaces, shopping complexes, and recreational facilities, creating a conducive environment favourable for business and their employees.
- d) Networking opportunities- Being, a hub for various businesses and industries, Cyber Hub provides opportunities for networking and collaboration. Professionals working in this area may find it beneficial to be in close proximity to other companies and potential partners.
- e) Connectivity- Gurugram has good connectivity with other parts of the National Capital Region (NCR), including Delhi, through a network of roads and the Delhi Metro. This accessibility makes it convenient for commuters to travel to and from Cyber Hub.

Distance travelled:

Table 4.1- Distance travelled by commuters from one side

DISTANCE TRAVELLED	NO. OF OBSERVATIONS
10-15KM	21

15-20 KM	18
20-30 KM	24
MORE THAN 30 KM	58

This table (4.1) mentions the entire distance that is travelled by a commuter to reach its workplace from one side and vice-versa (Figure 4.1).

From the observation, we can conclude that-

About 47.50% of the commuters travels more than 30 km from one side to reach their work place.

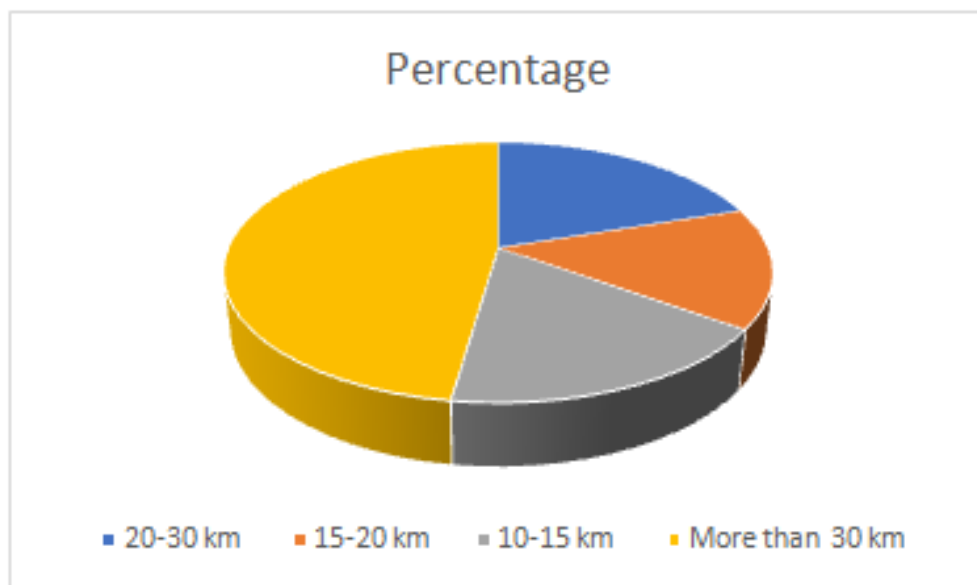
About 14.87 % of the commuters travels between 15-20 km from one side to reach their destination.

About 17.35% of the commuters travels between 10-15 km from one side to reach their work place.

About 19.83% of the commuters travels between 20-30 km from one side to reach their destination.

This observation clearly mentions that the majority of the commuters travels more than 30 km on an average from one side every day.

Figure 4.1: Distance travelled to work Place

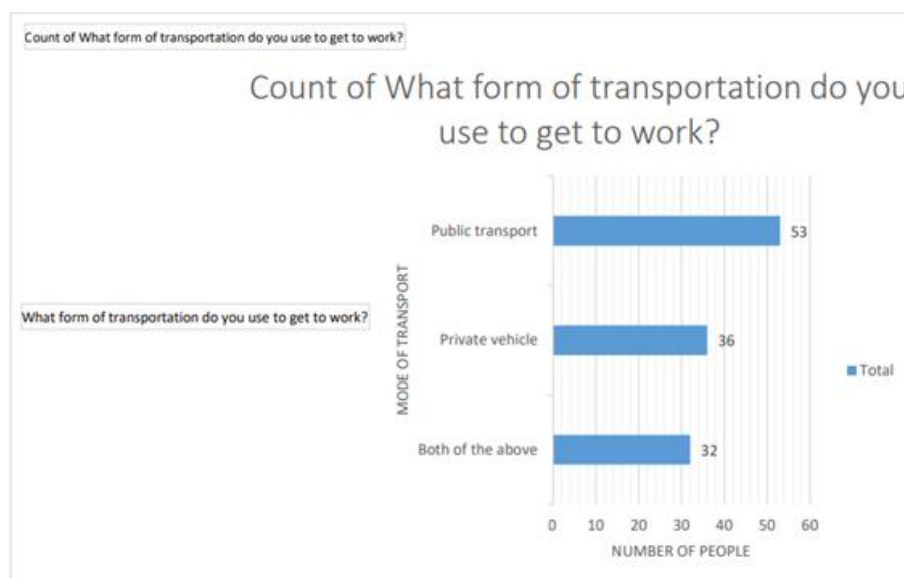


Transport Network Used

Here, as we have observed, a significant majority of the population, approximately 50%, rely on public transport as their primary mode of commuting to work. It is worth noting that this preference for public transportation is driven by various factors, such as the convenience and accessibility it offers, the cost-effectiveness compared to private vehicles, and the desire to reduce carbon emissions and contribute to a sustainable environment. On the other hand, around 25% of individuals opt to travel by private vehicles, specifically by driving their own cars to work. This preference for private transportation could be attributed to reasons such as the flexibility it provides in terms of route selection and travel timings, the convenience of carrying personal belongings, and the desire for a more personalized travel experience. Interestingly, it should be mentioned that 25% of the population indicated a willingness to invest in both types of transport. This suggests a growing trend of individuals who choose to maintain a flexible and adaptable commuting routine, utilizing public transport on some days and relying on private vehicles on others, depending on factors like weather conditions, personal schedules, or the need to transport bulky items.

Overall, it is evident that a diverse range of commuting preferences exists among the population, with public transport being a popular choice for half of the individuals, followed closely by private vehicle usage. The existence of a segment that embraces both options highlights the importance of accommodating the varying needs and preferences of commuters in order to create sustainable and efficient transportation solutions.

Figure- 4.2: Mode of Commuting



Mode of Commuting

The Delhi-Gurgaon corridor, bustling with professionals and business activity, presents various commuting options for individuals navigating this route daily. Here's a breakdown of the different modes available:

Public Transportation:

- **Delhi Metro:** The most popular and convenient option, the Delhi Metro offers extensive connectivity with several lines connecting key points in Delhi and Gurgaon. It's affordable, efficient, and avoids traffic Congestion.
- **Rapid Metro Gurgaon:** This elevated metro system operates within Gurgaon, connecting major business hubs and residential areas. It's a good option for shorter commutes within Gurgaon.
- **Buses:** Public buses connect various points in Delhi and Gurgaon, offering a budget-friendly option. However, they can be Crowded and prone to traffic delays.
- **Shared Autos:** These shared rickshaws are a quick and affordable option for shorter distances within Delhi or Gurgaon, but can be uncomfortable due to overcrowding.

Private Transportation:

- **Personal Cars:** While offering flexibility and convenience, cars face significant traffic congestion, especially during peak hours. Parking can also be a challenge.
- **Cabs:** Ride-hailing services like Uber and Ola offer convenient door-to door travel, but can be expensive, especially for regular commutes.
- **Carpooling:** Sharing rides with colleagues or neighbours can significantly reduce costs and traffic congestion, but requires coordination and trust.

Other Options:

- **Cycling:** For the environmentally conscious and physically fit, cycling can be a healthy and sustainable option for shorter distances, especially with dedicated cycling lanes being developed.
- **E-rickshaws:** These electric rickshaws offer an eco-friendly and Affordable option for shorter distances within the city. Important factors under consideration include, for instance,

- (1) **Distance:** For longer commutes, the Delhi Metro or Rapid Metro might be more convenient;
- (2) **Budget:** Public transport is generally more affordable, while cabs and cars are more expensive;
- (3) **Time:** The Delhi Metro and Rapid Metro offer the fastest travel times, while cars face traffic congestion; and
- (4) **Comfort:** while choosing between options Consideration for the preference for personal space and convenience weighs more.

Frequency of Trips

Understanding the frequency of trips is a pivotal aspect of transportation research, offering insights into mobility patterns, consumer behaviour, and urban planning. The present interpretation delves into unravelling the dynamics that influence how often individuals embark on journeys.

Table-4.2: Commuting Frequency in a Month

No. of trips in a month	No. of observations
0-10	9
10-20	3
20-30	12
30-40	5
40-50	87
More than 50	1

The examination of gathered data discloses discernible trends in trip frequency among the surveyed populace. Predominantly, a significant majority, constituting 74% of the sample, engages in a moderate level of travel, falling within the bracket of 40 to 50 trips per month. This underscores a noteworthy demographic of individuals exhibiting consistent commuting habits or possessing recurrent requirements for transportation services within the surveyed routes. Close in prevalence, 10% of respondents report a frequency range of 20 to 30 trips per month, indicating another substantial segment with a marginally reduced yet still substantial degree of mobility. On

the lower spectrum, 8% of participants disclose involvement in 0 to 10 trips per month, emphasizing a cohort experiencing sporadic or minimal travel demands. Unexpectedly, the data reveals a significant cohort 4% falling within the 30 to 40 trips per month category, denoting a noteworthy level of mobility slightly below the predominant range. Conversely, the 10 to 20 trips per month category accounts for 3% of participants, indicating a lesser prevalence in comparison to both the 20 to 30 and 40 to 50 trips per month segments. Of particular interest is the least common frequency of travel identified in the category of individuals making more than 50 trips per month, representing merely 1% of the surveyed population. This subset of frequent travellers implies a specialized demographic with distinctive mobility needs, potentially associated with specific professions or lifestyle choices.

Time Involved in Travel

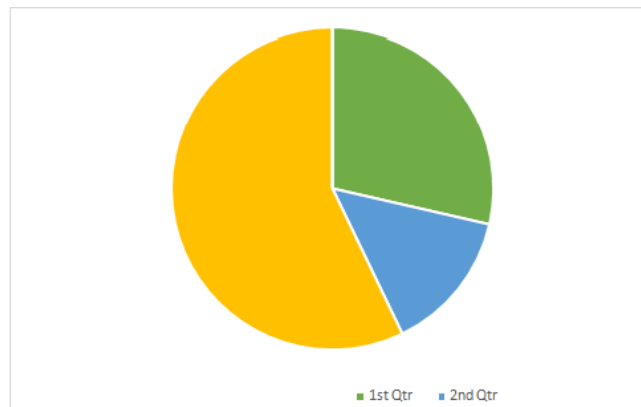


Figure 4.3: Time Involved in Travel

QTR.	PERCENTAGE
1	17.21%
2	18.85%
3	21.31%

1. Less than 2000 = The number of people eligible in this range is 17.21 percent. It is 17.21% out of 100%. This means that many people travel less distance than others in this corridor for employment. This saves you, but it is also possible that you are less in all these.

2. 2000-3000 = The number of eligible people in this range is 18.85%. This shows that the number is more than 2000 and its character will also be a little longer.

3. 3000-4000 = The number of eligible people in this range is 21.31%. Thus, the number of people who spend between Rs 4000-5000 is the highest at 23.77% and the number of people who spend more than Rs 5000 is 18.85%.

Gurgaon have been a major hub of it sector and it attracts a lot of people from all over the India, the commuters living in Delhi have to travel daily to Gurgaon and it consumes their time, due to traffic issues and some irregularities of policies and rules the time consumed in commuting increasing. In the survey we found that around 56% people are travelling for more than 1 hour to reach their destination in Gurgaon. Such people are coming from southern and western part of Delhi. Around 28% people are travelling for about 1 hour to reach their workplace. About 14% commuters who are living near the border area are travelling for less than 1 hour.

Expenditure on Travel

In the Delhi-Gurgaon corridor, people spend a minimum of Rs 2000 and more than Rs 5000 in a month on commuting. Rest of the people's expenses range from Rs 2000-3000, 3000-4000 and 4000-5000. In this way we understand two things. Firstly, people go to this corridor for employment, their salaries will be higher as compared to others. Because when so much money is spent in Patra, only salary will help in meeting it. Secondly, people with lower salaries will not be able to travel that much because they themselves are less, so how will they meet the expenses of the journey. For this, we should make arrangements to minimize the expenditure on the container. Because with this, people of all income levels can become eligible and go to their respective jobs. This will bring development and rapid growth in this corridor.

Seen this way, the money spent by people in Patra gives an idea of their journey and the distance covered in their journey. And together we get to know the frequency. One thing is clear from this that people have as many expenses as you do, but to a small extent, Metro has reduced the travel expenses and has also saved time. To bring further development in this corridor, we will have to increase the options of fast travel and also expand the metro lines. And in view of all the problems arising in it, it is mandatory to repair and replace them. In this way, the easier and less expensive people will be able to qualify, the more people will have employment and this will bring development to our country.

Conclusion:

In Conclusion, the exploration of commuting dynamics within the Delhi-Gurgaon corridor offers profound insights into the intricate life of commuters. As we dissect the components influencing commuting dynamics, it becomes evident that Gurgaon's Cyber Hub emerges as a nucleus of professional activity, drawing individuals from various corners. Factors such as corporate presence, commercial vibrancy, modern infrastructure, networking opportunities, and robust

connectivity contribute to its magnetism, transforming it into a preferred destination for work and leisure alike. As we reflect on the myriad factors influencing commuting behaviours, it becomes clear that the quest for efficient, sustainable transportation solution is paramount. Public transport emerges as a cornerstone of mobility, offering affordability, accessibility, and sustainability to approximately 50% of the commuters. Conversely, 25% commuters opt for private transportation, characterized by personal vehicles and ride-hailing services, caters to those valuing flexibility and convenience. The frequency of trips reflects a diverse spectrum of mobility patterns, with 74% majority engaging in moderate levels of travel, falling within a bracket of 40-50 trips per month and 1% minority taking more than 50 trips per month. Time investments in commuting underscore the challenges posed by traffic congestion, and geographical distances with 56% commuters spending over an hour traversing the corridor. Expenditure on travel unveils economic disparities and underscore the importance of accessible and cost-effective transportation solutions. As from analysis, this is clear that people spend a minimum of Rs.2000 to more than Rs.5000 in a month on commuting. The delineation of expenditure brackets provides insights into commuting habits, journey distances, and financial capacities, emphasizing the need for inclusive transportation infrastructure and policy interventions.

CHAPTER 5

CHALLENGES AND REMEDIES

In the dynamic urban landscape of Delhi and Gurgaon, where economic opportunities converge and infrastructural networks intertwine, the phenomenon of reverse commuting has emerged as a distinctive facet of the daily lives of residents. Reverse commuting, characterized by the movement of individuals from the bustling metropolis of Delhi to the burgeoning corporate hub of Gurgaon, poses a unique set of challenges.

Our exploration into the challenges encompasses an array of factors, ranging from the intricacies of socio-economic factors to the environmental consequences keeping the administrative challenges in view which are associated with mass reverse commuting. Understanding these challenges becomes paramount in devising effective solutions that not only alleviate the hardships faced by commuters but also foster a harmonious coexistence between the two urban centres.

Environmental Challenges and Remedies

Environmental challenges to a large extent impact the commuters, in general and the commuting patterns in particular, as both aspects are closely intertwined. Commuting patterns such as the modes of transportation people use and the distances they travel significantly impact the

environment through factors like carbon emissions, air pollution and habitat destruction. Conversely, environmental patterns, such as climate change and pollution level can influence commuting behaviours by affecting transportation infrastructure, fuel prices and public policies aimed at sustainable transportation options. Understanding and addressing these interconnected patterns is crucial for mitigating environmental degradation and promoting more sustainable commuting patterns.

Understanding commuters' knowledge and response towards environmental challenges faced while traveling through Delhi-Gurugram corridor can imply the nature of a particular pattern of commute. Further, mitigating these challenges can help lay the foundation of a better environment and hence better living as well as commuting conditions for people involved.

Delhi

Delhi being the ninth most populated metropolis in the world grapples with numerous environmental issues. Delhi and its residents struggle with issues such as pollution (air, water, land and noise) overcrowding, water issues (scarcity of water being the most prominent), loss of flora and fauna. Number of actions are in process to control the hazardous impacts of such issues that not only affect the environment but have long term effects on people residing in the city and even the residents of neighbouring cities as well.

Pollution

The air quality index is used to check how clean or polluted the air around us is. Air quality indices are divided into groups/ranges based on the level of pollutants present in the atmosphere at a given point of time. Good (0-50), Satisfactory (51-100), moderate (101-200), Poor (201-300), Severe (301-400) and Hazardous (401-500) are the categories suggested by various government agencies. The Department of Environment under the Government of NCT of Delhi is responsible to measure and provide real time ambient Air Quality Data which is further used to calculate the Air Quality Index of Delhi which is the most important measure of pollution and is thus an important indicator. The World Health Organisation in September 2011 reported that Delhi has exceeded the maximum PM10 limit by almost 10 times. Vehicular pollution and industrial activities top the list when reasons for air pollution in Delhi are marked. Further, the air traffic in Delhi is proliferating, contributing to the deteriorating air quality in the territory. Each jet that takes off expels a huge number of pollutants which usually comes from small matter that is exhausted. The number of vehicles in Delhi are increasing faster than the number of roads. More vehicles mean better infrastructure that ultimately leads to industries operating at a higher rate and construction activities taking place at a higher pace that further causes pollution. Delhi's vehicular pollution has reached nearly three times to 7.6 million from 2.2

million in 1994, registering an annual growth of 14%. However, a decrease has been witnessed in recent years with the implementation of several control measures as suggested by Delhi Pollution Control Committee.

Metropolitan Expansion

Delhi metro became operational in the year 2002 stretching from Shahdara to Tis Hazari on the red line. Back then the metro network was just 8.4 kms long with six stations. Today, the metro network expands over 393 kms with 288 stations making it one of the largest transit systems in the world. Further, presently another 65 kms of new lines are being laid. In June 2023, the union cabinet approved metro connectivity from Huda city centre, now Millennium city centre to Cyber city. This route would be 28 kms long and bear a budget of Rs 5452 Crore. The above-mentioned data from DMRC clearly depicts that metro expansion is taking place ever since the birth of Delhi metro. Metro expansion in Delhi has been both boon and bane for the environment. On one hand, it has significantly reduced air pollution and traffic congestion by providing a convenient and efficient mode of public transportation. As data from Indian Statistical Institute suggest, each extension of the metro rail resulted in a decline in nitrogen dioxide and carbon monoxide in Delhi. The estimates for nitrogen dioxide reductions range from 3 to 47 percent, while those for carbon monoxide range from 31 to 100 percent. For ITO, a major traffic insurrection in Delhi, the cumulative effect of multiple extensions, is found to be a net of 35 percent. On the other hand, construction activities associated with metro expansion such as excavation, land clearing and material transportation have resulted in the loss of green spaces, biodiversity and natural habitats. Additionally the increased impervious surfaces associated with metro stations and infrastructures can exacerbate urban heat island effects, leading to higher temperatures in surrounding areas and further impacting local ecosystems and human comfort.

Gurugram

Gurugram, as a matter of fact, is categorized as very high on the Human Development Index, with an HDI of 0.889 (HDRO, UNDP). Since it is a part of NCR and is a leading metropolitan expansion, it is not free from environmental issues that come with development.

Urban Flooding is a major issue facing Gurugram every monsoon. News headlines are gouged of Gurugram's flood every monsoon when the areas around NH-8 such as Honda Chowk, Basai, Dhankot, sector 37 etc. are fighting floods causing extreme traffic jams, waterlogging persisting for days thereby hampering the day to day public life. A report published by NIDM depicted that there is huge change in land use patterns in the city in recent times that has led to choking and disappearance of natural drain systems, Badshahpur drain for instance. Municipality of agencies

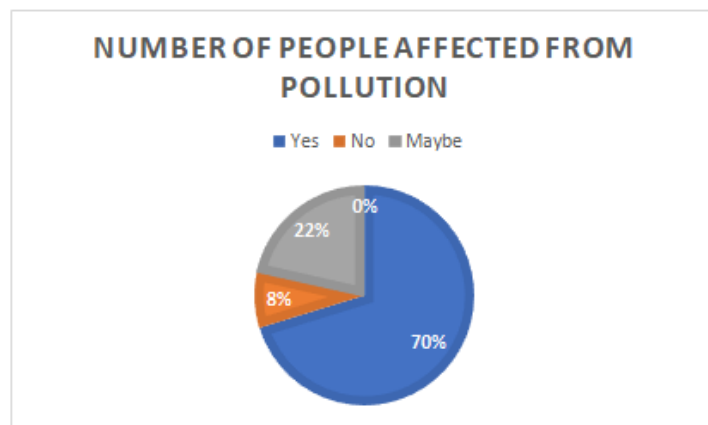
working in patches also create huge problems apart from private ownership of the drainage land at many places.

Gurugram is among the worst affected cities by air pollution. As the reports published by IQAir show, Gurugram was the 11th most polluted city in the world in 2022 while it was the most polluted air in the world in the year 2018. A human body exposed to high levels of air pollution can be affected in a number of ways and prolonged exposure can prove to be fatal as well. It gears up the risk of cardiac diseases, risk of stroke lung cancer, and acute respiratory infections. Not only that, but it can also cause mental health complications. The typical sources of air pollution in Gurugram are similar to that of Delhi i.e. vehicular discharge and industrial fumes. The city still has limited public transportation options that result in high rates of vehicle ownership and pollution. Data suggests that the city has the highest vehicle ownership rates in the country i.e. 323 cars per 1000 people which is even greater than Delhi.

Table-5.1: Response to Metropolitan Expansion as Cause of Pollution

Does metropolitan expansion cause pollution?	Number of people
Yes	85
No	10
Maybe	26

Figure 5.1: Response to Metropolitan Expansion as Cause of Pollution



Out of the 121 individuals surveyed, a significant majority of 85 respondents identified metropolitan expansion as a primary contributor to environmental pollution. Interestingly, 26 participants remained undecided, while a minority of 10 individuals disagreed, asserting that metropolitan expansion does not lead to pollution. It's worth noting that respondents exhibited diverse viewpoints on this matter.

While it's undeniable that construction activities associated with metropolitan expansion can exacerbate air pollution levels, there's a nuanced consideration to be made regarding the role of effective public transportation systems. The proliferation of public transit, such as metro lines, offers a potential solution by reducing reliance on private vehicles for commuting, thus curbing pollution emissions. However, it's pertinent to acknowledge that the construction necessary for expanding metro lines may contribute to short-term pollution.

A report prepared by centre for Science and Environment highlights in 2018 following issues of Gurugram that need to be looked into and worked upon-

- The gap between demand and supply of water will jump from 34% to 57% in the years to come. Due to unchecked use of groundwater, the water table falls at a rate of 1-3 meters in a year. Over 300 % over- extraction in several blocks. Central Ground Water Board warning- once the water table reaches 200 m below ground level only rocks will be left.
- Official forecast for sewage generation is 533 million litres in 2021 while the capacity to treat the same is just 255 million litres. Treated water is drained out of the city and not recycled. Tankers carry sewage from unsewered areas and dump it in fields and storm water drains.
- Growing dependence on personal vehicles is increasing. Between 2008 and 2015 car registration increased by 352%. Bus registration is down by 300% while para-transit has declined by 39%. Share of public transport, walk and cycle has dropped from 58% to 40%.
- Less than 23% of road lengths have a usable footpath; only 20 % of the streets have proper street lights.
- 90% of the collected solid waste is taken to a landfill. Waste generation is growing at 5% annually. According to MCG, per capita incremental increase in waste generations is about 1.3% per annum.
- About 10% of the slum population of the state lives in Gurugram. 72% of the migrant workforce lives with the shared basic facilities. In some areas, migrants are 60-90% of

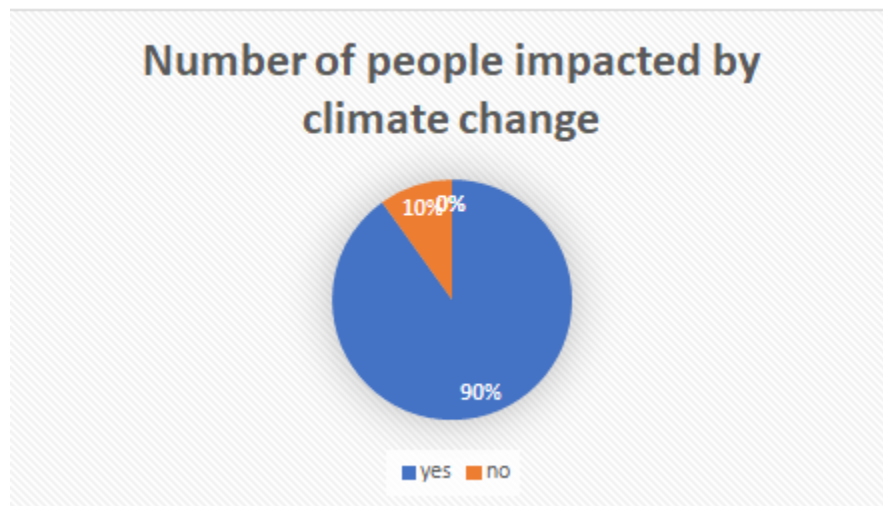
the local population. An affordable housing policy should cater to the stratified needs of the urban poor building typology, habitat planning and basic services.

Table-5.2: Response to Human interference and Climate Change

If human activities impact climate change	Number of people
Yes	109
No	12

Out of a sample size of 121 individuals in the study, a staggering 90%—equivalent to 109 respondents—believe that human activities significantly influence environmental dynamics, particularly climate change. The spectrum of climate change encompasses a myriad of phenomena, ranging from escalating temperatures and shifts in rainfall patterns to the alarming melting of polar ice caps and the heightened occurrence of natural disasters. Notably, the primary emphasis lies on the alterations in climatic patterns, with a particular focus on temperature fluctuations and shifts in precipitation trends. These profound changes wield considerable influence over individuals' commuting preferences and habits.

Figure-5.2: Response to Human interference and Climate Change

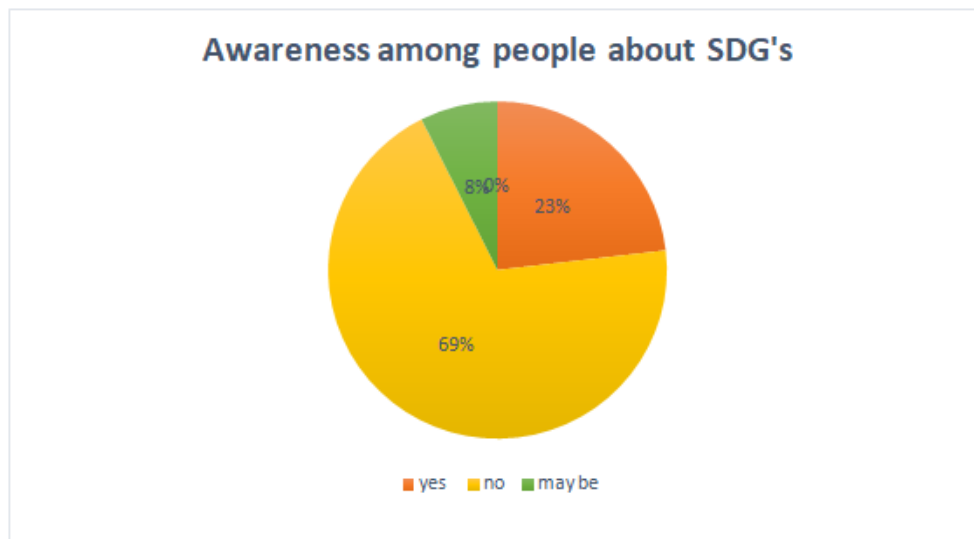


In the context of Delhi, a city grappling with severe air pollution issues, commuting patterns to neighbouring areas like Gurugram are influenced by environmental concerns. This underscores the intricate interplay between metropolitan expansion, pollution, and transportation dynamics in urban environments.

Table 5.3: -Sustainable Development Goal 11: An Awareness

Do you have any idea about SDG 11	No. of People
Yes	28
No	84
Maybe	9

Figure 5.3-Sustainable Development Goal 11: An Awareness



The essence of Sustainable Development Goal 11 lies in fostering cities and human settlements that embody inclusivity, safety, resilience, and sustainability. This overarching objective entails crafting urban environments that embrace every community, furnish secure spaces for livelihoods, and fortify their capacity to withstand natural calamities, all culminating in the creation of sustainable urban centres. The significance of this goal is particularly pronounced in metropolitan areas, where such attributes are often lacking.

Despite the imperative nature of SDG 11, a mere 23% of the surveyed population—29 individuals out of 121—demonstrated a clear understanding of its meaning and importance. Alarming, the vast majority, comprising 69.4% or 84 respondents, exhibited a profound lack of

awareness regarding SDG 11. This knowledge gap underscores the pressing need for greater education and advocacy surrounding the importance of sustainable urban development.

Furthermore, a fraction of the surveyed individuals, approximately 7.4%, possessed only vague notions about SDG 11, indicating a lack of concrete action or engagement with the goal. It is evident that fostering safer, more resilient, and inclusive cities not only aligns with SDG 11 but also bears significant implications for improving commuting experiences and fostering sustainable urban ecosystems.

Solutions:

- 1. Afforestation-** Afforestation, widely acknowledged as an effective strategy, serves to diminish various forms of pollution and rejuvenate degraded environments. Social forestry stands out as a proven method for reinstating greenery, thereby exerting control over pollution and mitigating the urban heat island effect. Additionally, the establishment of fresh green belts and the revitalization of existing ones hold immense potential in sequestering CO₂ emissions from vehicles, thereby contributing significantly to environmental restoration efforts.
- 2. Promoting Electric Vehicles (EVs)-** In cosmopolitan hubs boasting diverse populations, transitioning to electric vehicles, both in private and public transport sectors, emerges as a pivotal step in alleviating adverse environmental impacts. These vehicles not only curb pollution stemming from traditional fuel-powered counterparts but also address the dependency on non-renewable energy sources like petroleum and diesel, thus fostering sustainability in the transportation sector.
- 3. Using Public Transport-** While private transport typically accommodates a maximum of four individuals per vehicle, public transportation has the capacity to ferry numerous passengers simultaneously, each headed to diverse destinations, all within a single vehicle. This collective approach not only optimizes fuel consumption but also reduces the overall number of vehicles on the roads, consequently minimizing exhaust emissions and curbing pollution levels significantly.
- 4. Managing Waste-** The quintessential and highly efficacious approach to waste management lies in adhering to the principles of the 5 R's: Refuse, Repurpose, Reduce, Recycle, and Reuse. Embracing these principles not only diminishes the volume of waste destined for landfills but also enhances the efficiency of recycling initiatives. It's imperative to recognize that every item casually discarded has the potential to linger in landfills for centuries, underscoring the critical importance of conscientious waste management practices.

5. Population Control Measures- Population control in Delhi can alleviate strain on resources, mitigate pollution, reduce traffic congestion, improve public health, and preserve green spaces. By stabilizing population growth, the city can ensure more efficient resource allocation, cleaner air and water, smoother transportation, better healthcare access, and protection of natural habitats. This holistic approach is essential for creating a sustainable and livable environment for all residents.

6. Awareness- The majority of commuters remain oblivious to the government's policies and provisions designed to streamline their daily travels. Awareness stands as the cornerstone solution, the initial and pivotal step to address any challenge that arises. Only through awareness can individuals embark on implementing other mitigation measures effectively, thereby ensuring smoother and more efficient daily commuting experiences.

Socio-Economic Challenges:

Commuting between Delhi and Gurgaon, despite its economic benefits, presents several socio-economic challenges for individuals navigating this route daily. Here are some key problems faced by commuters:

Time and Cost:

- **Long commutes:** Traveling between Delhi and Gurgaon often involves long travel times due to traffic congestion, especially during peak hours. This can lead to fatigue, stress, and reduced productivity.

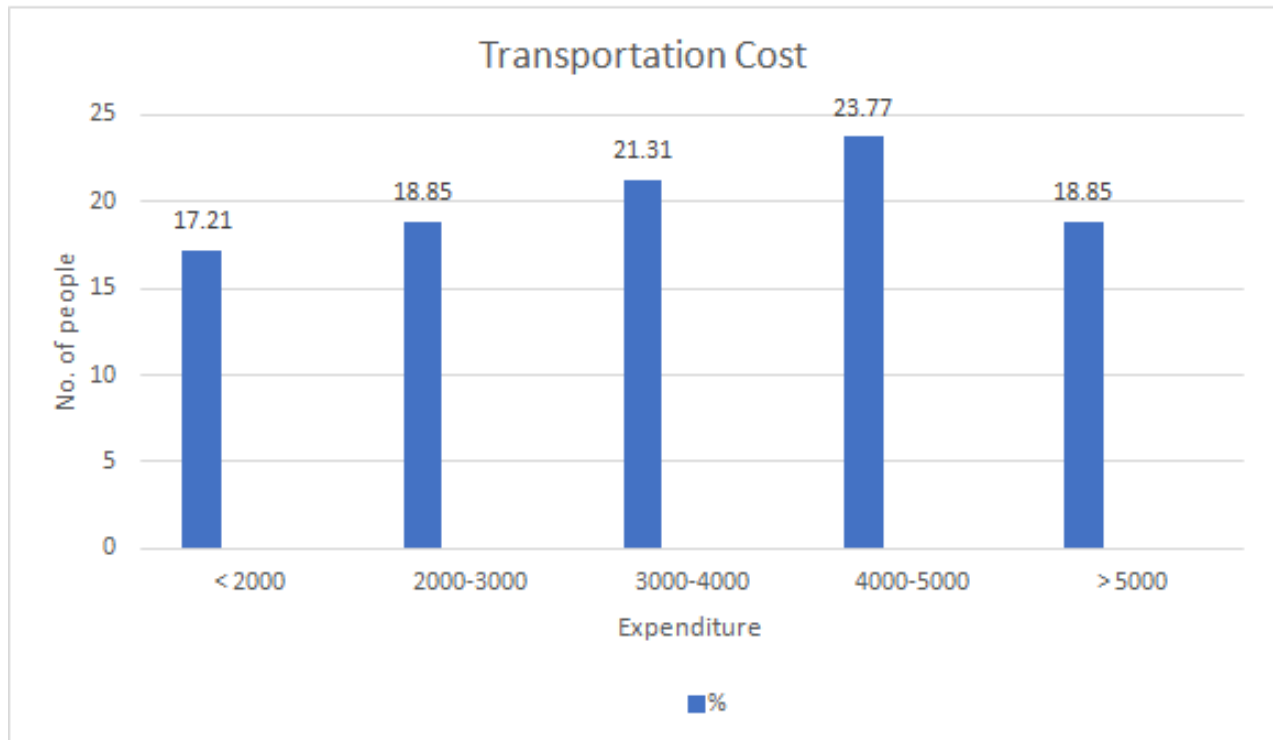
Figure-5.4: Long commutes



- **High transportation costs:**

Daily commuting expenses can be significant, especially for those using cabs or private vehicles. This can strain household budgets, particularly for low-income earners.

Figure-5.5: Transportation Cost



Stress and Work-Life Balance:

- **Long commutes can lead to chronic stress and fatigue,** reducing quality of life and affecting mental well-being. This can impact work performance and relationships with families and friends.
- **Limited time for personal and family life:** Long commutes leave less time for leisure activities, personal development, and family interactions, affecting overall well-being and social connections.

Social Inequality:

- **Limited access to affordable housing:** Rising housing costs in Gurgaon often force low-income earners to live far from their workplaces in

- Delhi, leading to even longer commutes and economic burdens.
- **Unequal access to quality transportation:** Access to affordable and reliable public transportation is often limited, forcing some commuters to rely on expensive private options, exacerbating economic inequalities.

Solutions:

Tackling the Delhi-Gurgaon Commute

The Delhi-Gurgaon commute, while economically vibrant, presents several socio-economic challenges for individuals navigating this route daily. Finding lasting solutions requires a multi-pronged approach addressing various aspects of the problem. Here are some potential solutions:

Improving Public Transportation:

- **Metro Expansion:** Extending metro lines and increasing frequency on existing routes can significantly reduce reliance on personal vehicles and offer affordable, efficient travel options.
- **Bus Rapid Transit (BRT) System:** Implementing dedicated BRT corridors with priority lanes and improved infrastructure can enhance bus efficiency and reliability.
- **Integration and Ticketing:** Seamless integration between different public transport modes (metro, buses, shared autos) with a unified ticketing system can encourage multi-modal commuting.

Promoting Sustainable Alternatives:

- **Cycle Infrastructure:** Developing dedicated cycling lanes, secure parking facilities, and public bicycle sharing programs can incentivize cycling for shorter commutes, promoting health and reducing traffic congestion.
- **E-mobility Solutions:** Encouraging the use of electric vehicles for public transport and carpooling can contribute to environmental sustainability and reduce pollution.

Work-Life Balance Initiatives:

- **Remote Work Options:** Employers offering flexible work arrangements or remote work opportunities can significantly reduce daily commutes and improve work-life balance for employees.

- **Staggered Working Hours:** Staggering office start and end times can help decongest peak-hour traffic, improving travel experience for everyone.
- **Policy and Regulatory Congestion Pricing:** Implementing congestion pricing tolls on personal vehicles during peak hours can discourage their use and generate revenue for improving public transport infrastructure.
- **Parking Management:** Stricter parking regulations and promoting carpooling can optimize available parking space and incentivize shared commutes.
- **Pollution Control Measures:** Implementing stricter emission Standards, promoting electric vehicles, and investing in green infrastructure can significantly improve air quality on the route.

Measures:

Social and Community Initiatives:

- **Carpooling Programs:** Establishing community-based carpooling programs can connect like-minded commuters and reduce traffic congestion and costs.
- **Financial Assistance:** Providing financial subsidies or travel passes to low- income earners can make public transport more accessible and alleviate economic burdens.
- **Awareness Campaigns:** Promoting awareness about the benefits of sustainable commuting modes and responsible travel behaviour can encourage positive change at the individual level.

Administrative Challenges:

The dynamic interplay between urbanization, transportation infrastructure, and workforce mobility has given rise to a myriad of administrative challenges, particularly in the realm of commuting patterns. In the context of the bustling Delhi-Gurgaon corridor, where economic activities thrive, the complexities of managing and optimizing commuter flows present multifaceted challenges for administrators and policymakers.

Understanding and mitigating these challenges is imperative for fostering sustainable urban development, enhancing the quality of life for residents, and bolstering economic activities in the region. By illuminating the intricacies of reverse commuting, this research contributes to the broader discourse on efficient transportation administration and urban planning practices.

Table 5.4: Major Challenges faced by people

Primary Challenges people face during commuting	No. of people facing Challenges during Commuting.
Over-expenditure	8
Safety	11
Traffic Delays	26
Work stress	8

Figure 5.6: Major Challenges faced by people



Traffic Delays: Number of People (26), the most prominent challenge reported by commuters is traffic delays, with 26 individuals expressing concern. This indicates a significant impact on the efficiency and predictability of their daily commute.

Safety Concerns: Number of People (11), Safety emerges as a notable concern for 11 individuals during their commute. This could encompass various aspects, such as road safety, personal security, and the overall safety of transportation modes

Over-Expenditure: Number of People (8), eight individuals express concerns about over-expenditure related to commuting. This could involve expenses associated with fuel, tolls, or alternative transportation options.

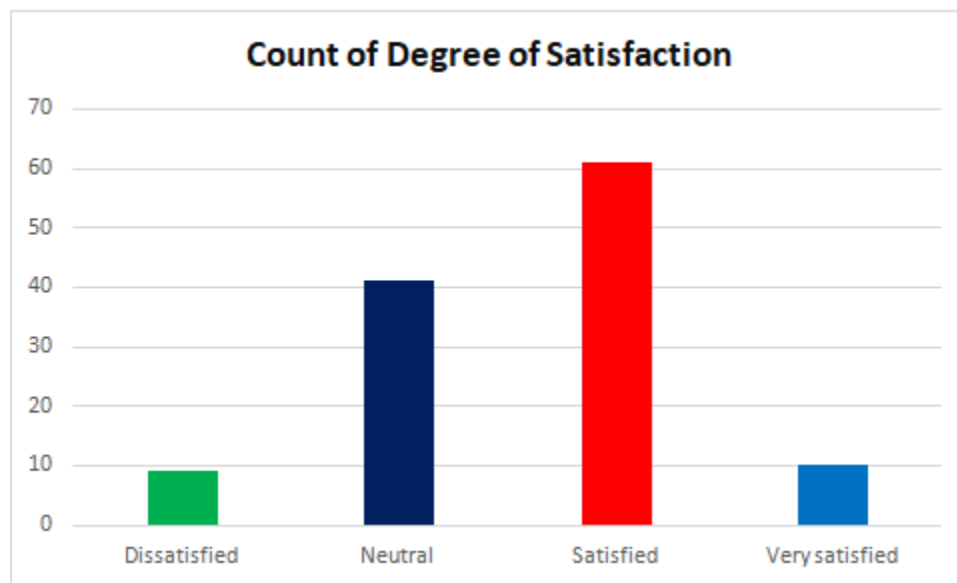
Work Stress: Number of People (8), a notable portion of individuals (8) highlights work stress as a commuting challenge. This emphasizes the psychological toll of commuting on individuals, potentially influenced by factors such as long travel times and unpredictable delays

Cross-Cutting Themes: The data reveals a complex web of challenges, with some individuals facing multiple issues simultaneously. For example, those experiencing traffic delays may also encounter safety concerns, contributing to an overall negative commuting experience.

Table 5.5: Degree of Satisfaction people have during commuting

Degree of Satisfaction	Count of Degree of Satisfaction
Dissatisfied	9
Neutral	41
Satisfied	61
Very satisfied	10

Figure 5.7: Degree of Satisfaction people have during commuting



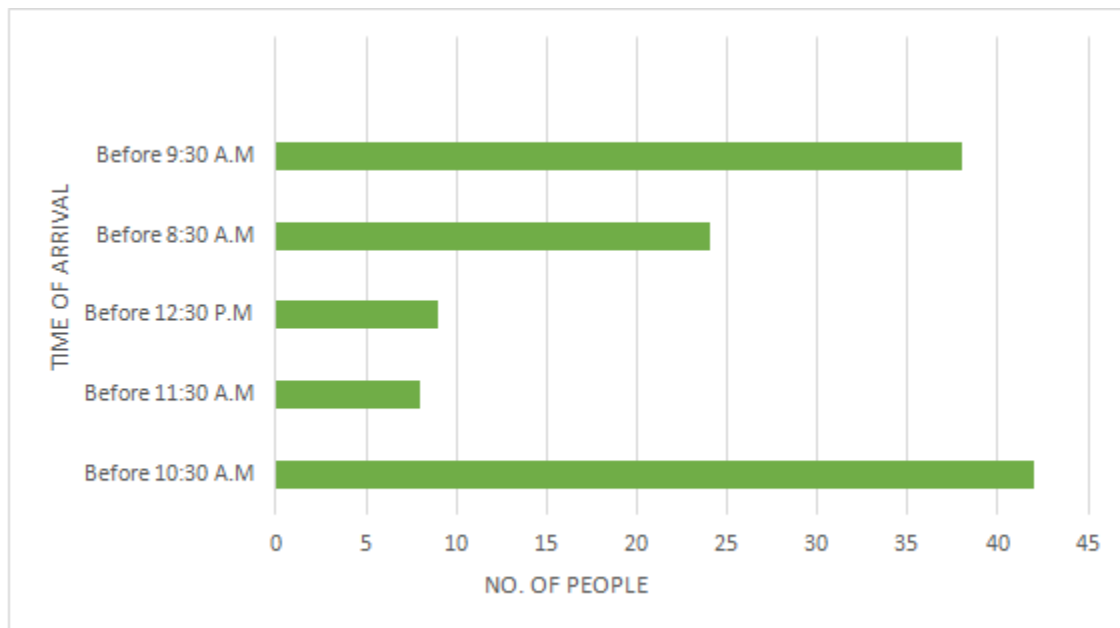
The data indicates a predominantly positive sentiment, with 61 individuals expressing satisfaction and an additional 10 very satisfied respondents. However, the presence of 41 neutral responses and 9 dissatisfied individuals suggests a diverse range of opinions. This calls for an in-depth analysis to understand specific factors influencing satisfaction levels. Administrators should consider leveraging the positive feedback, addressing concerns contributing to dissatisfaction, and exploring ways to engage individuals with neutral sentiments. The study's

significance lies in its potential to guide targeted administrative actions aimed at enhancing overall satisfaction and addressing nuanced perspectives.

Table 5.6: Traffic Congestion: Peak Hours

TIME OF ARRIVAL	NO. OF PEOPLE
Before 10:30 A.M	42
Before 11:30 A.M	8
Before 12:30 P.M	9
Before 8:30 A.M	24
Before 9:30 A.M	38

Figure 5.8: Traffic Congestion: Peak Hours

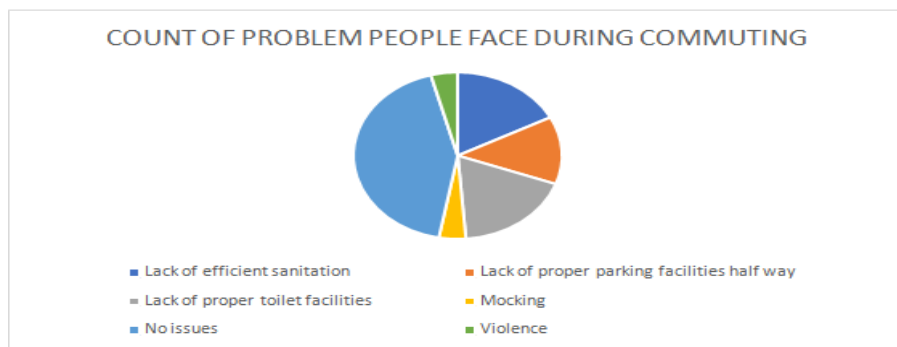


The data illustrates that the peak commuting hours are primarily concentrated before 10:30 A.M, with 42 individuals arriving during this period. There's a noticeable tapering off in arrivals after 10:30 A.M, suggesting a decline in peak activity. Administrators should focus on optimizing traffic management and public transportation services during these crucial morning hours to enhance overall efficiency for commuters.

Table-5.7: Secondary Challenges Faced by Commuters

SECONDARY PROBLEMS FACED BY PEOPLE	COUNT OF PROBLEM PEOPLE FACE DURING COMMUTING
Lack of efficient sanitation	21
Lack of proper parking facilities half way	16
Lack of proper toilet facilities	22
Mocking	5
No issues	52
Violence	5

Figure-5.9: Secondary Challenges Faced by Commuters



The data on secondary problems faced by people during commuting, along with the corresponding counts, reveals several challenges that commuters experience beyond the primary concerns.

1. **Lack of Efficient Sanitation (21):** A notable number of individuals (21) face challenges related to insufficient sanitation facilities during their commute. This issue highlights the need for improved public amenities and sanitation infrastructure.
2. **Lack of Proper Parking Facilities Halfway (16):** Sixteen individuals encounter challenges with halfway parking facilities, indicating a gap in infrastructure support for individuals who park midway during their commute. Administrators should address this to enhance convenience.

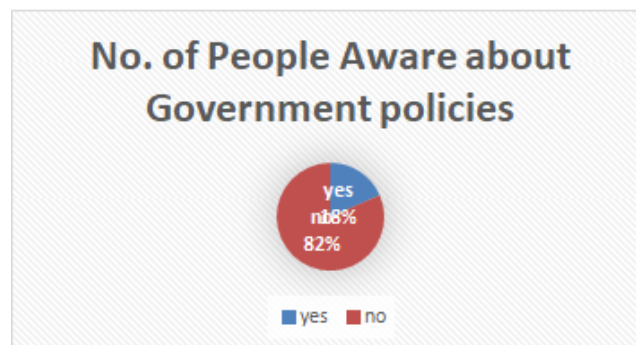
- Lack of Proper Toilet Facilities (22):** Twenty-two individuals report issues with inadequate toilet facilities during commuting. Addressing this challenge is crucial for ensuring the well-being and comfort of commuters.
- Mocking (5):** A small but significant number of individuals (5) face challenges related to mocking during commuting. This points to social and behavioural issues that may impact the overall commuting experience and requires attention from administrators.
- No issues (52):** The majority of respondents (52) report having no specific issues during their commute. While positive, administrators should consider continued efforts to maintain and enhance the overall positive commuting experience for this group.
- Violence (5):** A subset of individuals (5) reports experiencing violence during commuting. This raises concerns about commuter safety and highlights the need for security measures and awareness campaigns. Thus, Secondary challenges extend beyond typical commuting issues, encompassing sanitation, parking, social interactions, and safety concerns. Administrators should address these diverse challenges to create a more holistic and positive commuting environment.

Other Challenges:

Table 5.8: Awareness about Government Policies

Awareness among people about govt. policies.	No. of People Aware about Government policies
yes	26
no	115

Figure 5.10: Awareness About Government Policies



The data indicates a significant gap in awareness about government policies, with 115 individuals reporting they are not aware, while only 26 individuals claim awareness. This underscores the need for targeted awareness campaigns to ensure effective communication and dissemination of government policies among the public. Administrators should focus on comprehensive strategies, utilizing various communication channels, to bridge this awareness gap and foster an informed and engaged community.

Solutions:

Addressing overall administrative challenges in the context of commuting on the Delhi-Gurgaon corridor requires a multifaceted approach. Some possible solutions can be:

- 1. Integrated Traffic Management:** Implement advanced traffic management systems to optimize signal timings, monitor traffic flow in real-time, and identify congestion points. Integration of smart technologies can enhance overall traffic efficiency.
- 2. Public Transportation Enhancement:** Expand and improve public transportation services, including buses and metro connectivity. Introduce innovative solutions such as dedicated bus lanes, park-and-ride facilities, and feeder services to enhance accessibility.
- 3. Last-Mile Connectivity:** Develop comprehensive last-mile connectivity solutions, including shared mobility options, bike-sharing programs, and pedestrian-friendly infrastructure. This reduces dependency on personal vehicles and eases the transition between transportation modes.
- 4. Infrastructure Development:** Invest in the development and maintenance of robust road infrastructure, addressing bottlenecks, expanding capacity, and ensuring regular maintenance to minimize disruptions.
- 5. Regulatory Reforms:** Streamline and update regulations related to traffic management, parking, and public transportation. Encourage policies that promote sustainable commuting practices and discourage single-occupancy vehicle use.
- 6. Urban Planning Strategies:** Integrate land use planning with transportation planning to create mixed-use developments, reducing the need for long-distance commuting. Promote sustainable urban designs that prioritize walkability and accessibility.
- 7. Technology Integration:** Leverage technology for data-driven decision-making. Implement intelligent transportation systems, digital communication platforms, and mobile applications to provide real-time information to commuters and authorities.

- 8. Environmental Initiatives:** Introduce and promote eco-friendly transportation options such as electric vehicles, cycling lanes, and walking paths. Encourage initiatives that reduce the overall carbon footprint of commuting.
- 9. Community Engagement:** Foster community engagement through awareness campaigns, town hall meetings, and feedback mechanisms. Involve the public in decision-making processes related to transportation planning and infrastructure development.
- 10. Flexibility in Work Arrangements:** Encourage flexible work hours and remote work options to stagger peak commuting times. This can help distribute the traffic load more evenly throughout the day.
- 11. Safety and Security Measures:** Enhance safety measures, including improved street lighting, surveillance systems, and visible law enforcement. Implement initiatives to address concerns related to violence or harassment during commuting.
- 12. Effective Commuting Options:** Explore and promote cost-effective commuting options, including subsidies for public transportation, carpooling incentives, and employer-sponsored commuting programs.
- 13. Continuous Monitoring and Adaptation:** Regularly assess the effectiveness of implemented solutions through data analysis and feedback mechanisms. Be adaptive and willing to modify strategies based on evolving commuting patterns and needs.
- 14. Interagency Collaboration:** Foster collaboration among different government agencies, local authorities, and private stakeholders to ensure a coordinated and comprehensive approach to addressing administrative challenges.

Conclusion

In summary, the study of the landscapes of Delhi and Haryana has unearthed a myriad of challenges, spanning environmental, socio-economic, and administrative realms. Environmental woes such as pollution and climate change loom large over both regions, exacerbated by a concerning lack of awareness among the populace regarding Sustainable Development Goals (SDGs). Socio-economic challenges compound the situation, with commuters grappling with exorbitant costs and prolonged travel times, leading to heightened stress levels and compromised work-life balance. Moreover, social disparities in accessibility and affordability underscore the urgent need for policy interventions aimed at fostering greater equity.

Administrative hurdles further complicate matters, manifesting in traffic congestion, escalating expenditures, and safety concerns. These issues, stemming not just from burgeoning population but also inadequate infrastructure and policy frameworks, demand immediate attention. Mitigating these challenges necessitates a multi-pronged approach, including vigilant governmental oversight, investments in robust infrastructure, streamlined institutional collaboration, and strategic planning initiatives. By embracing these solutions, stakeholders can pave the way for a more sustainable, equitable, and resilient future for the landscapes of Delhi and Haryana.

CHAPTER 6

FUTURE PROSPECTS

With the addition of contemporary transit options, enhanced road infrastructure, and metro development, Gurgaon's future connectivity is expected to experience substantial improvements that will boost accessibility and convenience for both locals and visitors.

In order to promote economic growth, employment possibilities, urban development, quality of life enhancement, regional integration, business competitiveness, and the tourism and hospitality sectors, there is a need for improved connectivity to Gurgaon.

Several programs and policies are created and carried out in order to satisfy commuter demands and convenience. Gurgaon is gearing up for a major connectivity overhaul. A three-pronged approach involving metro expansion, revamped road infrastructure, and cutting-edge transportation solutions is set to transform the city, making it more accessible and user-friendly for both residents and visitors.

In this chapter we are studying the future of transportation and connectivity of Delhi Gurgaon corridor.

Western Peripheral Expressway

The Gurgaon-Manesar Urban Complex, which is known for Automobile Industries, Modern Commercial Malls, Towers of Cyber Parks and Software Development, is situated on prime location on National Highway Number 8, only at a distance of 4 kilometres from the Indira Gandhi International Airport and is well linked with all capitals of the world through airways.

For solving the inter-city and intra-city traffic problems of Gurgaon-Manesar Urban Complex, new road links with Delhi Metropolitan City and upcoming Sohna town have been proposed in the master plan of Gurgaon (2031) as mentioned below: –

1. 90 metres wide road link between Vasant Kunj in Delhi to Mehrauli road in Gurgaon.
2. 90 metres wide road link from Andheria Mor in Delhi to Gurgaon-Faridabad Road in Gurgaon through Mandi and Gual Pahari.
3. 150 metres wide road link between Dwarka residential complexes of Delhi to Gurgaon at National Highway number 8 before Toll Plaza towards Gurgaon.
4. 90 meters wide road link from junction of sector 63A/64 with V3(b) road of Gurgaon-Manesar Urban Complex-2031 AD to sector dividing road of sector 30/31 of Development Plan of Sohna -2031 AD

Transport Nagar

The Haryana Urban Development Authority has created a Transport Nagar on 28 hectares in sector 33. The Transport Nagar and Container Depots have been proposed next to the Garhi-Harsaru Railway Station on the Delhi-Rewari Railway line in order to meet future public demand. 45 hectares of land have been set aside for idle parking next to the settlement of Garhi Harsaru, across the railway line from the proposed wholesale market in sector 99A.

MRTS

An additional “Mass Rapid Transit System Corridor” along the 150 metres wide northern link road to Delhi extending from Dwarka in Delhi has been proposed up to Inter State Bus Terminal proposed near village Kherki Duala. The area shown under Inter State Bus Terminal is approximately 162 hectares which can be very appropriately used for Inter State Bus Terminal-cum-Mass Rapid Transit System Depot.

The alignment of Regional Rapid Transit System (RRTS) linking Delhi to Alwar via Gurgaon passes along NH-8. An Integrated Mobility Plan for Gurgaon Manesar Urban Complex (GMUC) has already been got conducted from Urban Mass Transit Co. Ltd. (UMTC) and its recommendations have been accepted by the Government.

Various recommendations have been made by UMTC for facilitating the movement of motorized, non-motorized and pedestrian traffic. These recommendations will be implemented earnestly by the executing agencies like HUDA, HSIIDC, Municipal Corporation, Gurgaon and PWD (B&R).

Transit-oriented development: New policy can push affordability in Gurgaon’s MRTS corridors

For Gurgaon residents who are tired of traffic snarls, things could change with introduction of the new Transit Oriented Development (TOD) Policy, notified by the Haryana government. Originally announced in 2014, the policy underwent various changes based on feedback received from various stakeholders and corporate bodies, before being ratified recently. As part of the policy, the TOD zone of influence will extend till 800 metres on either side from the edge of the Right of Way (ROW) of the road along which the transit network is developed, irrespective of the alignment of the Mass Rapid Transit System (MRTS).

Transit Oriented Development in Haryana

The idea is to allow for greater densification along transit corridors while also raising capital for further development of mass transit and transports services. Only group housing, mixed-use complexes and IT/ITeS are permitted usages in the TOD zones. The main beneficiaries will be the developers who have already developed projects or are holding lands in the vicinity of such transit corridors in Haryana. The MRTS corridors identified are the ones along the current operational metro corridors running in to Gurgaon and Faridabad as well the rapid metro network.

GMDA invites bids for up gradation of Southern Peripheral Road in Gurugram

GMDA invites bids for up gradation of Southern Peripheral Road in Gurugram. The project will not only benefit residents of Sectors 57-71 but also ease traffic load on the SPR connected with the Dwarka Expressway and the recently opened Sohna elevated road. The authority said construction work for the project is likely to begin early in 2023 and is expected to be completed within two years. According to projections, the volume of traffic on this road will increase manifold from 2026. The proposal for the project was approved at the 10th meeting of the GMDA on June 24 this year. The cost of this project is estimated at around \$845. The proposed project will have eight flyovers to ensure smooth movement of vehicles. The project will be completed at a cost of around \$1.5 million. The proposal was approved by the GMDA board.

Road policies of Gurgaon transport in future prospects

1. Implementation of a Robust Public Transportation System: To address the growing traffic congestion, Gurgaon needs to prioritize the development of a comprehensive and efficient public transportation system. This can be achieved by improving the existing bus network, introducing an integrated ticketing system, and expanding the reach of metro connectivity. A robust public transportation system will not only provide an affordable and convenient alternative to private vehicles but also help in reducing vehicle emissions, promoting sustainability, and creating a more equitable transport system.

2. Encouraging Non-motorized Transport Options: Gurgaon must embrace non-motorized transport options like cycling and walking to reduce the reliance on cars and lessen the burden on existing road infrastructure. The city can achieve this by building dedicated cycling lanes, pedestrian-friendly walkways, and establishing policies that promote the use of bicycles and pedestrians in urban areas. Encouraging active modes of transport not only contributes to reducing traffic congestion but also promotes a healthier lifestyle and enhances the overall liveability of the city.

3. Effective Traffic Management Systems: Technological advancements present opportunities to implement smart traffic management systems in Gurgaon. The installation of intelligent traffic signals, real-time traffic monitoring, and predictive analytics can help optimize traffic flow, prevent congestion, and improve road safety. Additionally, the integration of such systems with mobile applications that provide real-time information on traffic conditions, parking availability, and alternative routes can empower commuters to make informed decisions and reduce travel time.

4. Promotion of Electric and Shared Mobility: To combat the rising levels of pollution and reduce carbon emissions, Gurgaon should encourage electric and shared mobility options. Providing incentives for purchasing electric vehicles, establishing charging infrastructure, and introducing shared mobility services like carpooling and bike-sharing will not only reduce the number of private vehicles on roads but also contribute to achieving the city's sustainability goals. Moreover, the adoption of electric vehicles will lead to cleaner air quality, lower noise levels, and a healthier environment.

5. Integrated Land-use and Transport Planning: Gurgaon needs an integrated approach to land-use and transport planning. By creating mixed-use developments, where residential, commercial, and recreational areas are in close proximity, the need for long commutes can be reduced. Encouraging developers to include provisions for walking and cycling infrastructure within their projects will lead to a more connected and sustainable urban environment.

Regional Rapid transit system

The National Capital Region Planning Board (NCRPB), in order to enhance the connectivity within the National Capital Region, has proposed to connect the Urban, industrial (SEZs/industrial parks), regional and sub-regional centers through a Regional Rapid Transit System (RRTS).

Delhi-Gurgaon-Rewari-Alwar Regional Rapid Transit System (Delhi–Alwar RRTS) is a 164 km long proposed, semi-high speed rail corridor connecting Delhi, Gurgaon, Rewari and Alwar.

It is one of the three rapid-rail corridors planned under Phase-1 of the Rapid Rail Transport System of the **National Capital Region Transport Corporation (NCRTC)**.

With a maximum speed of 160 kmph and average speed of 105km/h, the distance between Delhi and Alwar will be covered in 104 minutes.

Some Key Highlights

- **Design Speed** – 180 kmph
- **Running Speed** – 160 kmph
- **Track Gauge Standard Gauge** – 1435 mm
- **Rolling Stock** – Aerodynamic, 3.2 m wide x 22 m long, stainless steel/aluminium body
- **Signalling** – European Train Control System Level 2 of ERTMS
- **Traction** – 1 x 25 KV AC overhead catenary
- **Coach Classes** – Economy and Business

Gurgaon Metro Project

Haryana government formed the Haryana Metro Rail Corporation (HMRC) on the lines of the Delhi Metro Rail Corporation (DMRC).

The proposed metro train connection in Gurugram will link proposed Gurugram and Old Gurugram, running from Millennium City Centre to Cyber City. The project will include 27 stations throughout its 28.50 km total length. The projected cost of construction is Rs 5452.72 crore. By building a station close to Sector 101, the Dwarka Expressway would be connected to this metro route as well.

The Gurugram Metro project will be an extension of DMRC's Yellow Line network to Old Gurugram. A separate line will connect Palam Vihar with Dwarka Sector 21, as per the plan.

The Union Cabinet last year in June approved metro connectivity between the two places. This new metro link will bolster connectivity within Gurugram as well as with the railways and airways. This project will further provide a significant boost to the economic growth of the region.

Orbital Rail Corridor

The Gurgaon district will be substantially covered by the proposed 121.742 km semi-high-speed rail line, which would connect Harsana Kalan (Sonipat) and Asaoti (Palwal) in Haryana. The route will travel via 17 stations along the Kundli – Manesar – Palwal (KMP) / Western Peripheral Expressway. Through Sohna, Manesar, and Kharkoda, passenger trains on this new broad gauge route will connect important logistical hubs, while freight trains, using the Dedicated Freight Corridor standard, will convey freight.

By avoiding Delhi and offering interchange connectivity with the Indian Railways' primary radial routes—the Delhi – SNB RRTS Line at Panchgaon, major logistic hubs, and the Dedicated Freight Corridor (DFC) at Pirthala (near Palwal)—the orbital rail corridor will further improve connectivity. Gurgaon will benefit from five stations: Dhulavat, Chandla Dungarwas, Panchgaon, Manesar, and New Patli. The orbital corridor will make it easier for Shatabdi trains to run from Gurugram to Chandigarh, avoiding Delhi, which is an important advantage for daily passengers. This is a noteworthy feature of the project. In addition, a railway line will link the corridor to the Maruti Plant in Manesar.

Conclusion

Gurgaon's future connectivity is expected to improve with contemporary transit options, improved road infrastructure, and metro development.

In order to alleviate traffic congestion, the Gurgaon-Manesar Urban Complex, situated on National Highway Number 8, is set to receive new road links with the Delhi Metropolitan City and Sohna town. These links will be 90 meters wide and connect Vasant Kunj to Mehrauli road, 150 meters wide and connect Dwarka residential complex to Gurgaon, and 90 meters wide and connect the junction of sector 63A/64 with V3(b) road to sector 30/31 of the Sohna development plan.

The Haryana Urban Development Authority has proposed a 28-hectare Transport Nagar and Container Depots near the Garhi-Harsaru Railway Station on the Delhi-Rewari Railway line. Additionally, 45 hectares of land have been set aside for idle parking. An additional "Mass Rapid Transit System Corridor" is being proposed along the 150-meter northern link road to Delhi, extending from Dwarka to the Inter State Bus Terminal near Kherki Duala. An Integrated Mobility Plan for Gurgaon Manesar Urban Complex has been approved by the government.

The Haryana government has introduced the Transit Oriented Development (TOD) Policy, which aims to improve traffic in Gurgaon by extending the TOD zone of influence to 800 meters from the road's Right of Way, regardless of the Mass Rapid Transit System alignment.

The Regional Rapid Transit System (RRTS), which would link urban, industrial, regional, and sub-regional areas, is one of the ways the National Capital Region Planning Board (NCRPB) intends to improve connectivity. The 164-kilometer Delhi-Gurgaon-Rewari-Alwar Rapid Rail Transit System is designed to travel 104 minutes at a top speed of 160 kmph.

The Haryana government has formed the Haryana Metro Rail Corporation (HMRC) to connect Gurugram and Old Gurugram, with a 28.50 km project costing Rs 5452.72 crore. The project also includes a Dwarka Expressway connection.

Harsana Kalan and Asaoti in Haryana will be connected by the projected 121.742 km semi-high-speed rail line, which will travel through 17 stations on the Kundli – Manesar – Palwal (KMP) / Western Peripheral Expressway.

CHAPTER 7

CONCLUSION

The project examined the relationship between Urban Sprawl and Commuting pattern on an urban corridor formed between Delhi and Gurgaon, and accounts for the different attributes of Vehicular Commuting in a part of the Metropolitan region of Delhi. Particularly the Reverse Commuting from Delhi to Gurgaon is under the study. The issues explored are related to urban sprawl and commuting in Delhi-Gurgaon corridor of NCT of Delhi considering Delhi as the Point of Origin and Gurgaon as that of Destination. There is an interrelationship between the urban sprawl and patterns of commuting to the city, facilitating particularly the journey to work.

Urban Sprawl not only involves the commuting from the suburb to the main city, but also the a 'Reverse Commuting' to suburbs. The behavioural responses of commuters between the Place of origin and destination reflected in the parameters like: Flow-Network, Mode-Choice, Travel-Distance, Time, Cost and Frequency of Communication.

The study area encompasses Delhi and Gurugram, integral parts of the National Capital Region (NCR), offering a rich blend of topography, natural surroundings, and socio-economic dynamics. Gurugram, also known as Gurgaon, stands as a prominent satellite city in Haryana, situated amidst the fertile plains of the Yamuna River. Characterised by a relatively flat terrain with undulating features, Gurugram lies at the northern edge of the Aravali Mountain range. Its climate reflects the typical patterns of the Indian subcontinent, with hot summers, monsoon rains from July to September, and mild winters. The region's natural vegetation, influenced by its semi-arid environment, includes native shrubs and grasses, alongside the Aravalli Biodiversity Park, displaying diverse flora and fauna. Socio-economically, Delhi and Gurugram exhibit distinct characteristics. Delhi, a pot of cultural diversity, ranks among the top in terms of per

capita income and is spread across various sectors such as trade, finance, and professional services. Its historical significance, coupled with modern economic aims, has led to its emergence as a global hub. Gurugram, on the other hand, has experienced rapid urbanisation driven by industries and commercial ventures. With a growing population and a flourishing industrial landscape, Gurugram has become a magnet for investment and development. Educationally, both cities boast prestigious institutions and a high literacy rate, contributing to their intellectual human resource. Furthermore, the transportation infrastructure between Delhi and Gurugram is robust, featuring major highways, expressways, and metro networks facilitating excellent connectivity. The Delhi-Gurugram corridor, featured by arteries like NH-48 and M.G. Road serve as lifelines for both commuters and businesses. These corridors not only enhance connectivity but also drive economic activities and shape the socio-economic landscape of this region. In essence, Delhi and Gurugram stand as vibrant metropolitan centres, symbolising India's socio-economic dynamism and cultural diversity.

The Commuters between Delhi and Gurgaon are a varied bunch - professionals, students, daily wage earners - united by their daily trek. Public transport (metro, buses) is common, but traffic congestion is a major hurdle. Long commutes and air pollution take a toll on well-being. Solutions include improved public options, promoting cycling/carpooling, and flexible work arrangements to ease congestion and improve work-life balance.

The exploration of commuting dynamics within the Delhi-Gurgaon corridor offers profound insights into the intricate life of commuters. As we dissect the components influencing commuting dynamics, it becomes evident that Gurgaon's Cyber Hub emerges as a nucleus of professional activity, drawing individuals from various corners. Factors such as corporate presence, commercial vibrancy, modern infrastructure, networking opportunities, and robust connectivity contribute to its magnetism, transforming it into a preferred destination for work and leisure alike. As we reflect on the myriad factors influencing commuting behaviours, it becomes clear that the quest for efficient, sustainable transportation solution is paramount. Public transport emerges as a cornerstone of mobility, offering affordability, accessibility, and sustainability to approximately 50% of the commuters. Conversely, 25% commuters opt for private transportation, characterized by personal vehicles and ride-hailing services, caters to those valuing flexibility and convenience. The frequency of trips reflects a diverse spectrum of mobility patterns, with 74% majority engaging in moderate levels of travel, falling within a bracket of 40-50 trips per month and 1% minority taking more than 50 trips per month. Time investments in commuting underscore the challenges posed by traffic congestion, and geographical distances with 56% commuters spending over an hour traversing the corridor. Expenditure on travel unveils economic disparities and underscore the importance of accessible and cost-effective transportation solutions. As from analysis, this is clear that people spend a

minimum of Rs.2000 to more than Rs.5000 in a month on commuting. The delineation of expenditure brackets provides insights into commuting habits, journey distances, and financial capacities, emphasizing the need for inclusive transportation infrastructure and policy interventions.

The study of the landscapes of Delhi and Haryana has unearthed a myriad of challenges, spanning environmental, socio-economic, and administrative realms. Environmental woes such as pollution and climate change loom large over both regions, exacerbated by a concerning lack of awareness among the populace regarding Sustainable Development Goals (SDGs). Socio-economic challenges compound the situation, with commuters grappling with exorbitant costs and prolonged travel times, leading to heightened stress levels and compromised work-life balance. Moreover, social disparities in accessibility and affordability underscore the urgent need for policy interventions aimed at fostering greater equity. Administrative hurdles further complicate matters, manifesting in traffic congestion, escalating expenditures, and safety concerns. These issues, stemming not just from burgeoning population but also inadequate infrastructure and policy frameworks, demand immediate attention. Mitigating these challenges necessitates a multi-pronged approach, including vigilant governmental oversight, investments in robust infrastructure, streamlined institutional collaboration, and strategic planning initiatives. By embracing these solutions, stakeholders can pave the way for a more sustainable, equitable, and resilient future for the landscapes of Delhi and Haryana.

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